Dendrological Studies of the Japanese and Some Foreign Genera of the Thymelaeaceae

—Anatomical and Phylogenetic Studies—

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CONTENTS

INTRODUCTION

It has been the object of my consecutive studies to enlarge and revise our dendrological knowledge of the Thymelaeaceae in Japan and the adjacent regions. A part of the results was already published in the previous paper (1955 b). Though it was rather merely descriptive, it suggested that comprehensive studies in anatomy of them might advance our knowledge on their phylogenetic relationship better than the studies in external morphology, and that the pentamerous species of *Daphne* and *Wikstroemia* in China (especially in the western regions) might take an important rôle in the phylogenetic interpretation. On the other hand, it has left some pending questions with respect to the taxonomic conception of the Japanese species.

In this study, I at first investigated the anatomical characters of wood and

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bark of the Japanese species, then anatomically studied the leaves of the pentamerous species listed by REHDER in SARGENT, Pl. Wilson. Vol. 2, the specimens or fragments of which had been loaned or given me by Dr. C. E. KOBUSKI, Curator of the Herbarium of the Arnold Arboretum, and Dr. R. A. HOWARD, Director of the Arboretum, through the introduction of Dr. H. HARA, University of Tokyo. I, at the same time, examined the anatomical as well as the exomorphic characters, to which I gave special attentions in this and the preceding studies, about foreign species as many as possible — based on literature only when circumstances compelled it —, and, on its ground, tried to search out the phylogenetic relationship between the Japanese genera. For the latter purpose, I extended the scope of study to all the tribe *Daphneae* in DOMKE's sense with exception of the subtribe *Daphnopsinae*, as mentioned later.

There are a few systematic studies from the standpoint of anatomy, e. g. of VAN TIEGHEM (1893), SUPPRIAN (1894) and LÉANDRI (1930), mainly based on the characters other than those of the adult wood. The taxonomic value of the characters adopted by the former two authors was severely rejected by GILG (1894 b), and limited in its application by SUPPRIAN himself. DOMKE (1934), who criticized LÉANDRI's results, and METCALFE and CHALK (1950) pointed out that "the microscopical variation" is "of value for the diagnosis of genera rather than tribes or groups of higher rank" in this family. I likewise think, on the basis of my studies, that LÉANDRI's mechanical application of his results to GILG's system based on the knowledge of exomorphic characters is unreasonable, apart from his hasty conclusion with respect to the arrangement of vessels in the young axes. But I think that the anatomical characters are very valuable to consider the relationships between sections, genera or groups of higher rank under the close comparison or combination with the exomorphic characters, in some cases even more valuable than the latter.

The system of the Japanese Thymelaeaceae published in the previous paper also accepted some revisions in specific rank, resulting from the researches in the pending problems and from the examination of specimens deposited in main herbaria in Japan, accompanied by the revision of the distribution maps.

I wish to express my gratitude to Professor T. INOKUMA and Assist. Professor S. KURATA who kindly leaded and encouraged me in this study, and to Mr. K. SHIMAJI who gave me very helpful advices on the anatomical problems. My sincere thanks are also due to Dr. H. HARA for introducing me to Dr. C. E. KOBUSKI and Dr. R. A. HOWARD, and to Dr. S. WATARI, University of Tokyo, for his useful advices about some techniques. I am greatly indebted to the directors and curators of the following herbaria who gave me facilities for examining specimens or for the loan of materials:

Arnold Arboretum, Harvard University, Cambridge, U. S. A. (A).
The Botanic Garden, Göteborg C, Sweden (G).

Forestry Department, Faculty of Agriculture, University of Kagoshima, Kagoshima (KAG).

Botanical Institute, Faculty of Agriculture, Hokkaidô University, Sapporo (SAP).

Botanical Institute, Faculty of Science, Hokkaidô University, Sapporo (SAPS).

Botanical Institute, Faculty of Science, University of Tokyo, Tokyo (TI).

National Science Museum, Tokyo (TNS).

Institute of Forest Botany, Faculty of Agriculture, University of Tokyo, Tokyo (TOFO).

Biological Institute, Faculty of Science, Tôhoku University, Sendai (TUS).

Part I. ANATOMICAL STUDIES OF THE JAPANESE SPECIES

Materials and Methods. Wood materials for this study are enumerated before the description of each species. The specimens with numbers were taken from the collection of Institute of Forest Botany, Faculty of Agriculture, University of Tokyo. Those with no citation of personal names are my own collections.

Most of them were with bark, and some were preserved in formal acetic alcohol immediately after they were collected. Treatment before cutting was either softening by boiling in water or steeping in hydrogen fluoride. Some specimens were embedded in celloidin. Sections cut with the sliding microtome were double stained with safranin and DELAFIELD's haematoxylin or fast green. Materials macrated with SCHULZE's solution also were examined.

The following abbreviations are used in the descriptions of the wood anatomical characters:

D. and D′.: radial and tangential diameter, respectively, of vessels, tracheids, fiber-tracheids and wood parenchyma cells.
L.: longitudinal length of the same elements.
W.: tangential width of ray cells.
R.: radial length of ray cells.
H.: height of ray cells.
Th.: thickness of cell walls.
P.: longer diameter of pits and inner apertures of each element.

These abbreviations are likewise used for bast fibers, but the diameter (D.) was measured on the macerated material of bark.

§ 1. The Wood Anatomy

Wikstroemia ENDL.

1. **Wikstroemia pseudoretusa** KOIDZ. (Pl. I, A, B, D; Pl. VIII, B).

1) Isl. Hahajima, Bonin (No. 7758).

(i) The macroscopical characters.

Wood light brownish white, no scent, light and soft. Growth rings indistinct.

Pores visible with a hand lens, solitary or in radial or tangential groups, exhibiting no variation in size indicative of growth rings. Parenchyma hardly visible to the naked eyes, forming short oblique masses or tangential bands, including pore groups. Multiseriate rays plainly visible under a hand lens. Parenchyma and multiseriate rays lighter than the back ground. Fibrous tissue lustrous on the longitudinal surface.

(ii) The microscopical characters.

a) Arrangement of elements.

Vessels: evenly distributed, solitary or every 2–10 in a group, forming clusters or oblique, tangential and sometimes radial groups, occasionally intermingled with a few parenchyma cells, those in clusters often tangentially flattened, round except the intervascular walls, moderately thick-walled, longitudinal lines of vessels usually straight.

Tracheids: few vascular (or vasicentric) tracheids contiguous to vessels.

Wood parenchyma: paratracheal and apotracheal; *paratracheal* parenchyma usually somewhat abundant on the abaxial side of vessels, short aliform or sometimes confluent, on the adaxial side sparse, *apotracheal* parenchyma restricted to the occasional cells or groups in the vicinities of vessels.

Fiber-tracheids: irregular in radial series, composing the ground mass of the wood, with no remarkable variation in size, thin-walled, only rarely twisted with each other at their ends, often arranged in irregular horizontal series in radial sections.

Wood rays: homogeneous Type I* or nearly so, 1–6 (mostly 1–3)-seriate; multiseriate rays numerous, up to 47 cells and 550 μ high, ca. 70 μ wide; uniseriate rays occasionally in part biseriate, 1 to ca. 20 cells and 21–380 (–480) μ high, bended at the supposed growth ring boundaries.

b) Description of elements.

Vessels: D. 15–126 μ, D′. 15–85 μ, L. 120–350 μ, Th. 2–4 μ; truncate or abruptly or attenuately tailed at one or both ends; perforations simple, nearly horizontal or oblique; intervascular pits alternate, orbicular to oval or angular through crowding, bordered, P. ca. 3–5 μ, apertures horizontal to moderately oblique, lenticular and often 2 or a few apertures coalescent on vessel members of large diameter, pits to rays or parenchyma similar and numerous.

Tracheids: L. ca. 105–220 μ, similar to fibriform vessel members or short fiber-tracheids in the outline; pits numerous, similar to those of vessels. Rarely strand tracheids present, contiguous to parenchyma strands.

Wood parenchyma (Fig. 1, D): usually parenchyma strands much more numerous than fusiform cells, D. 10–45 μ, D′. 8–35 μ, L. (fusiform) 140–310 μ, (2-cell strand) 130–300 μ, (3-cell) 190–265 μ, Th. ca. 1 μ, simple pits usually more numerous on radial walls.

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* The ray type follows Kribs's sorting.

Fiber-tracheids (Fig. 1, H): D. up to 54 μ, D′. up to 30 μ, L. (270-) 420-900 (-1020) μ, Th. 1-2.5 μ; abruptly or very gradually tapered at the ends; inter-fiber pits sparse, rarely nearly as many as in tracheids, bordered, P. ca. 2.5-6 μ, apertures linear, steep or slightly oblique, faintly extended.

Wood rays (Fig. 1, A, B): W. 6-33 μ, R. 19-160 μ, H. 8-90 μ, Th. 1-1.5 μ; mostly procumbent, but those in the marginal rows radially short, procumbent to square in the uniseriate rays, round in tangential sections; pits small, the outline similar to those of tracheary elements.

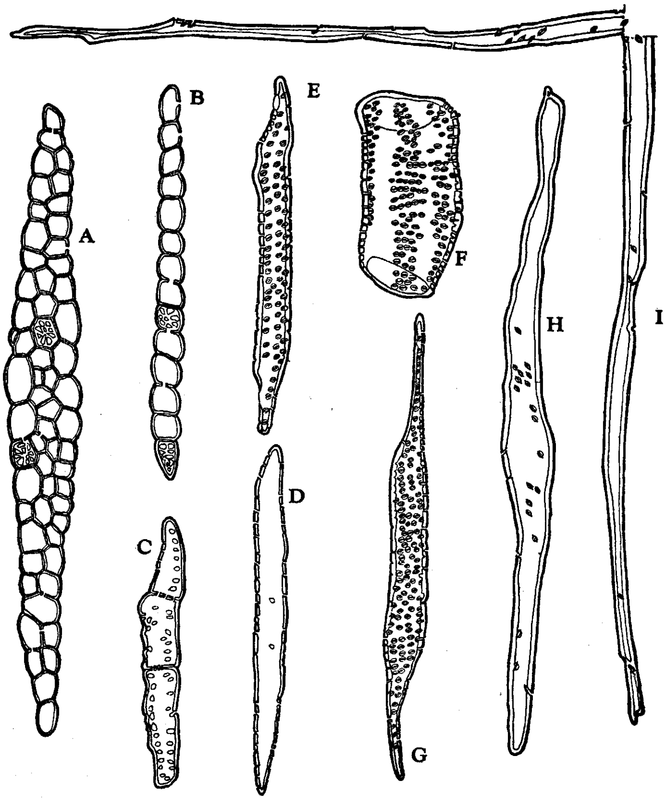

Fig. 1. A, B, D, H: *Wikstroemia pseudoretusa*. C, E, F, I: *W. retusa*. A-B: rays, A (460 μ), B (285 μ). C: parenchyma strand (200 μ). D: fusiform parenchyma cell (250 μ). E-F: vessel members, E (250 μ), F (140 μ). G: tracheid (360 μ). H-I: fiber-tracheids, H (485μ), I (930μ).

2. **Wikstroemia retusa** A. GRAY (Pl. I, C).

1) Okinawa (No. 3870) and 2) a 3-year-old plant cultivated in the research field of Institute of Forest Botany, Faculty of Agriculture, University of Tokyo.

(i) The macroscopical characters.

Similar to *W. pseudoretusa*.

(ii) The microscopical characters.

Similar to *W. pseudoretusa* except the following characters.

a) Arrangement of elements.

Wood parenchyma: richer than the preceding species, and as abundant on the lateral as on the abaxial side of vessels and more conspicuously aliform or confluent.

Fiber-tracheids: partially regular in radial series, not so in horizontal series.

Wood-rays: 1-5 (mostly 1-4)-seriate, multiseriate rays up to 28 cells and 625 μ high; uniseriate rays 1-several cells and 15-300 (-525) μ high; remarkably bended at the supposed growth ring boundaries.

b) Description of elements.

Vessels (Fig. 1, E, F): D. 17-105 μ, D′. 15-92 μ, L. 130-280 μ, Th. 2-5 μ, intervascular pits P. 4–5 μ.

Tracheids (Fig. 1, G): similar to small vessel members.

Wood parenchyma (Fig. 1, C): 2–3-cell strands ca. 80% of all, D. 10–34 μ, D′. 10–30 μ, L. (fusiform) 120–250 μ, (2-cell strand) 140–250 μ, (3-cell) 150–265 μ, (4-cell) 200–260 μ, Th. ca. 1–2 μ; rarely forming a strand with tracheids.

Fiber-tracheids (Fig. 1, I): D. up to 45 μ, D′. up to 30 μ, L. (160–) 300–1210 μ, Th. 1–2 μ, inter-fiber pits P. 3–5.5 μ.

Wood rays: W. 5–38 μ, R. 14–100 μ, H. 10–95 μ, Th. 1–2 μ.

Edgeworthia MEISSN.

1. **Edgeworthia chrysantha** LINDLEY (Pl. II, A—D; Pl. VIII, C).

1) Government Forest Experiment Station, Tokyo (cult., No. 1064), 2) ex Beppu Branch Station, Forest Experiment Station of Kôchi Prefecture (cult., Kôchi- and Shizuoka-race, Feb. 25, 1957), 3) ex Kôchi Regional Forestry Office, Kôchi (No. 7470), 4) ex Shimizu Forestry Station, Kôchi Pref. (No. 9832), 5) Oginoiri, Mt. Amagi, Prov. Izu (Apr. 30, 1955) and 6) Mt. Ena, Prov. Mino (Aug. 19, 1955).

(i) The macroscopical characters.

Fresh wood greenish yellow-white; pith light greenish, ca. 3 mm in diameter; foliar rays white; grassy-smelling. Dried wood light brownish or yellowish white, no scent, light and soft. Growth rings distinct under a hand lens, up to ca. 5 mm wide. Early wood about half of the ring, pores visible with a hand lens, solitary or in small groups, evenly diffused or often forming loose radial, tangential or oblique rows; transition in size gradual. Late wood pores hardly or not visible. The light-coloured tissue (parenchyma) under a hand lens forming small diffuse masses including pores, the masses conspicuous especially in the late wood, often having short tangential wings or forming narrow concentric bands which connect between diffuse pores. The margins of the rings also often light-coloured. Rays barely or easily visible with a hand lens. Longitudinal surface lustrous.

(ii) The microscopical characters.

a) Arrangement of elements.

Vessels: diffuse porous; large *early* wood vessels solitary or in small groups of 2–3 (rarely more), in narrow growth rings tending to be gathered in radial or tangential rows, moderately thick-walled, more or less angular except the flattened intervascular walls; small *late* wood vessels solitary or in small clusters or short radial chains and rarely (specimen 3) in very loose concentric rows which occur at long radial intervals, very thick-walled, polygonal with round narrow lumina; transition in diameter from early wood to late wood very abrupt or somewhat gradual; number per mm^2 and distribution comparatively variable by specimens; longitudinal lines of vessels somewhat curved in tangential sections; sparse deposits occasionally present.

Tracheids: typical ones rare.

Wood parenchyma: apotracheal, confluent and aliform; *apotracheal* parenchyma 1–2-seriate banded or diffuse and sometimes terminal narrow, *confluent* and short or long *aliform* parenchyma 1-2-seriate but scanty around vessels, in late wood often forming distinctly concentric narrow bands at long or short radial intervals; parenchyma generally less abundant in early wood; crystalliferous cells occasionally observed in wood parenchyma; pith flecks rarely present.

Fiber-tracheids: composing the ground mass of the wood, transition in diameter very gradual or nearly uniform, cells in terminal part only a little radially flattened, irregular in radial series, very rarely forming zones of thick-walled cells within an annual ring; often arranged in somewhat regular horizontal series in radial sections.

Wood rays: heterogeneous Type III (or I) or often nearly homogeneous Type III, mostly uniseriate, frequently in part or in all length 2(-4)-seriate and often two rays connecting at the ends in tangential sections, numerous, 1-53 (mostly 4-25) cells and 40-1200 (-1800)μ high, up to 91μ wide.

b) Description of elements.

Vessels (Fig. 2, D—F): in *early* wood, D. 15-180μ, D′. 12-135μ, L. (140-)170-370(-425)μ, Th. 1-4μ, truncate or slightly oblique at the ends, perforations simple. intervascular pits densely alternate to scattered, oval or angular through crowding, P. 4-10μ, apertures horizontal or nearly so, lenticular, included or screw-head, sometimes 2 or a few apertures coalesced, pits to rays or parenchyma similar and numerous, often in groups; in *late* wood (Fig. 2, E, F), D. 8-60(-100)μ, D′. 6-70μ, L. 145-360μ, Th. 2-7 (rarely to 15)μ, truncate or abruptly or attenuately tailed at the ends, perforations simple, pits similar to those of early wood vessels, P. 3-5μ.

Wood parenchyma (Fig. 2, B, C): mostly fusiform, parenchyma strands few to at most 50% of all, D. 4-47μ, D′. 8-41μ, L. (fusiform) 130-305μ, (2-cell strand) (135-)180-350μ, Th. 1-1.5μ; simple pits angular or round, often several or more

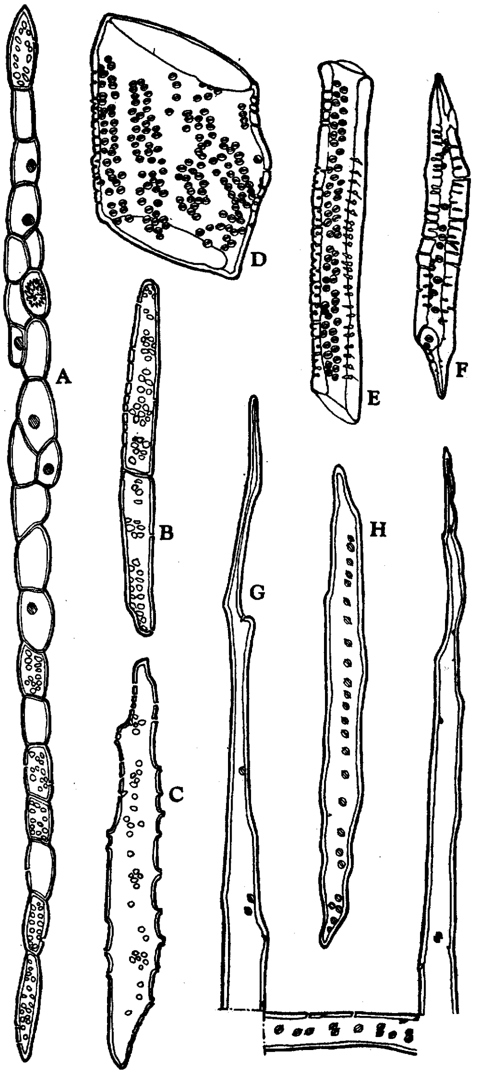

Fig. 2. *Edgeworthia chrysantha.* A: yar (650μ). B: parenchyma strand (265μ). C: fusiform parenchyma cell (300μ). D: early wood vessel member (150μ). E-F: late wood vessel members, E (280μ), F (230μ). G-H: fiber-tracheids, G (930μ), H (370μ).

in groups.

Fiber-tracheids (Fig. 2, G, H): D. up to 70 μ, D′. up to 47 μ, L. (195–)260–1230 μ, Th. 0.7–2 μ, abruptly or long tapered at the ends; inter-fiber pits sparse, oval, borders very incomplete on the thin walls (but not simple as SOLEREDER noted), P. ca. 3–6 μ, apertures lenticular, oblique or horizontal, barely extended.

Wood rays (Fig. 2, A): W. 5–45 μ, R. 16–145 μ, H. 12–200 μ, Th. ca. 1 μ, procumbent to square or upright, the latter appearing in the marginal or central rows and in the ends of the growth rings; central cells elliptic or cornered and marginal cells acute at the apex in tangential sections; pits similar to those of wood parenchyma; druses of calcium oxalate commonly present, crystalliferous cells solitary or 2 to a few in rows.

Diplomorpha MEISSN.

1. **Diplomorpha trichotoma** NAKAI (Pl. III, A).

1) Hôrigawa, Prov. Hiuga (Aug. 8, 1952), 2) no loc., Prov. Hiuga (No. 5584), 3) Mt. Rokkô, Prov. Settsu (Apr. 19, 1957) and 4) Mt. Futatabi-san, Prov. Settsu (Apr. 28, 1957, S. NAKANISHI).

(i) The macroscopical characters.

Wood light greenish yellow or light brownish when fresh, turning to light brown or brownish white when dry, no scent, light and soft. Growth rings distinct to the naked eyes. Early wood pores visible under a hand lens, diffuse porous, loosely ring porous in narrow rings. Late wood pores not or barely visible. The light-coloured tissue forming narrow terminal bands from which small masses are often directed inwards in narrow rings. Rays hardly visible under a hand lens, lighter than the back ground. Tangential surface somewhat lustrous.

(ii) The microscopical characters.

a) Arrangement of elements.

Vessels: usually diffuse porous; *early* wood vessels frequently arranged in close initial 1–2 rows especially in narrow rings, a few to many within an interval of rays, often a vessel or a group of vessels occupying all the width of a narrow ring, transition in diameter gradual or somewhat abrupt, polygonal or nearly so, often tangentially flattened; *late* wood vessels solitary, in small clusters or in loose radial rows or streams, often indistinct from fiber-tracheids in diameter; moderately thick-walled; longitudinal lines of vessels mostly straight; sparse deposits occasionally present in tracheary elements.

Tracheids: terminal and occasionally tangential bands of 1–6 (rarely to 11 or more) rows, often transitional to the fiber-tracheids, in specimen 1) and its root wood the growth rings becoming very irregular and tracheids arranged in irregular or radial groups (not in bands), the tangential bands usually narrow and irregular (thick-walled fiber-tracheids ?), often intermingled with small vessels; tracheids arranged in regular series, 4–6-angular, thick-walled.

Wood parenchyma: terminal 1–2 (or 3)-seriate and occasional cells contiguous to large early wood vessels, in irregular growth rings parenchyma bands often interrupted.

Fiber-tracheids: composing the ground mass of the wood, 4-several-angular, usually irregular in radial series, transition in diameter gradual, thin-walled; often irregularly storied in radial sections.

Wood rays: homogeneous Type III or in a few cases nearly heterogeneous Type III, moderate in number, mostly uniseriate but occasionally in part 2-3-seriate, many 2-4-seriate rays observed partially in specimen 3), often dense deposits present in the same specimen, usually high and narrow in tangential sections, 2-62 (mostly 6-20) cells and 45-1000(-1500) μ high, but in specimen 1) 1-17 (mostly 3-9) cells and 35-480 μ high, up to ca. 48 μ wide.

b) Description of elements.

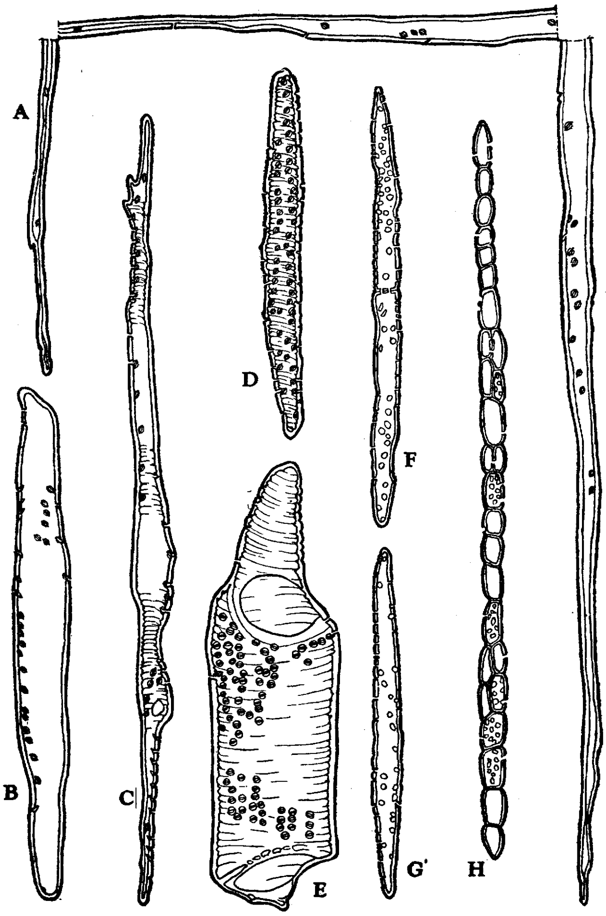

Fig. 3. A, C, D, *Diplomorpha yakushimensis*. B: *D. Ganpi*. E-G: *D. sikokiana*. H: *D. pauciflora*. A-B: fiber-tracheids, A (1100 μ), B (345 μ). C: transitional form between vascular tracheid and fiber-tracheid (480 μ). D: tracheid (235 μ). E: vessel member (320 μ). F: parenchyma strand (315 μ). G: fusiform parenchyma cell (250 μ). H: ray (525 μ).

Vessels: D. 15-120 μ, D'. 15-90 μ, L. 85-360(-565) μ, Th. 1.5-3(or 4) μ, truncate or abruptly or short attenuately tapered at the ends; perforations simple, horizontal to steeply oblique; spiral thickenings absent or slightly linear on large vessels, very conspicuous on small vessels; intervascular pits densely alternate or scattered, numerous and oval or angular in large vessel members, less numerous in small or slender members, P. 5-7 μ, apertures horizontal to slightly oblique, lenticular, included or screwhead, pits to rays or parenchyma similar and numerous.

Tracheids: D. 5-17 μ, D'. 8-30 μ, L. (100-)190-400 (-735) μ, Th. up to 2 or 3 μ, mostly with conspicuous spiral thickenings, abruptly or attenuately tapered at the ends, sometimes similar to fiber-tracheids with spiral thickenings, sometimes to small vessel members (fibriform), occasionally strand tracheids present, pits numerous or sparse, P. ca. 4–7 μ, apertures slit-like, oblique.

Wood parenchyma: fusiform or 2 (or 3) cells in a strand, the latter few or predominant and variable with parts or specimens, D. 5–35 μ, D′. 7–35 μ, L. 110–455 μ, Th. ca. 1–1.5 μ, simple pits round, numerous in parts, often several crowded.

Fiber-tracheids: D. up to 55 μ, D′. up to 40 μ, L. 130–790(–1200) μ, Th. 1–1.5 (or 2.5) μ, short fusiform or moderately long by specimens, very rarely 2 cells forming a strand, acute or abruptly or attenuately tapered and frequently divided at the ends, occasionally with linear thickenings at the tails or other parts; inter-fiber pits oval, P. ca. 4–5 μ, apertures lenticular or slit-like, oblique or steeply so, screwhead or a little extended.

Wood rays: W. 5–25 μ, R. 11–115 μ, H. 7–100 μ, Th. ca. 1 μ, mostly procumbent, cells in the marginal rows procumbent to square, those in low rays often exclusively upright, oblong or round in the tangential view, pits similar to those of wood parenchyma.

2. **Diplomorpha albiflora** NAKAI.

1) Mt. Ohkue, Prov. Hiuga (Aug. 9, 1952) and 2) Mt. Ohdaigahara, Prov. Yamato (May 22, 1955, S. KURATA).

(i) The macroscopical characters.

Similar to *D. trichotoma*.

(ii) The microscopical characters.

Similar to *D. trichotoma*, except the following characters.

a) Arrangement of elements.

Fiber-tracheids: often thick-walled in the terminal part of growth rings, often together with tracheids forming radial masses directed inwards from the terminal tracheid bands in irregular rings.

Wood rays: usually heterogeneous Type III and in part of specimen 2) 10–30% of all rays 2–3-seriate, rarely the ends of fiber-tracheids bending along the margin of rays in radial direction, 1–29 (mostly 3–14) cells and 30–650 μ high, up to 40 μ wide.

b) Description of elements.

Vessels: D. 11–78 μ, D′. 10–88 μ, L. 110–355 μ, Th. 1.5–2.5 μ; pits oval, P. 5–6 μ.

Tracheids: D. 5–14 μ, D′. 10–22 u, L. (100–) 145–495 μ, Th. ca. 2 μ; pits P. 3–5 μ.

Wood parenchyma: D. 5–20 μ, D′. 6–29 μ, L. 150–280 μ, Th. ca. 1 μ, parenchyma strands up to about half of all.

Fiber-tracheids: D. up to 45 μ, D′. up to 40 μ, L. 150–680 μ, Th. 1–2 μ; pits P. 4–5 μ.

Wood rays: W. 4–30 μ, R. 7–100 μ, H. 7–80 μ, Th. 1–1.5 μ.

3. **Diplomorpha Ganpi** NAKAI.

1) ex Kôchi Regional Forestry Office (No. 7426), 2) Onoaida, Isl. Yaku (Au2. 15, 1956) and 3) Mt. Rokkô, Prov. Settsu (Apr. 19, 1957).

(i) The macroscopical characters.

Similar to *D. trichotoma.*

(ii) The microscopical characters.

Similar to *D. trichotoma* except the following characters.

a) Arrangement of elements.

Vessels: vessels except those in the initial part arranged in radial or oblique streams in higher tendency and transition in diameter from early wood to late wood usually more gradual than in *D. trichotoma.*

Wood parenchyma: beside the terminal parenchyma, rarely occasional cells contiguous to solitary vessels or groups of vessels in specimen 3).

Fiber-tracheids: often forming false rings in part, more thick-walled in early wood than in late wood in some specimens.

Wood rays: nearly homogeneous Type III; 1–40 (mostly 3–16) cells and 30-860μ high, up to 35μ wide.

b) Description of elements.

The spiral thickenings in each element are usually somewhat slighter than in the preceding species.

Vessels: D. 14–103μ, D′. 12-86μ, L. 100-350μ, Th. 1.5-2μ; pits P. 4-6μ.

Tracheids: D. 4-16μ, D′. 7-24μ, L. 130-370μ, Th. up to 2μ; pits P. ca. 4μ.

Wood parenchyma: D. 5-28μ, D′. 7-26μ, L. 130-315μ, Th. ca. 1μ, parenchyma strands up to about 40% of all.

Fiber-tracheids (Fig. 3, B): D. up to 50μ, D′. up to 41μ, L. 160-760μ, Th. 0.7-2μ; pits P. ca. 4-5μ.

Wood rays: W. 5-35μ, R. 10-100μ, H. 8-118μ, Th. ca. 0.7-1μ.

4. **Diplomorpha pauciflora** NAKAI.

1) Mito, Prov. Idzu (Apr. 21, 1957).

(i) The macroscopical characters.

Similar to *D. trichotoma.*

(ii) The microscopical characters.

Similar to *D. trichotoma* except the following characters.

a) Arrangement of elements.

Wood rays: 1-47 (mostly 4-19) cells and 25-1075μ high, up to 36μ wide.

b) Description of elements.

Vessels: D. 20-106μ, D′. 10-117μ, L. 115-455μ, Th. 1.5-2.5(-3.5)μ; perforations simple, but only in one vessel member irregularly scalariform with one broad bar at one end; pits P. ca. 4-6μ.

Tracheids: D. 5-18μ, D′. 6-20μ, L. 120-535μ, Th. up to 2μ.

Wood parenchyma: D. 5-20μ, D′. 5-25μ, L. 195-340μ, Th. 0.5-1μ, parenchyma strands up to about half of all.

Fiber-tracheids: D. up to 72μ, D′. up to 40μ, L. (145-)255-1005μ, Th. 1-2.5μ, strand fiber-tracheids occasionally present; pits P. ca. 4-5μ.

Wood rays (Fig. 3, H): W. 5-25 μ, R. 10-118 μ, H. 7-87(-116) μ, Th. 1-2 μ.

5. **Diplomorpha yakushimensis** MASAMUNE.

1) Hôrigawa, Prov. Hiuga (Aug. 7, 1952), 2) Kosugi-dani, 3) ditto, thick bark only, 4) ditto, debarked stem, ca. 6 cm in diameter (2-4: Aug. 13, 1956), 5) no loc. (No. 1188), 2-5 in Isl. Yaku, and 6) ex Miyazaki University.

(i) The macroscopical characters.

Similar to *D. trichotoma.*

(ii) The microscopical characters.

Similar to *D. trichotoma* except the following characters.

a) Arrangement of elements.

Vessels: large early wood vessels usually scattered and not always forming continuous initial rows, in the other parts within the growth ring or, in some specimens, all over the ring the arrangement of vessels similar to *D. trichotoma* or in higher tendencies forming radial or oblique streams; somewhat less angular than in *D. trichotoma*; sparse deposits occasionally present in tracheary elements.

Wood parenchyma; beside the terminal parenchyma, rarely some cells contiguous to diffuse vessels, such cells a little more numerous in the first some rings and in the vicinities of foliar rays (traces).

Wood rays: often abruptly bended at ring boundaries, sparse deposits present in specimen 5), 1-51 (mostly 5-25) cells and 28-1005 μ high, up to 33 μ wide.

b) Description of elements.

Vessels: D. 13-140 μ, D′. 8-115 μ, L. 95-500 μ, Th. 1.5-3 μ; pits P. 3-6 μ.

Tracheids (Fig. 3, C, D): D. 5-14 μ, D′. 9-27 μ, L. (105-)160-650 μ, Th. up to 2.5 μ.

Wood parenchyma: D. 5-29 μ, D′. 6-27 μ, L. 150-330 μ, Th. ca. 1-1.5 μ; parenchyma strands few or somewhat numerous by specimens or parts, nearly 10-30% of all.

Fiber-tracheids (Fig. 3, A): D. up to 80 μ, D′. up to 45 μ, (115-)180-1100(-1300) μ, Th. 1-2 μ, often strand fiber-tracheids present; pits P. ca. 3-6 μ.

Wood rays: W. 4-23 μ, R. 10-163 μ, H. 10-95 μ, Th. 1-2 μ.

6. **Diplomorpha sikokiana** HONDA (Pl. III, B—D).

1) ex Kôchi Regional Forestry Office (No. 7417), 2) Shirasaka, Aichi Univ. Forest, University of Tokyo (No. 11369) and 3) two specimens, Mt. Rokkô, ca. 250 m alt., Prov. Settsu (May 2, 1957, S. NAKANISHI).

(i) The macroscopical characters.

Similar to *D. trichotoma.*

(ii) The microscopical characters.

Similar to *D. trichotoma* except the following characters.

a) Arrangement of elements.

Vessels: nearly similar to *D. yakushimensis*, but in specimens 2) and 3) late wood vessels very often forming radial or oblique clusters and connecting or intermingled with the inwards directed groups of tracheids; round or less angular in specimen 3) in outline; deposits occasionally present.

Tracheids: often arranged in inwards directed groups or rows at some tangential intervals in specimens 2) and 3).

Fiber-tracheids: thick-walled nearly all over the rings of specimen 3).

Wood rays: often abruptly bended at the growth ring boundaries, 1-59 (mostly 5-25) cells and 28-1095 μ high, up to 34(-47) μ wide.

b) Description of elements.

Vessels (Fig. 3, E): D. (9-)27-120 μ, D′. 16-120 μ, L. 120-520 μ, Th. up to 2.5 μ, pits P. ca. 4-6 μ; rarely bars across the lumina observed.

Tracheids: D. 4-20μ, D′. 9-32μ, L. (100-)175-500(-655) μ, Th. 1.5-2μ, pits P. 5-7μ.

Wood parenchyma (Fig. 3, F, G): D. 3-19 μ, D′. 10-30 μ, L. 150-390 μ, Th. ca. 1 μ, parenchyma strands less than 30% of all.

Fiber-tracheids: D. up to 60 μ, D′. up to 44 μ, L. 160-1080 μ, Th. 1-2.5 μ, pits P. 5 μ or more.

Wood rays: W. 4-26 μ, R. 7-120 (-200) μ, H. 10-70 μ, Th. ca. 1 μ, mostly procumbent.

Daphnimorpha NAKAI

1. **Daphnimorpha Kudoi** NAKAI (Pl. IV, A, C, D).

1) Hanano-egô, Isl. Yaku (Aug. 12, 1956), 2) ditto, ex Miyazaki University, 3) ditto (No. 1194), 4) ditto (No. 7339) and 5) ditto (No. 11414).

(i) The macroscopical characters.

Wood yellowish or light brownish white, no scent, light and soft. Growth rings distinct under a hand lens, narrow, the boundaries irregularly connate at slow-grown parts. Early wood pores visible under a hand lens, diffuse porous. Late wood pores not visible. The light-coloured tissue forming narrow terminal bands (often interrupted) and radial or short tangential tracts, the radial tracts very short or long and sometimes reaching to both boundaries of a ring or occasionally flame-shaped, small masses also scattered. Parenchyma and rays not visible under a hand lens. Tangential surface lustrous, storied arrangement of axial elements partially distinct under a hand lens.

(ii) The microscopical characters.

a) Arrangement of elements.

Vessels: diffuse porous; *early* wood vessels arranged in short or long tangential rows, occasionally forming small clusters, a few to many vessels within an interval of rays, in narrow rings often a vessel or a group of vessels occupying all the width of a ring, mostly tangentially flattened and polygonal or nearly so; *late* wood vessels solitary or in small groups, often tending to be radially arranged, mostly indistinct from fiber-tracheids in diameter; transition in diameter gradual or abrupt especially in narrow rings; longitudinal lines of vessels mostly straight; sparse deposits occasionally present in tracheary elements.

Tracheids: arranged in short or long radial groups or narrow (1-3 or more rows) terminal bands, sometimes narrow tangential bands connecting some adjacent radial groups, or sometimes single cells or small groups scattered or contiguous to late wood vessels, the radial groups very often arranged on the adaxial side of vessels or vessel groups in the next ring and here the growth ring boundary often dips inwards, tracheids occasionally absent at long tangential intervals, often intermingled with inconspicuous small vessels; cells in groups arranged in regular radial series with rectangular outline, thick-walled; often somewhat horizontally seriated in radial sections.

Wood parenchyma: terminal, usually 1(-2)-seriate, terminal bands often interrupted at long tangential intervals; occasional cells contiguous to large early wood vessels. Pith flecks also observed.

Fiber-tracheids: composing the ground mass of the wood, large cells in early wood tangentially flattened and polygonal, those in late wood small, radially flattened and rectangular, regular in radial series, transition in diameter gradual, thin-walled; often arranged in somewhat regular horizontal series in radial sections.

Wood rays: nearly homogeneous Type III, comparatively less numerous in a cross section, uniseriate, occasionally in part 2-3-seriate, 1-33 (mostly 3-15) cells and 25-970 μ high, up to ca. 57 μ wide.

b) Description of elements.

Vessels (Fig. 4, D—F): in *early* wood, D. 21-110 μ, D′. 10-100 μ, L. (incl. late wood vessels) (80-)150-430 μ, Th. 1.5-4 μ, truncate and with or without short tails at one or both ends, not or slightly to moderately spirally thickened; in *late* wood, D. 10-55 μ, D′. 10-35 μ, Th. up to ca. 2 μ, abruptly or attenuately tailed at the ends, usually with conspicuous spiral thickenings; perforations simple, horizontal to oblique; intervascular pits densely alternate or scattered, orbicular to oval or angular through crowding in large vessel members, less numerous in fibriform members, P. ca. 5-6 μ, apertures horizontal or oblique, lenticular, included or screwhead, in large members sometimes some few apertures coalesced, pits to rays or parenchyma

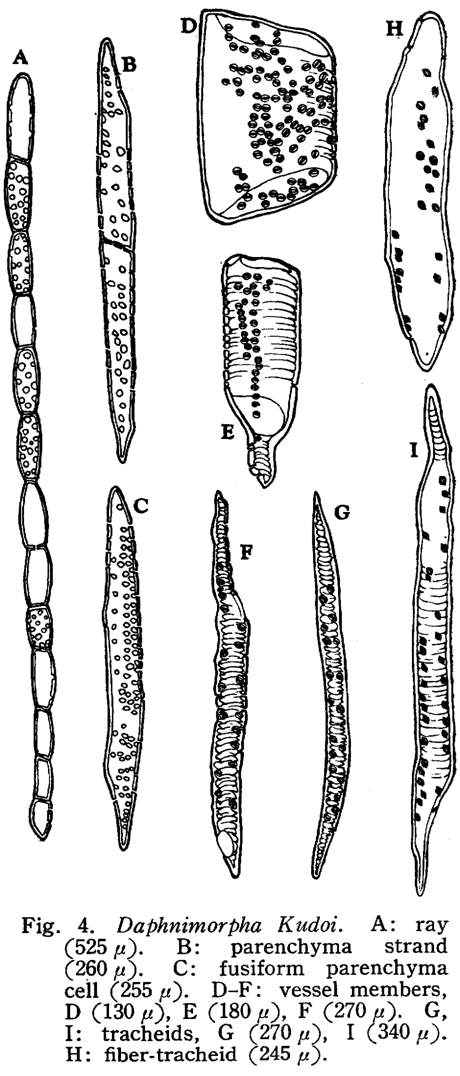

Fig. 4. *Daphnimorpha Kudoi*. A: ray (525 μ). B: parenchyma strand (260 μ). C: fusiform parenchyma cell (255 μ). D-F: vessel members, D (130 μ), E (180 μ), F (270 μ). G, I: tracheids, G (270 μ), I (340 μ). H: fiber-tracheid (245 μ).

similar and numerous.

Tracheids (Fig. 4, G, I): D. 5-26 μ, D′. 6-30 μ, L. 80-465 μ, Th. 2-2.5(-5) μ, mostly with conspicuous spiral thickenings, the thickness of which rarely up to 2 (?) μ, attenuately tailed at the ends, sometimes very similar to some fiber-tracheids, sometimes to small vessel members (fibriform); pits numerous or sparse, P. ca. 3 μ, apertures steeply oblique.

Wood parenchyma (Fig. 4, B, C): mostly fusiform, parenchyma strands nearly absent or less than 10% of all, D. 4-37 μ, D′. 8-33 μ, L. 140-380 μ, Th. 0.5-1(-1.5) μ, simple pits numerous in part, small.

Fiber-tracheids (Fig. 4, H): D. up to 84μ, D′. up to 48μ, L. 100-425(660 in root) μ, Th. 0.7-1.5 μ, fusiform but very variable in feature, truncate or abruptly or attenuately tapered at the ends, occasionally having linear thickenings; inter-fiber pits oval, borders very incomplete on the thin walls, P. ca. 3-6 μ, apertures lenticular, oblique, barely extended.

Wood rays (Fig. 4, A): W. 4-32 μ, R. 12-110(-185) μ, H. 8-100 μ, Th. 1-1.5 μ, mostly procumbent, those in the marginal rows procumbent to square, cells in the middle part oblong or cornered and marginal cells acute at the apex in tangential sections; pits similar to those of wood parenchyma.

2. **Daphnimorpha capitellata** NAKAI (Pl. IV, B).

1) Hôrigawa, Prov. Hiuga (Aug. 8, 1952).

(i) The macroscopical characters.

Similar to *D. Kudoi.*

(ii) The microscopical characters.

Similar to *D. Kudoi* except the following characters.

a) Arrangement of elements.

Vessels: in wide growth rings, early wood vessels more gathered in clusters than the preceding species, not so tangentially flattened.

Fiber-tracheids: more regular in radial series.

Wood rays: 1-18 (mostly 3-12) cells and 29-650 μ high, up to ca. 40 μ wide.

b) Description of elements.

Vessels: D. 20-90 μ, D′. 11-75 μ, L. 130-280 μ, Th. 2-3 μ; pits P. 4-6 μ.

Tracheids: D. 5-24 μ, D′. 6-30 μ, L. 130-300 μ, Th. 2-4 μ.

Wood parenchyma: D. 4-22 μ, D′. 6-29 μ, L. 130-275 μ, Th. less than 1 μ, parenchyma strands few.

Fiber-tracheids: D. up to 65 μ, D′. up to 35 μ, L. 115-500 μ, Th. 1-1.5 μ.

Wood rays: W. 5-20 μ, R. 8-49(-90) μ, H. 10-155 μ, Th. ca. 1 μ; in narrow growth rings often cells exclusively square or upright.

Daphne LINN.

1. **Daphne pseudo-mezereum** A. GRAY (Pl. V, A—D).

1) two specimens, Gôdai and Kiyozumi, Chiba Univ. Forest of University of Tokyo (Nov. 8 and 9, 1955), 2) Mt. Bukô, ca. 1200 m alt., Prov. Musashi (Mar. 27, 1955), 3) two specimens, Minamiyama National Forest, Mt. Fuji, ca. 1650 m alt. (Nov. 17, 1955,

K. TAKASUGI), 4) Mt. Fuji, ca. 1400 m alt. (Nov. 18, 1956, H. OHHASHI and H. SAHO), 5) Shuzenji, Prov. Idzu (May 2, 1954), 6) Mt. Amagi, Prov. Idzu (Apr. 30, 1955) and 7) Mito, Prov. Idzu (Apr. 21, 1957).

(i) The macroscopical characters.

Wood light yellowish white with slightly green or brownish tinge, no scent, light, very soft and easy to cut. Growth rings very faint or somewhat distinct under a hand lens. Pores barely or not visible with a hand lens, grouped or scattered within tracts of light-coloured tissue. The light-coloured tissue forming narrow flame-shaped tracts or small scattered groups, the flame-shaped tracts radial or oblique, sometimes extending across several rings, in narrow rings often dendritic, about growth ring boundaries those irregularly widened and very narrow terminal bands connecting between them. Rays barely or not visible under a hand lens. Axial elements under a hand lens distinctly arranged in tiers usually on radial and sometimes on tangential surfaces, but in part not so.

(ii) The microscopical characters.

a) Arrangement of elements.

Vessels: arranged in clusters or in occasional cases solitary, usually intermingled with tracheids and forming flame-shaped or dendritic tracts or scattered groups, the flame-shaped tracts often absent at several or more intervals of rays, polygonal in outline and indistinct from tracheids and fiber-tracheids in size especially in fast-grown wood, but vessels in the initial parts of rings somewhat larger and often arranged in short tangential rows, moderately thick-walled; longitudinal lines of vessels straight.

Tracheids: surrounding or contiguous to vessels and forming flame-shaped or dendritic tracts or rarely short tangential bands, regular in radial series, rectangular or polygonal, walls a little thicker than fiber-trachids.

Wood parenchyma: terminal, 1(-2)-seriate, very rarely diffuse scanty or paratracheal scanty. Pith flecks occasionally present.

Fiber-tracheids: composing the ground mass of the wood, rectangular or polygonal, mostly regular in radial series, transition in radial diameter very gradual, thin-walled; very often arranged in tiers in radial sections especially in wide growth layers, and sometimes tending to be so in tangential sections.

Wood rays: mostly homogeneous Type III, or in part heterogeneous Type III, uniseriate, occasionally in part biseriate, numerous or less so in a cross section, 1-37 (mostly 3-14) cells and 30-750(-980) μ high, up to 34 μ wide.

b) Description of elements.

Vessels: D. 10-87 μ, D′. 10-66 μ, L. 80-400 μ, Th. 1.5-3 μ, truncate or abruptly or attenuately tailed at the ends, spiral thickenings faint on the walls of broad vessel members and very conspicuous on those of small or slender members; perforations simple, nearly horizontal or steeply oblique; intervascular pits sparsely or densely alternate, large and round, P. 5.5-10 μ, apertures nearly round, P. ca. 2-3 μ, but in root wood vessels pits often angular through crowding and apertures round or lenticular, pits to rays or parenchyma similar.

Tracheids: D. 5-30 μ, D′. 7-21 μ, L. 140-315 μ, Th. 1-3 μ, mostly with conspicuous spiral thickenings, short or attenuately tapered at the ends, similar to slender vessel members in outline, occasionally two cells with and without spiral thickenings forming a strand, pits somewhat dense or sparse, P. ca. 6 μ, apertures oblique.

Wood parenchyma: mostly fusiform, parenchyma strands few, D. 6-28 μ, D′. 5-30 μ, L. 115-250 μ, Th. 0.5-1 μ, simple pits round, often in groups.

Fiber-tracheids: D. up to 60 μ, D′. up to 32 μ, L. 110-580(-830) μ, Th. 0.5-2 μ, very variable in feature, mostly fusiform, with abrupt or attenuate tails or often truncate at the ends; inter-fiber pits oval, borders sometimes very narrow, P. ca. 3.5-5 μ, apertures lenticular, barely or somewhat extended.

Wood rays (Fig. 5, B): W. 4-25 μ, R. 11-100(-180) μ, H. 13-110 μ (usually higher in root wood), Th. up to 1.5 μ, mostly procumbent, often square or upright in marginal rows, pits similar to those of wood parenchyma.

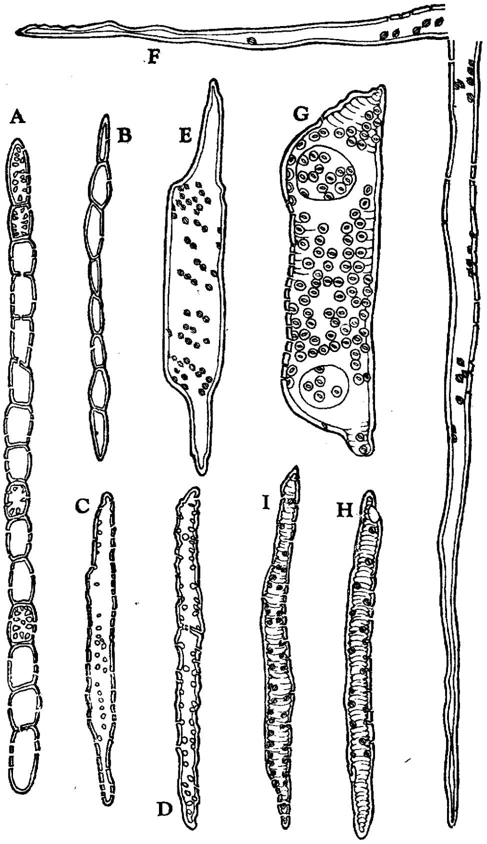

Fig. 5. A, C, F, I: *Daphne odora*. B, E: *D. pseudo-mezereum*. D, H: *D. kiusiana*. G: *D. Miyabeana*. A-B: rays, A (430 μ), B (250 μ). C: fusiform parenchyma cell (220 μ). D: parencyma strand (235 μ). E: fiber-tracheid in the subsect. *Pseudo-mezereum* (270 μ). F: ditto in the subsect. *Daphnanthoides* (875 μ). G-H: vessel members, G (250 μ), H (250 μ). I: tracheid (260 μ).

2. **Daphne pseudo-mezereum** subsp. **jezoensis** HAMAYA.

1) Yamabe, Hokkaidô Univ. Forest of University of Tokyo (Oct. 6, 1956).

(i) The macroscopical characters.

Similar to subsp. *pseudo-mezereum*.

(ii) The microscopical characters.

Similar to subsp. *pseudo-mezereum* except the following characters.

a) Arrangement of elements.

Vessels: vessels distinct from tracheids and fiber-tracheids in cross sections especially in narrow growth rings of the root wood, thick-walled.

Wood parenchyma: beside the terminal bands, often apotracheal uniseriate bands present in anomalously irregular growth rings.

Fiber-tracheids: very thin-walled, often the radial diameter uniform all through the growth ring.

Wood rays: 1-31 (mostly 3-8) cells and 30-830 μ high, up to 47(-60) μ wide.

b) Description of elements.

Vessels: D. 14-115 μ, D′. 15-80 μ, L. 125-250 μ, Th. 2-3 μ; pits P. 6-8 μ, apertures round or lenticular, P. 2.5-5 μ.

Tracheids: D. 8-25 μ, D′. 6-22 μ, L. 65-260 μ, Th. 1.5-3 μ.

Wood parenchyma: parenchyma strands less than 20% of all, D. 8-27 μ, D′. 8-32 μ, L. 95-200 μ, Th. ca. 1 μ.

Fiber-tracheids (Fig. 5, E): D. up to 39 μ, D′. up to 30 μ, L. 135-625 μ, Th. up to 1.5 μ.

Wood rays: W. 5-38 μ, R. 18-130 μ, H. 9-95 μ, Th. 0.5-1.5 μ.

3. **Daphne Miyabeana** Makino (Pl. VI, B, D).

1) by Fujimi-pass, Tokura, Prov. Kôzuke (Jul. 17, 1952), 2) Mt. Bunanotairayama, Isl. Sado (Aug. 29, 1956), 3) Mt. Ashibetsu, ca. 500 m alt., Prov. Ishikari, Hokkaidô (Oct. 6, 1956) and 4) Tsuta Spa, Prov. Mutsu (No. 6327).

(i) The macroscopical characters.

Similar to *D. pseudo-mezereum*, but wood harder than this species. Growth rings often indistinct.

(ii) The microscopical characters.

Similar to *D. pseudo-mezereum* except the following characters.

a) Arrangement of elements.

Wood parenchyma: terminal, diffuse or paratracheal; *terminal* bands mostly uniseriate and in part biseriate, often interrupted, *diffuse* parenchyma usually near to the paratracheal, and rarely single cells scattered among fiber-tracheids, *paratracheal* parenchyma contiguous to the flame-shaped tracts, restricted to occasional cells or arranged in small clusters or in short aliform or confluent bands of 1-2 rows.

Fiber-tracheids: radial diameter often uniform all through the growth ring; arrangement in tiers usually not observed on longitudinal surface.

Wood rays: 1-23 (mostly 3-7) cells and 25-685(-915) μ high, up to 35 μ wide.

b) Description of elements.

Vessels (Fig. 5, G): D. 15-85 μ, D′. 13-70 μ, L. 100-350 μ, Th. 1.5-2.5 μ; pits round or often angular through crowding, P. 6-9 μ, apertures nearly round, P. 2-2.5 μ.

Tracheids: D. 5-36 μ, D′. 7-25 μ, L. 115-355 μ, Th. 1.5-2.5 μ.

Wood parenchyma: parenchyma strands less than 10% of all, D. 6-35(-52) μ, D′. 6-30 μ, L. 115-340 μ, Th. ca. 1 μ.

Fiber-tracheids: D. up to 55 μ, D′. up to 37 μ, L. 105-600(-760) μ, Th. 0.7-2 μ, mostly short and with abrupt tails at the ends as in *D. pseudo-mezereum*, sometimes with long tapered ends and somewhat similar to those of *D. kiusiana* etc., a few strand fiber-tracheids present.

Wood rays: W. 5-30 μ, R. 13-100 μ, H. 10-125(-170) μ, Th. ca. 1 μ.

4. **Daphne kiusiana** MIQUEL.

1) Hase, Minô-mura, Prov. Hiuga (Aug. 14, 1952), 2) some specimens, Chiba Univ. Forest of University of Tokyo (Nov. 4, 1955) and 3) Hanano-egô, Isl. Yaku (Aug. 12, 1956).

(i) The macroscopical characters.

Similar to *D. Miyabeana*.

(ii) The microscopical characters.

Similar to *D. Miyabeana* except the following characters.

a) Arrangement of elements.

Fiber-tracheids: in specimen 3) irregularly twisted in longitudinal sections.

Wood rays: 1-21 (mostly 3-7) cells and 20-445 μ high, up to 36 μ wide.

b) Description of elements.

Vessels (Fig. 5, H): D. 11-78 μ, D′. 13-78 μ, L. 100-400 μ, Th. 1.5-2.5 μ; pits round or oval, P. 7-9 μ, apertures nearly round or oblong, P. 3-4 or 5 μ.

Tracheids: D. 5-17 μ, D′. 7-24 μ, L. 120-320 μ, Th. 2-2.5 μ; pits P. 4-5 μ, apertures oblique, lenticular.

Wood parenchyma (Fig. 5, D): parenchyma strands less than 20% (or more) of all, D. 6-35 μ, D′. 6-26 μ, L. 90-255 μ, Th. ca. 1.5 μ.

Fiber-tracheids: D. up to 47 μ, D′. up to 30 μ, L. (145-)250-920 μ, Th. 0.8-2.5 μ, mostly short or moderately long, with long tapered ends, often irregularly twisted, strand fiber-tracheids rarely present, pits P. 3-6 μ.

Wood rays: W. 6-34 μ, R. 15-120 μ, H. 10-95 μ, Th. 1.5-2 μ, mostly procumbent.

5. **Daphne odora** THUNBERG (Pl. VI, A, C; Pl. VIII, D).

1) two cult. plants in the close of Faculty of Agriculture, University of Tokyo and 2) cult. in a private garden, Mitaka, Tokyo (Jan. 16, 1957).

(i) The macroscopical characters.

Similar to *D. kiusiana*.

(ii) The microscopical characters.

Similar to *D. kiusiana* except the following characters.

a) Arrangement of elements.

Vessels and *tracheids*: occasionally containing dense deposits.

Wood rays: 1-33 (mostly 3-9) cells and 16-465 μ high, up to 30 μ wide.

b) Description of elements.

Vessels: D. 9-74 μ, D′. 8-61 μ, L. (110-)170-415 μ, Th. 2-3 (rarely 5) μ; pits round, P. 6-8 μ, apertures nearly round, P. ca. 2 μ.

Tracheids (Fig. 5, I): D. 8-17 μ, D′. 7-25 μ, L. 155-420 μ, Th. ca. 2 μ.

Wood parenchyma (Fig. 5, C): parenchyma strands few, D. 6-26 μ, D′. 6-32 μ, L. 180-345 μ, Th. ca. 1.5 μ. Pith flecks rarely present.

Fiber-tracheids (Fig. 5, F): D. up to 60 μ, D′. up to 40 μ, L. 165-965 μ, Th. 1-2 μ, pits P. 4-5 μ.

Wood rays (Fig. 5, A): W. 5-24 μ, R. 6-113 μ, H. 12-130 μ, Th. ca. 1 μ, generally square or procumbent, often the ends of fiber-tracheids bending along the margin of rays.

6. **Daphne Genkwa** Sieb. et Zucc.

Only a 2-year-old branch was taken from the herbarium specimen for the examination. Its macro- and micro-scopical features are nearly the same as those of the other *Daphne*, especially of the subsect. *Daphnanthoides*.

The faint differences from these are as follows: ① the vessels are more distinct in the diameter from the fiber-tracheids than in the other *Daphne*, and they are somewhat round and not polygonal in outline. ② The intervascular pits of vessels are round or oval; and the apertures are lenticular and horizontal or oblique, sometimes some extended apertures are coalescent as in the other genera.

Notes. (i) As understood from the descriptions, the anatomical features are nearly uniform in each genus. There is only a slight difference with concern to the arrangement of wood parenchyma between two groups within a genus, i. e. the group of *Daphne pseudo-mezereum* and that of *D. Miyabeana*. Therefore it is usually difficult to identify species by the anatomical characters only.

(ii) In the root wood, the fundamental features of the anatomical structure are not different from those of the stem wood. Merely, the fiber-tracheids appear to be a little more numerous, the vessels are generally more distinct from the tracheids and fiber-tracheids in diameter, and the growth rings tend to be more irregular, than in the stem wood. In size of elements, there seems to be no constant tendency of modification from that of the stem wood.

(iii) In general, the axial elements of wood of the groups examined are very similar to each other in the thickness of the walls and the length of the cells. Among those elements, fiber-tracheids usually have thin walls, and in some species are of fusiform shapes. By reason of the first condition, it is very difficult to ascertain the arrangement of wood parenchyma in transverse sections. And the tiered arrangement of fiber-tracheids in radial sections often results, to some extent, from the latter condition. The fiber-tracheids also have obviously bordered pits, though the borders are comparatively faint when the cell-walls are thin. The transition from the critical forms of vessel members to the fiber-tracheids through the vascular or vasicentric tracheids is very gradual (see Fig. 3, C). In some groups, the conspicuous spiral thickenings appear as a characteristic feature of tracheids, but in the others they are absent.

§ 2. The Bark Anatomy (Pl. VII, A—D; Pl. VIII, A)

The characters of the phellem or cork tissue and the cortex were briefly described in the previous paper (1955 b). It is only remarkable that, in *Edgeworthia chrysantha*, the phellem usually consists of less than 10 layers of component cells (in the other genera often 50 layers or more), and that crystalliferous cells are scattered in the cortex. But the thickness of the phellem is variable due to the condition of habitats or according to the parts of a plant. The origin of the phellogen or cork cambium is, van Tieghem (1893) noted, either in the epidermis or in the outermost part of the cortex. He appreciated in this difference a taxonomic value for genera. But according to Gilg (1894) and others, such difference also is found within a genus or even between closely related species.

In other tissues, any difference of taxonomic importance could not be found because of the want of sufficient fresh materials or perhaps by their nature. I have, in consequence, studied the arrangement and other characters mainly about the bast fibers or phloem fibers which give a practical value to some species of this family.

In the phloem (strictly speaking, the axial elements of this), it is very difficult to distinguish the sieve tube members from the phloem parenchyma cells in transverse sections. Therefore these two kinds of cells shall be temporarily called 'the thin-walled cells' in one and the same term in contrast to fibers. In radial sections, the sieve tube members are about 200 μ long, have compound sieve plates including 1-3 (or more) sieve areas, and are accompanied by very slender companion cells (cf. Léandri).

i. The arrangement of the bast fibers.

(i) The phloem or inner bark in this group is commonly rather wide, and, except in the bark of very young axes, the axial elements appear in transverse sections usually as triangular or flame-shaped groups with outwards directed apices and separated from each other by the enlarged distal ends of some rays. The places of such separation in transverse sections are variable and, in general, may coincide with those of multiseriate rays or the places, where uniseriate rays are densely arranged, in the xylem. Supprian (1894) and Domke (1934) considered this triangular or wedgy arrangement of phloem including numerous fibers as a common character of this family.

In some specimens of *Diplomorpha* (e. g., *D. yakushimensis*), nearly all phloem rays maintain their initial width to the comparatively outer part. In the others, each triangular or flame-shaped group of the phloem usually contains a few uniseriate rays whose distal ends are not enlarged. Though the former case is usually conspicuous in *Diplomorpha* and, to some extent, in *Daphnimorpha*, it appears owing to the slow growth of the bark in these genera. In fact, the latter case also is observed in the young axes of them, and it seems gradually to change into the former condition when the axes become older.

In the outer part of the phloem, especially in the latter case, the apices of the flame-shaped groups irregularly divide themselves or connect with those of the adjacent groups or become isolated masses between which the tangentially stretched (swollen) cells occupy the spaces. It is entirely not able to distinguish a tissue called the pericycle from the phloem, though some authors wrote about it (cf. van Tieghem 1893).

(ii) Numerous fibers are distributed within the flame-shaped groups of axial elements. In transverse sections they are usually scattered in small groups of 1 to many cells, and these groups are of various outlines and intermingled with the thin-walled cells or cell groups which also may be rarely arranged in tangential uniseriate bands. At some radial intervals in the phloem, there are somewhat regularly arranged narrow concentric bands of a few to several rows of the thin-walled cells. These bands are usually nearly fiber-less, and a layer between these appears to correspond to an annual increment of the phloem, but in some cases doubtfully so. The bast fibers are distributed within the layer (much wider) alternate with the aforesaid bands of the thin-walled cells in the species in which the bark grows slowly or in which the phloem rays do not so much enlarge. The thin-walled cells are usually of larger diameter in the fast-grown bark of *Daphne* and, to some extent, in the root bark of the other genera. In such cases, the bark is of very coarse feeling under a hand lens; the aforenamed concentric bands are difficult to be ascertained; and the groups of fibers themselves seem to be scattered without regularity. In *Daphne*, furthermore, the swelling (or multiplication through division) of the thin-walled cells appears rather to be more remarkable than the enlargement of the rays.

Thus, JENČIČ's opinion (1902) that the zonation of bast fibers is recognized in *Edgeworthia* is right at least in the normal condition.

(iii) In short, the density of the bast fibers decreases, with many variations or exceptions, in the order of *Diplomorpha* — *Daphnimorpha*, *Wikstroemia* (?), *Edgeworthia* — *Daphne*, so far as this study is concerned. The arrangement and number of the fibers was utilized by VOGL for the specific diagnosis of *Daphne* (cf. METCALFE and CHALK). According to my observation, however, this character is variable with specimens or parts in a specimen, and even the utilization for generic diagnosis is in need of further sufficient examination.

(iv) LÉANDRI (1930) made much of the occurrence and arrangement of the thick-walled, lignified fibers and the normally thin-walled fibers. But my observations show that the former may occur in any species, and that their number and arrangement is variable with specimens as mentioned in the individual description. The former also are usually remarkable by their larger diameter in comparison with the normal fibers.

(v) In tangential sections of the inner part of phloem, the groups of bast fibers are nearly straight in axial direction including rather narrow phloem rays, while in the outer part they become winding with the enlargement of rays and at last become netted or isolated.

The axial phloem parenchyma cells are fusiform or forming strands of 2-4 cells. But in *Daphne*, as mentioned above, these appear to be tangentially swollen as the growth layer containing them becomes older, except ones contiguous to the fibers.

(vi) In radial sections, the groups of fibers are always straight in the axial direction. The ray cells are generally square or upright.

ii. The characters of individual bast fibers.

(i) As noted by JENČIČ (1902), LÉANDRI (1930) and others, the bast fibers in this family are of very irregular outline in the macerated condition. They sometimes exhibit various forms of indentation or ruggedness of the walls, e. g. outer branches or irregular outgrowths, which are conspicuous especially at the ends. The thickness of the wall, too, is variable with the part of a cell, in part obturating the lumen and in part very thin. JENČIČ regarded such irregularity of the bast fibers as a characteristic feature of this family. Thus, the bast fibers in most cases are irregularly winding, but are nearly straight in some specimens or some of the parts from which they are obtained. The thick-walled fibers are generally straight.

In cross sections, the fibers are polygonal or irregularly folded in outline. The foldings are observed as longitudinal lines on the macerated fibers. The fibers are usually devoid of pits against JENČIČ's opinion except occasional long or short, axial or oblique slits on the longitudinal walls.

(ii) The bast fibers are supplied for making paper of special uses widely in the world, and formerly the bark or the bast fibers of the Philippine species were imported into this country (cf. BROWN 1920). Many investigators, for example, LÉANDRI, WIESNER and others, therefore measured the bast fibers mainly about the size. I also measured those of the Japanese species, — the results are described in the succeeding. The diameter, the length and the thickness of walls were measured about the macerated materials.

The mean length in a specimen was gained from the measurement of (10-) 15 normal thin-walled fibers. The disparity in the mean lengths (of specimens) may reach 1000-1500 μ in some species. It sometimes corresponds to the difference of the cultivated races (*Edgeworthia chrysantha*), sometimes to the difference of individuals in different habitats, or rarely that of species. For example, in *Daphne kiusiana* the mean length in a specimen collected at the high altitude (Hanano-egô, Isl. Yaku, ca. 1400 m) is smaller than those at the low altitude. That in a specimen of *Diplomorpha trichotoma*, which was collected in the similar condition (Hôrigawa, Prov. Hiuga, ca. 800 m alt.), also is smaller than the others and is nearly the same as the average length of *D. albiflora*, as mentioned later. But in general, no constant relation is found with concern to the difference of habitats, as in *Daphne pseudo-mezereum*.

The average lengths in the Japanese species are not very different from one another, so far as the bark of adult plants is concerned. Therefore, the fast growth of bark and the dense arrangement of bast fibers are more important from the standpoint of practical use.

The thick-walled fibers are usually much shorter than the normal thin-walled and about 1000 μ long, but often those are transitional to the latter.

(iii) Paper made from *Edgeworthia*-bark usually includes numerous parenchyma cells some of which contain druses. Such crystals are entirely absent in *Diplomorpha*-paper. JENČIČ pointed out the presence or absence of crystals as a feature distinguishing between both sorts of papers. I also made spodograms of these papers and likewise ascertained the presence of druses only in *Edgeworthia*-paper. Therefore, this difference is useful to distinguish the sort of these papers, while any other character of bast fibers is entirely the same in the two.

iii. Description of the bark and fibers.

Wikstroemia ENDL.

1. **Wikstroemia pseudoretusa** KOIDZUMI.

Bark: groups containing fibers flame-shaped under a hand lens, brownish and conspicuous from the back ground, with silky lustre on the longitudinal surface.

Fibers: D. 6-13(-21)μ, L. 2700-4340μ, av. 3510μ, Th. 1-2μ; thick-walled fibers: D. up to 29μ, Th. 6-8μ.

2. **Wikstroemia retusa** A. GRAY.

Fibers: D. 5-15(-23)μ, L. 2440-3840(-5210)μ, av. 3460μ, Th. 1-1.5μ.

Edgeworthia MEISSN.

1. **Edgeworthia chrysantha** LINDLEY (Pl. VII, A, B; Pl. VIII, A).

Bark: in fresh bark, flame-shaped or triangular groups containing fibers light greenish, other parts light greenish white, narrow phloem rays not visible under a hand lens, outer part of phloem greenish, phellem brownish, thin; root bark yellowish white. In dried bark, flame-shaped groups light purplish brown, with silky lustre on the longitudinal surface.

In young axes, the bark consisting of the outer band of the thick-walled fibers and the inner one of the thin-walled fibers. Druses frequently occurring in axial and radial parenchyma cells. Phellem consisting of less than 10 layers of component cells.

Fibers: D. 6-20(-35)μ, L. 2400-5850μ, av. 4260μ, the mean length in Kôchi-race 5060μ, that of Shizuoka-race 3870μ, this difference was already pointed out by HYODO (1954), Th. 1-2(-4)μ; thick-walled fibers: D. 26-37μ, L. ca. 1000μ, Th. 5-6μ.

Diplomorpha MEISSN.

1. **Diplomorpha trichotoma** NAKAI.

Bark: flame-shaped groups containing fibers light yellowish brown when fresh, turning to light brownish when dry, with silky lustre on the longitudinal surface; phellem consisting of very many layers of regularly arranged, flattened component cells.

Fibers: D. 8-20(-34)μ, L. 2720-5390(-6330)μ, av. 4850μ, the mean length is 3720μ in specimen 1), Th. 1-2μ; thick-walled fibers sparse, ca. 1800μ long.

2. **Diplomorpha albiflora** NAKAI.

Bark: phellem consisting of ca. 60 layers of component cells.

Fibers: D. ca. 7-25μ, L. 2140-4230μ, av. 3110μ, Th. 1-2(-4)μ; short thick-walled fibers often present.

3. **Diplomorpha Ganpi** NAKAI.

Bark: similar to *D. trichotoma.*

Fibers: D. 9-32 μ, L. 2740-5470 μ, av. 4290 μ, Th. 1-3 μ; thick-walled fibers often scattered among thin-walled fibers.

4. **Diplomorpha pauciflora** NAKAI.

Bark: similar to *D. trichotoma.*

Fibers: D. 10-27 μ, L. 2920-4900 μ, av. 4000 μ, Th. 1-2 μ; thick-walled fibers often diffuse.

5. **Diplomorpha yakushimensis** MASAMUNE (Pl. VII, C).

Bark: in very thick bark, concentric bands of fibers regularly alternate with those of the thin-walled cells, rays meandrine and narrow as in the wood.

Fibers: D. 10-29(-52) μ, L. 2430-6730 μ, av. 4380 μ, Th. 1-3 μ, the mean length (in specimens) very variable; thick-walled fibers sometimes numerous, sometimes few, ca. 2600 μ long.

6. **Diplomorpha sikokiana** HONDA.

Bark: similar to *D. yakushimensis.*

Fibers: D. 10-33(-43) μ, L. 2400-5770 μ, av. 4530 μ, Th. 1-2 or 3 μ; thick-walled fibers present.

Daphnimorpha NAKAI.

1. **Daphnimorpha Kudoi** NAKAI.

Bark: flame-shaped groups containing fibers visible under a hand lens, light brownish, including meandrine yellowish phloem rays; with silky lustre on the longitudinal surface.

Fibers: D. 5-28 μ, L. (1870-)2680-4750 μ, av. 3710 μ, Th. ca. 1.5 μ; thick-walled fibers not observed.

2. **Daphnimorpha capitellata** NAKAI.

Bark: similar to the preceding.

Fibers: D. 9-27 μ, L. 2500-5040 μ, av. 3760 μ, Th. ca. 1 μ.

Daphne LINN.

1. **Daphne pseudo-mezereum** A. GRAY.

Bark: light brownish or greenish, the wide fast grown bark coarse, and flame-shaped groups containing fibers indistinguishable from the back ground; with silky lustre on the longitudinal surface. Under the microscope, fibers often very sparse in the fast grown bark, phellem consisting of ca. 10-many layers of component cells.

Fibers: D. 6-22(-27) μ, L. 2610-5980 μ, av. 4030 μ, Th. 1-3 μ; thick-walled fibers often scattered among thin-walled fibers.

2. **Daphne pseudo-mezereum** subsp. **jezoensis** HAMAYA.

Bark: similar to the preceding.

Fibers: D. 7-20 μ, L. 2320-4170 μ, av. 3220 μ, Th. 1-2 μ.

3. **Daphne Miyabeana** MAKINO.

Bark: flame-shaped groups often distinct in narrow bark under a hand lens.

Fibers: D. 6-26 μ, L. 3210-5770(-7310) μ, av. 4530 μ, Th. 1-3 or 5 μ; thick-walled fibers rare.

4. **Daphne kiusiana** Miquel (Pl. VII, D).

Bark: in specimen 1), component cells of the phellem containing numerous minute granules deeply stained with safranin.

Fibers: D. 7-20 μ, L. 3020-5800 μ, av. 4370 μ, Th. 1-2 μ or more; thick-walled fibers: D. 18-30 μ, L. ca. 1300 μ or nearly as long as the thin-walled, Th. 5-8 μ. The mean length of specimen 3) (Hanano-egô, Isl. Yaku, ca. 1400 m alt.) is 3680 μ, while those of the other two 4340 μ and 4600 μ, respectively.

5. **Daphne odora** Thunberg.

Bark: similar to the preceding.

Fibers: D. 8-28 μ, L. 3150-5460(-7180) μ, av. 4500 μ, Th. 1-2 μ; thick-walled fibers: D. up to 30 μ, Th. 4-8 μ, lignified, sometimes layers of them are alternate with those of thin-walled fibers, sometimes both kinds of fibers intermingled with one another.

Part II. STUDIES ON THE CHARACTERS OF TAXONOMIC IMPORTANCE AND THEIR PHYLOGENETIC SIGNIFICANCE

In investigating the interrelationship of five Japanese genera, I extended the scope of research and argument to the tribe *Daphneae* in Domke's sense (1934) with exception of the subtribe *Daphnopsinae* in which most genera include species with petaloid scales and all grow in the New World. Hereafter, this tribe in narrow sense shall be simply called the *Daphneae*. The following genera are included in this: *Daphne, Daphnimorpha, Diarthron, Diplomorpha, Edgeworthia, Eriosolena, Rhamnoneuron, Stellera* (incl. *Dendrostellera*) and *Wikstroemia*.. Beside these, *Linodendron* shall be added in this discussion. This is similar to *Edgeworthia* and grows in the New World according to Domke.

Among them, the species enumerated below were actually studied on the anatomical and exomorphic characters in this work (the Japanese ones omitted from this enumeration). The parts anatomically studied are the axes or branches (a) and the leaves (f). The former were studied with hand sections or, when circumstances compelled it, those on the herbarium specimens were observed under a hand lens. The petioles and midribs of the leaves, and very young branches or branchlets, were cut with a razor after being soaked in water of about 60°C for 2 or 3 days. The sections were steeped in eau de Javelle for 3-6 minutes, affixed serially with Watari's agar-agar adhesive after washing, and then double stained with safranin and fast green. The branches and leaves were also macerated with Schulze's solution to observe the spiral thickenings and the pits of the tracheary elements.

To meet the convenience of following discussions, every section or subsection is temporarily treated as a separate unit. Consequently some genera are those in narrow sense, and groups of species whose true taxonomic positions are pending are represented with the specific epithets of the representative species. Such appellations shall be enumerated here together with the species examined actually (*: only literature referred to). The abbreviations in parentheses represent the parts anatomically studied.

1. Tetramerous groups.

Daphne (sect.) Daphnanthes.

(Subsect.) Daphnanthoides: *Daphne arisanensis* HAYATA (a, f), *D. papyracea* WALL., *D. nana* TAGAWA, *D. tangutica* MAXIM. (a, f) and *D. Morii* HAYATA in sched.

(Subsect.) Alpinae: *D. altaica* PALL. (a, f).

(Subsect.) Oleoides: *D. oleoides* SCHREB. ? (f) and D. *Gnidium* L. (f).

(Subsect.) Cneorum: *D. Cneorum* L. (a, f) and *D. striata* TRATT. (a, f).

(Subsect.) Collinae.

(Subsect.) Pseudo-mezereum.

(Sect.) Laureola: *D. Laureola* L. (a, f).

(Sect.) Mezereum: *D. Mezereum* L. (a, f).

Championi: *D. Championi* BENTH. (a, f).

Aurantiaca: *D. aurantiaca* DIELS*.

Dendrostellera: *Stellera Lessertii* C. A. MEYER* and *S. stachyoides* SCHRENK* etc.

Diarthron: *D. linifolium* TURCZ. (a) and *D. vesiculosum* FISCH. et MEY.

Diplomorpha: *D. mononectaria* NAKAI (f) and *D. Chamaedaphne* C.A. MEYER (a, f).

Edgeworthia: *E. Gardneri* MEISSN. (a, f).

Eriosolena: *E. involucrata* VAN TIEGHEM (a, f).

Wikstroemia: *W. indica* C. A. MEYER (a, f), *W. Kusanoi* HAYATA in sched., *W. ovata* C. A. MEYER (a, f), *W. elliptica* MERR. (a, f), *W. nutans* CHAMPION (a, f), *W. lanceolata* MERR. (a), *W. meyeniana* WARBURG, *W. Uva-ursi* A. GRAY, *W. elongata* A. GRAY, *W. sandwicensis* MEISSN., *W. phillyreaefolia* A. GRAY, *W. villosa* HILLEB. and *W. foetida* A. GRAY.

Wang: a specimen called as *W. holosericea*, WANG, no 66544 (in A) (f).

2. Pentamerous groups.

Ambigua: *Daphne ambigua* MATSUDA (a, f).

Gemmata: *Daphne gemmata* PRITZEL (f), *D. gracilis* PRITZEL, *D. angustiloba* REHD. (f), *D. rosmarinifolia* REHD. (f), *D. modesta* REHD. (f) and *Wikstroemia holosericea* DIELS (f) (2 new species may be established among the specimens in A).

Penicillata: *Daphne penicillata* REHD. (f) and *D. myrtilloides* NITSCHE ?

Pentathymelaea: *Pentathymelaea thibetensis* LEC.* and, according to DOMKE, *Wikstroemia holosericea* DIELS is very similar to this.

Paxiana: *Wikstroemia Paxiana* WINKL.*, *W. eriophylla* WINKL.*, *Daphne flaviflora* WINKL.*, *D. Esquirolii* LÉV. (*D. leuconeura* REHD.)* and *D. tenuiflora* BUR. et FR. (?)*.

Dolicantha: *Wikstroemia dolicantha* DIELS (f) and var. *pubescens* DOMKE, *W. effusa* REHD. (f), *W. canescens* MEISSN.? (a, f), *W. scytophylla* DIELS* and *W. leptophylla* W. W. SM.*

Chamaestellera: *Stellera Chamaejasme* L. (a) and *S. rosea* NAKAI.

Circinata: *Stellera circinata* LEC.*, *S. Mairei* LEC.* and *S. Fargesii* LEC.*

Diffusa: *Stellera diffusa* LEC.* and *S. chinensis* LEC.*

§ 1. The Exomorphic Characters

Some of the exomorphic characters were already discussed in the previous paper (1955 b). They are also discussed here in view of the present knowledge again.

1. **Branching habit** (cf. op. cit. p. 54, Fig. 4).

(i) In that paper, three types were separated from each other mainly based on the relation between the position of the inflorescence and that of the buds from which subsequent main axes grow out. At the same time, the seasons when these axes grow were emphasized with respect to the separation of the subtypes in *Daphne*-type. I supposed from this typification an intimate relation, for example, between *Daphne* and *Wikstroemia*, because the latter and *Genkwa* belong to the same subtype. So far as only the Japanese species were concerned, the extent of every type seemed to be well in accord with that of every genus. But it has become clear that the branching habit is rather helpful only to comprehend the interrelationships of the groups of lower rank, e. g., sections of *Daphne*. It, furthermore, can not be considered quite separately from the life forms in some cases.

The gist of *Daphne*-type was as follows: Subsequent axis or axes grow sympodially from the base of the terminal inflorescence, and the latter leaves its remnant for a long time (a few to several years) after the flowering. But within *Daphne* itself *Mezereum* and *Laureola* depart from this type. Though I must refer here for large part to literature about knowledge of them on account of the lack of sufficient specimens, it is sure that in these two groups the axes grow monopodially. This is one of the reasons that compel me to think the branching habit having only a diagnostic value for sections or, at most, for some genera.

Some taxonomists attached importance to "the presence of bracts" as to the groups showing this type of habit and thought it one of the diagnostic features of sections. As formerly mentioned, however, those bracts are taxonomically not so important as they were considered. When the inflorescences are capitate and nearly sessile or with short peduncles, some of the uppermost leaves may only take form of bracts especially in the species which have wintering flowers. In species with small-sized leaves, on the other hand, such leaves scarcely differ from the other leaves in size,—though they regarded even those as bracts. New subsequent axes, furthermore, usually grow out of the axils of such bract-like leaves. This fact was also pointed out by DOMKE about the sect. *Daphnanthes*. (cf. Pl. X, A).

The growth of the subsequent axes and the flowering are usually susceptible to the influence from environmental factors, and so the seasonal relation between these two phenomena often shows striking variations. The separation of subtypes, such as formerly tried by me, must be, consequently, based on the examination on sufficient materials. At any rate, however, it is useful only to detect the interrelationships of groups of such lower rank as section.

The gist of *Diplomorpha*-type was as follows: Subsequent axes grow out of the axils of the leaves which are on the middle or lower part of a branchlet, and the part above those becomes withered after bearing fruits and falls shortly. This tendency is exceedingly advanced in some species of *Diplomorpha* (e. g. *D. Ganpi*), *Chamaestellera* and *Diarthron*; in the latter two the branches are nearly annual and so the plants seem to be herbaceous.

Edgeworthia-type was established on the basis of the branching habit of *Edgeworthia chrysantha*. But, among the features which characterized the type, the peculiar trichotomy may not always be found in the other species of this genus. Therefore, if this type is maintained in some form, its distinguishing feature must be rather found in the involucrate and long-pedunculate heads which are terminal or axillary on the annotinous shoots.

Here is given outline of the branching habit of every group.

a. The groups of the same branching habit as that of *Wikstroemia*.

In these groups, there is rarely observed branching habit somewhat similar to that of *Diplomorpha*.

Wikstroemia: the subsequent axes always grow out of the axils of the uppermost leaves beneath the inflorescence. These leaves are usually of normal size and not bract-like. *Phaleria* belonging to the *Phalerieae*, a tribe intimate to the *Daphneae*, has an appearance very similar to that of *Wikstroemia*, and therefore DOMKE supposed that these two have a common prototype. But in *Phaleria* the terminal or axillary heads have distinct peduncles on which several typical bracts are arranged. Such bracts are absent in *Wikstroemia*.

Ambigua: similar to *Wikstroemia* in general appearance except the alternate leaves.

Penicillata: similar to *Genkwa*.

Gemmata: some are similar to *Ambigua*. Because the leaves are densely arranged immediately beneath the inflorescence in some species, some of those are often considered as bracts (cf. REHDER).

Paxiana: according to the original or other descriptions this group seems very close to the preceding. But in *Wikstroemia Paxiana* "flores lateralis singuli vel bini". The true taxonomic position of this group is pending yet.

Pentathymelaea: according to DOMKE, *P. thibetensis* is similar to *Wikstroemia holosericea*, and therefore, LECOMTE's description "flores axillares" seems to suggest that its branching habit is also similar to that of *Gemmata*.

Wang: this is entirely the same as *Wikstroemia holosericea* in its general appearance, but its flowers are tetramerous, not pentamerous as in the latter.

Genkwa: this is similar to *Wikstroemia* except its winter-deciduousness. The flowering is precocious and normally in early spring, but often out of the season (cf. HAMAYA, 1955 b, c).

Daphnanthoides (Pl. X, A): the position of bract-like leaves is immediately beneath the inflorescence, e. g. *Daphne odora*, or at a distance from this, e. g. *D. Miyabeana*. New axes grow out of the axils of the bract-like leaves. DOMKE considered this as the closest to the prototype among the sections of *Daphne* in his sense.

Oleoides: the leaves close to the inflorescence are often diminutive. In *Daphne Stapfii*, there is a tendency to bloom on the lateral or axillary branchlets as well as at the top of main axis according to KEISSLER's note (1898).

Gnidium: the inflorescence is usually a dense panicle, whose peduncle is distinct from the branchlet and so free from the leaves or bract-like leaves. DOMKE included this taxonomically in the preceding. (LÉANDRI recorded the abnormal structure of rhizome in *Daphne Gnidium*.)

Cneorum: all leaves are nearly uniform in size and form, though it has been said that this has bracts.

Alpinae: in this group, according to DOMKE, the branches ramify sometimes sympodially, sometimes monopodially, and at the same time have terminal inflorescences on the lateral short branchlets. He supposed in this a prototype of *Mezereum*.

Pseudo-mezereum (Pl. X, B): I repeatedly discussed about this in the previous papers and it shall be taken up in Part III in view of the present knowledge again. DOMKE seems to have misunderstood the species of this subsection as winter-deciduous on the basis of a typical specimen of *D. jezoensis* (FAURIE no. 4176, Aomori, ut *D. pseudo-mezereum*, co-specimen in KYO). And the lines on the annotinous branches, which he thought as an indication that the autumn shoots grew from the axils of the leaves close to the flower clusters, are not always present, but are occasionally observed only on the slow-growing plants. In some cases, beside the axillary buds, one or two origins or rudiments of autumn shoots are found among the flowers which are clustered on the top of shoot in early autumn, though it is usual that only the uppermost axillary buds beneath the inflorescence grow sympodially. But I am agreeable to his opinion to separate this from *Mezereum*.

Collinae: the terminal heads are always accompanied by axillary ones, and both are bracteate. DOMKE considered that this is a transitional form to *Laureola*.

Daphnimorpha: the terminal heads or spikes have long peduncles. I formerly established a subtype about this.

a′. *Mezereum*: the branching is monopodial and the clusters of some flowers are axillary or lateral on the annotinous branches. The clusters are entirely or nearly sessile and surrounded by large bud scales (or bracts). Occasionally 2 clusters are longitudinally arranged above a leaf-scar. It is very difficult to decide which groups of *Daphne* this intimately connects with, though DOMKE took *Alpinae* for it.

Laureola: the branching is likewise monopodial. The floriferous branchlets are in the axils of the last year's leaves. Those branchlets bear bracts or diminutive leaves, and the inflorescence is a raceme or a head.

Though these two are different from the above-mentioned groups in the branching habit, their relationship can not be supposed other than that to *Daphne*. The discussion on the phylogenetic relationships between the sections of *Daphne*, however, is not sufficiently tried for the foreign ones, because I investigated only a few specimens of them.

b. The groups of the same branching habit as that of *Diplomorpha*.

Diplomorpha (Pl. X, C and D): the upper parts of the branchlets always wither after bearing fruits. *Dolicantha* is entirely the same as *Diplomorpha* in this character and in general appearance. *Stellera Alberti* REGEL seem also to show the same habit according to C. K. SCHNEIDER (1909). I think this species belongs to *Diplomorpha* rather than *Stellera*, judging from REGEL's original description and note (1886).

Dendrostellera: according to the descriptions and figures of JAUBERT et SPACH (1850-'53), this shows the same habit as the preceding.

Circinata: probably similar to the preceding.

Diffusa: probably similar to *Dendrostellera*, but according to the original descriptions (LECOMTE, 1916), all the species are small shrubs at most 25 cm tall and in *Stellera diffusa* "les fleurs isolées et axillaires".

Chamaestellera (*Chamaejasme*): the shoots are simple and annually grow from the bulbous stems which are nearly subterraneous. The uppermost leaves are in the form of bracts contiguous to the heads.

Diarthron: maybe similar to the preceding, but the branchlets (shoots) are divided. The inflorescence is a spike or a raceme.

c. The groups of the branching habit similar to *Edgeworthia*.

Edgeworthia: the branching habit of *E. chrysantha* is mentioned above. The other species may be of the same habit as it except the trichotomy.

Linodendron: this is somewhat similar to *Edgeworthia* according to DOMKE.

Eriosolena: the branching habit of this is unknown. But, as in *Edgeworthia*, the involucrate heads are terminal and/or axillary and bear slender peduncles which are often once or twice divided.

Rhamnoneuron: the branching habit is unknown. According to LECOMTE (1915) and to the figure of CREVOST et LEMARIÉ (1919-'21), individual heads are similar to those of the preceding, but those on a branch in all form a panicle-shaped inflorescence.

d. The pending groups.

Championi: the branching habit is unknown. 1-3 flowers are axillary to each leaf on the upper part of the branchlet.

Aurantiaca: judging from the figure and description of O. STAPF (1933), this may be similar to *Genkwa* or *Penicillata,* but its systematic position is pending.

(ii) I formerly considered the season of defoliation and the persistence of leaves as useful characters to separate the subtypes of branching habit. The winter-deciduousness is nearly common in the groups similar to *Diplomorpha* (b), while in *Wikstroemia* the species are mostly evergreen. But in the others, the season and the persistence are often markedly variable within or between species. For example, as mentioned in Part III, the summer-deciduous *Daphne pseudo-mezereum* changes to the winter-deciduous var. *koreana* on the high altitude. The transition from the evergreen to the deciduous form is also found within *Daphne cannabina* (*D. papyracea*) and between *D. oleoides* and *D. alpina* (cf. DOMKE, 1934). In these characters, therefore, there could not be found any distinct line of specialization corresponding to the trend of progress within the *Daphneae.* Those may be utilized only to consider the interrelationship of groups of lower rank.

2. Phyllotaxis.

In most of the groups the leaves are alternate. Opposite leaves are found only in *Genkwa,* some of *Diplomorpha* (incl. *Dolicantha*), *Aurantiaca* and *Wikstroemia.* DOMKE took this as one of the reasons to include all of these four into the genus *Wikstroemia* in wide sense. But in some species of the former two, the alternate leaves very frequently accompany to the opposite. The phyllotaxis consequently should not be exaggeratedly evaluated in the taxonomic or phylogenetic consideration.

3. Inflorescences.

In the groups other than those mentioned in the preceding paragraphs, the inflorescences are spikes, racemes, heads or small clusters, and sometimes panicles or paniculiform ones, e. g. in some of *Diplomorpha, Gnidium* and *Circinata* (?). In a few cases, flowers are solitary. The inflorescences can not be discussed about their phylogenetic or taxonomic significance separately from the branching habit.

When the peduncles are very short, the leaves close to them are often considered as bracts, as mentioned above.

The presence of involucres is very remarkable in the allies of *Edgeworthia.* Those are situated at the distal ends of peduncles and usually caducous. The involucre in *Edgeworthia* consists of about 7-9 bracts being like diminutive leaves in form, while in the other two that is membranaceous and consists of 2 bracts in *Rhamnoneuron,* 2-4 bracts in *Eriosolena.* That in *Linodendron* is vestigial.

The involucral bracts in these groups may have a common origion with the bracts in *Phaleria.*

4. Tetramerous and pentamerous flowers.

Among the *Daphneae,* the following groups have pentamerous flowers: *Gemmata, Paxiana, Pentathymelaea, Penicillata, Circinata, Diffusa, Ambigua, Chamaestellera, Dolicantha* and *Linodendron.* Considering the whole Thymelaeaceae, there is admittedly recognized a trend of specialization from the pentamerousness to the tetramerousness. In this circumstance, DOMKE considered *Wikstroemia* as the genus to have a systematic place in the beginning of the *Daphneae,* and included in the lump all the said groups other than *Linodendron* and *Ambigua* into it. I consider, however, that the (line of) specialization or progress in the groups of lower rank is not always advanced in the same direction or in parallel with such major trend in the character which divides the whole family roughly in two groups. In fact, the separation of the tetra- and penta-merousness is not always sharp in the *Daphneae,* and there can be found many exceptions within both categories in this tribe. Specimens with pentamerous flowers are found in the usually tetramerous groups or genera, e. g. in *Daphne Blagayana* FREYER (ex DOMKE), *D. pseudomezereum* (m.), *Diplomorpha canescens* MEISSN. ? (specimen in TI) and *Wikstroemia* (probably *Euwikstroemia*) *linearifolia* ELM. (ex ELM.). On the contrary, specimens with tetramerous flowers are observed or recorded in the usually pentamerous groups, e. g. in *Stellera Chamaejasme* L. (ex DOMKE), *Daphme myrtilloides* NITSCHE ? (specimen in A), *D. tenuiflora* BUR. et FR. (ex BUR. et FR.), *Pentathymelaea thibetensis* LEC. (ex LEC.), *Wikstroemia leptophylla* W. W. SM. (ex W. W. SM.) and *W. alba* HAND.-MAZZ. (ex HAND.-MAZZ.). But in most of these examples, the flowers are not exactly diplostemonous (various combinations of 4 or 5 lobes and 8, 9 or 10 stamens), and both tetra- and penta-merous flowers are often present on the same plants.

Phaleria also includes both penta- and tetra-merous species.

5. **Floral tubes.**

(i) It is said that the floral tubes have obvious articulations or narrow parts immediately above the stigmata only in *Diarthron* and *Stellera* (*Dendrostellera*) among the *Daphneae.* DOMKE attached importance to the presence of these narrow parts, and, on the basis of it, arranged those two genera close to the *Gnidieae,* which also have articulated flowers, in his system.

The floral tube above this articulation falls soon after the flowering, while the part below it is persistent and envelops a fruit (usually dry). According to DOMKE, the latter part is densely pubescent in *Dendrostellera.* But the figures of JAUBERT et SPACH indicate that the upper part is likewise pubescent, and moreover that such articulation is only a slightly narrow part of tube. *Diarthron linifolium* seems to show similarly slight narrowness. In *Daphnimorpha capitellata,* the tubes are bended and somewhat narrow above the stigmata, and the upper parts become withered and fall together with the lower parts enveloping fruits after ripening. The slight constriction of the floral tubes and the withering of the upper parts also are often observed in *Diplomorpha* and others with dry or thin-fleshy fruits. The phylogenetic significance of such articulations must be consequently limited or pending at least so far as this tribe or *Diarthron* and *Stellera* in this are concerned.

The floral tubes in *Linodendron* are remarkable by the pubescence on the inner side.

(ii) In the previous papers, I emphasized the difference in the position of the pedicel articulations (cf. 1955 b, p. 58, Fig. 3). But this difference is rather closely related with the sort of fruits. In general, the groups with dry fruits represent *Diplomorpha*-type, while those with berries, *Wikstroemia*-type. Thus this character is used to guess the sort of fruits during the florescence. The Hawaiian *Wikstroemia* also bear berries and show the articulation of the obvious *Wikstroemia*-type according to SKOTTSBERG's figures and to my examination. The difference in this character, however, is not very useful for the groups, in all of which fruits are dry, other than *Wikstroemia* and its allies.

6. **Hypogynous discs.**

As mentioned formerly (cf. l. c. p. 57, Fig. 2), many taxonomists, GILG, LECOMTE, etc., regarded the shape of hypogynous discs as a character of diagnostic importance. DOMKE arranged *Edgeworthia*, *Eriosolena* and *Rhamnoneuron* close to *Daphne*, because in all these the discs are cup-shaped or annular. He also included into *Wikstroemia* nearly all groups in which the discs are sometimes quadrate or lunar, sometimes scaly or subulate, and moreover even *Genkwa* because its cup-shaped discs are occasionally divided.

In this family, the organologic origin of the discs is more obscure—or rather entirely unknown—than that of the petaloid scales. The disc traces are irregularly divided from the sepal bundles (cf. LÉANDRI 1930, HEINIG 1951 and HAMAYA, 1, c.). Based on LÉANDRI's report with concern to *Daphne Gnidium* L., DOMKE considered that "es sich wenigstens bei dem Diskus von *Daphne* um das Produkt eines zweiten, inneren Staminalkreises handle". HEINIG also supposed the derivation from a kind of androecium. In any case, however, it can not be supposed that every group in the *Daphneae* has discs derived from different origins. Then I think, only the shape of this organ has been taken into account.

Representative shapes are as follows:

a. Annular or cup-shaped, the margin is entire, erose, lobate or rarely divided, sometimes steeply oblique: all sections of *Daphne*, *Championi*, some of *Dendrostellera*, *Diarthron*, *Edgeworthia*, *Linodendron*, *Eriosolena* and *Rhamnoneuron*.

In *Linodendron* and *Genkwa* (*Daphne Genkwa* f. *taitoensis*), the disc margin is pilose, as observed in *Aquilaria* etc.

b. Widely triangular, lunar, quadrate or half-cylindraceous and often cleft: *Wang*, *Daphnimorpha*, *Gemmata*, *Paxiana*, *Pentathymelaea*, *Penicillata*, some of *Circinata*, *Diffusa* and *Dendrostellera*.

In *Daphnimorpha*, the upper margin of discs is slightly glandular.

c. Scaly, subulate or liguliform, usually irregularly erose, lobate or divided:

Aurantiaca (?), some of *Chamaestellera*, *Diplomorpha* (incl. *Dolicantha*) and *Wikstroemia*.

There is no sharp difference between these three, especially between the latter two, and there are found some transitional shapes. In *Wang*, the base of a scaly disc completely surrounds an ovary-stipe in the shape of a very narrow ring. In a specimen of *Wikstroemia holosericea*, the bases of two opposite scales likewise connect with each other entirely to surround the ovary-stipe. Furthermore, according to SKOTTSBERG's figure (1935), a disc is cup-shaped with profoundly cleft margin in *Wikstroemia phillyreaefolia*.

Accordingly, it is admitted that there is no significant difference between the cup-shaped disc with steeply oblique margin and that opened on one side, and between the profoundly cleft cup-shaped disc and that surrounding the ovary-stipe with some scales. The hypogynous discs can be only used roughly to identify the groups belonging to individual categories mentioned above. And it is more fruitless to use the shape of them for further diagnostic purpose within each of three categories, though, for example, DOMKE and LECOMTE used it to separate *Pentathymelaea* from the allied groups as a section (DOMKE) or a genus (LECOMTE).

7. **Styles and stigmata.**

Styles are short, and stigmata are capitate or discoid in most groups.

Long styles are often regarded as an important feature for the diagnosis of the following groups (the characters of stigmata in parentheses): *Championi* (capitate, styles hairy), *Diffusa* (capitate), *Diarthron* (clavate, exserted from the tube), *Dendrostellera* (clavate or capitate), *Edgeworthia* (clavate, styles hairy), *Linodendron* (clavate) and *Eriosolena* (capitate).

Styles are a little long and stigmata are capitate in *Aurantiaca* (cf. DOMKE), *Daphnimorpha* and some species of *Gemmata*, *Paxiana* and *Penicillata* (cf. REHDER etc.). The length of styles in the pentamerous groups is considerably various.

The styles are usually very long in the less-progressed groups such as the *Phalerieae*, and at the same time in the more-progressed such as the *Gnidieae* according to DOMKE. The length of them consequently seems to be a character fluctuating yet or not to be related with the major trend of progress.

SKOTTSBERG (op. cit.) and WAWRA (1875) described abnormal pistils in the Hawaiian *Wikstroemia*, and the former seems to have judged the sex of the specimens (male, female or bisexual) on the basis of this abnormality. In *Daphne*, too, some species are dioecious or indistinctly so, others have bisexual flowers. But there can not be found any distinct trend valuable for the consideration on interrelationships of the genera or groups of other ranks, in the differentiation of sex.

The styles are terminal in all groups of the *Daphneae*.

8. **Stamens.**

Androecia in the *Daphneae* are mostly diplostemonous with some exceptions mentioned above, and haplostemonous only in *Diarthron linifolium*. The filaments are always short or very short (except *Linodendron*). They are not so long in *Championi* and *Eriosolena* as noted by DOMKE.

The stamens are arranged in two distinctly separate rows. Those in the upper row are opposite to the lobes, and their anthers are usually half-exserted from the floral tube. The lower anthers are alternate with the lobes and contiguous to the upper ones or inserted on the middle of the tube.

Both rows of stamens are entirely included in the tube at different heights in some species of the following groups: *Pseudo-mezereum, Daphnimorpha, Ambigua, Penicillata, Gemmata, Paxiana, Diarthron* and *Diffusa*. In *Rhamnoneuron*, on the other hand, the anthers are sitting on the lobes—the traces of filaments may be entirely connate to the sepal bundles—according to DOMKE's description.

The position of stamen-insertion and the length of filaments are useful for the diagnosis of groups of lower rank, but do not represent any distinct line of specialization. LECOMTE tried to establish a section called *Diffusa* in the genus *Stellera* based on this character.

9. **Pollen grains.**

As mentioned in the previous paper, the exine of pollen grains is smooth only in *Daphnimorpha*. In the other genera, so far as I examined, it is of subreticulate pattern (cf. LECOMTE 1916, ERDTMANN 1952 and IKUSE 1956). Special regard should be paid to the taxonomic significance of this difference.

The size of pollen grains is often variable even in the same species, e. g. in *Edgeworthia chrysantha* 40-105 μ in diameter according to NAKAHIRA (1954).

10. **Fruits.**

Berries grow in *Daphne* (except *Genkwa, Championi* and *Aurantiaca*) and *Wikstroemia*.

Dry fruits with thin pericarp are observed or recorded in *Daphnimorpha, Pentathymelaea, Circinata, Diffusa, Chamaestellera, Diarthron, Dendrostellera, Diplomorpha, Linodendron* and *Rhamnoneuron*.

Fruits with thin-fleshy pericarp are found in *Genkwa* (?) and *Edgeworthia*, and fruits with slightly fleshy exocarp and thin sclerotic endocarp in *Eriosolena* (cf. DOMKE).

It is considered that the pericarp is specialized from the fleshy or sclerotic to the thin-membranaceous within the family, but that, in the *Daphneae*, the degree of this specialization is variable with groups.

The floral tubes or at least the lower parts of them are more or less persistent and envelop the ripe fruits usually in the groups with dry fruits. In the species bearing berries they are generally caducous. But there is no clear difference between these two.

It is worth deliberation that the floral tubes are articulated above the stigmata and the fruits are with thin-membranaceous pericarp in most of the *Gnidieae* to which DOMKE arranged *Diarthron* and *Dendrostellera* close, as mentioned above.

The peculiar basal appendices or processes of seeds were described by LECOMTE (1914) in some species. But this organ was not examined about its taxonomic significance.

11. **Endosperm.**

In the *Daphneae*, the endosperm is generally poor or absent, except the following genera in which the endosperm is somewhat rich: *Edgeworthia* and, according to DOMKE, *Diarthron*, *Dendrostellera* and *Rhamnoneuron*; but GILG described that it is likewise poor in the latter three. Its quantity is, moreover, related with the thickness of cotyledons and the length of hypocotyls. DOMKE attached importance to it, because the correlation between it and the lateral styles is recognized in the *Gnidieae*. I refrain from further discussion, for I have no sufficient data about this character. But it seems that it does not play any decisive rôle in the phylogenetic discussion on the *Daphneae*.

§ 2. The Anatomical Characters

1. **Internal phloem and fibers.**

(i) In axes.

Since O. G. PETERSEN's study was published in 1882, the presence of internal phloem in the axes has been a well-known common character of the Thymelaeaceae (except a few genera) and has been studied by many other investigators (VAN TIEGHEM 1893, SUPPRIAN 1894, LÉANDRI 1930, etc.). I also studied and discussed about this tissue of the Japanese species in the previous paper. As in the external phloem, the internal phloem likewise contains more or less numerous fibers. I formerly described that the fibers are entirely absent in the internal phloem in *Daphnimorpha*. But, after then, I have noticed that a few internal fibers are certainly present in this genus as in *Diplomorpha*. There are some cases where it is very difficult to ascertain the presence of them, on the other hand, in *Daphne* and others which usually contain numerous internal fibers deeply stained with safranin. The difference in the number of internal fibers is consequently not very significant. But it may be generally said that the internal phloem fibers are few or entirely absent in the groups of the same branching habit as *Diplomorpha*—*Diplomorpha*, *Dolicantha*, *Diarthron*, *Chamaestellera*, some of *Circinata* and *Pentathymelaea* (cf. LÉANDRI)—and in *Daphnimorpha*, while more or less abundant in *Daphne*, *Edgeworthia*, *Eriosolena*, *Rhamnoneuron* and *Wikstroemia*.

The fascicles of internal phloem reach into the leaf traces in all of the *Daphneae*.

(ii) In leaves.

The bundles in the petioles and midribs of the leaves have phloem strands on the adaxial side in some groups, but not in the others. Those phloem strands shall be also called "the internal phloem" here after the manner of LÉANDRI. The anatomical structure of the internal phloem strands was investigated and discussed in detail by LÉANDRI (1930). I likewise studied this tissue on the Japanese and some foreign species, and distinguished three types concerning the presence or absence of the internal phloem and fibers in the previous paper. Since the publication of it, I have furthermore examined many other foreign species including the pentamerous species of *Daphne* and *Wikstroemia*. If the results of both my studies together are distinguished into three categories mentioned above, it is as follows:

a. The internal phloem and the fibers are more or less abundantly present: *Wikstroemia, Edgeworthia, Eriosolena, Rhomnoneuron* and *Linodendron*. (The latter three were referred to VAN TIEGHEM and LÉANDRI. The number of fibers in them is unrecorded.)

The internal fibers are very abundant and sometimes occupy full space on the adaxial side in *Wikstroemia,* while they are somewhat less so in *Edgeworthia*.

b. The internal phloem is arranged in a few small groups, while the internal phloem fibers are absent except some few ones occasionally observed in cross sections: *Ambigua* and most of *Diplomorpha*.

c. The internal phloem is entirely absent: *Daphne* (all sections except the unknown *Aurantiaca*), *Daphnimorpha, Penicillata, Gemmata, Pentathymelaea* (ex LÉANDRI), *Wang, Dolicantha, Diplomorpha Chamaedaphne, Diarthron* and *Stellera* (ex LÉANDRI).

In *Daphne Genkwa, D. gemmata* and *Wikstroemia dolicantha,* the bundle is often closed into a ring or nearly so in transverse section nearly at the distal end of the petiole, but it becomes lunar or horseshoe-shaped in the midrib and does not leave any tract of phloem cells on the adaxial side.

The shape of foliar bundles in cross sections is generally varied and with no taxonomic importance. Applying mechanically the above-mentioned grouping to GILG's system, as LÉANDRI tried, it seems that the groups with internal phloem are scattered in the family without any indication of phylogenetic significance of this tissue. This condition induced DOMKE to underestimate the taxonomic or phylogenetic value of every anatomical character. Adding some modifications to DOMKE's system, which seems less artificial at least than that of GILG, and applying the same grouping to the modified, however, we can notice that there is a trend of specialization from the foliar bundles with to those without internal phloem in this family. The line of this trend appears to be in parallel to that of the reduction of the included phloem in the wood and to that of the other anatomical characters, as mentioned later.

(iii) Numerous sclerenchymatous fibers are densely intertwining in the mesophyll of leaves only in *Eriosolena*. The presence of them has been regarded as a diagnostic feature for this genus (cf. VAN TIEGHEM).

In *Diarthron* and *Dendrostellera,* the leaves are isolateral and the palisade tissue is formed on both sides, while in *Chamaestellera* only on the upper side (VAN TIEGHEM). But, according to SUPPRIAN, there is recognized an inclination to change to the isolateral leaves in *Stellera Chamaejasme* L., and also in *Diplomorpha*

Chamaedaphne according to my observation. This may be due to the special habitats where they grow.

2. **Tracheary elements.**

As mentioned in the preceding part (p. 20), it is very difficult to decide which one macerated element is, vessel member or tracheid, and another, tracheid or fiber-tracheid. Fiber-tracheids are almost exclusively fusiform or very similar to some parenchyma cells or tracheids in the macerated condition in some species. When the spiral thickenings are present, tracheids and small vessel members generally show the most conspicuous thickenings among the three elements. The bordered pits and sometimes even the perforations are very difficult of recognition in such cases. Among such elements, however, some are doubtless fewly pitted. On the contrary, there are some imperforate cells with numerous bordered pits—though the apertures are usually steeply oblique—in the species in which the spiral thickenings are entirely absent. The presence of the tracheids is consequently evident for all genera, but the number of them is likely to be related to the pattern of vessel arrangement to some extent.

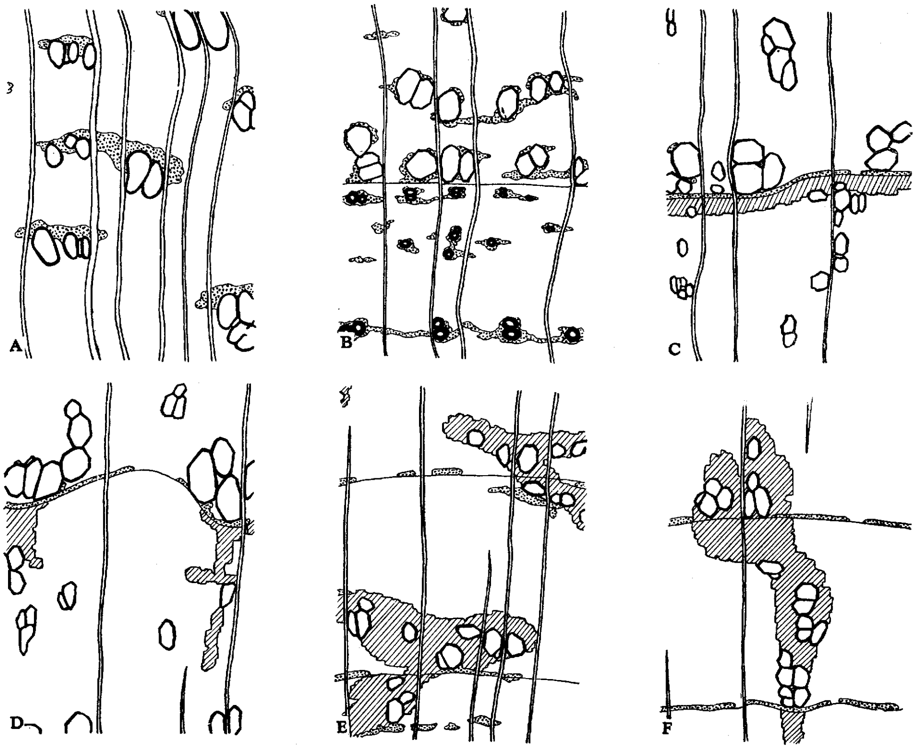

Fig. 6. Schematic figures of transverse sections of wood.
A: *Wikstroemia*. B: *Edgeworthia*. C: *Diplomorpha*.
D: *Daphnimorpha*. E: *Daphne—Daphnanthoides*.
F: *Daphne—Pseudo-mezereum*.
Closed lines: pores; dotted area: wood parenchyma; hatched area: masses of tracheids; narrow area contained between parallel lines: rays; other white area: masses of fiber-tracheids.

(i) Arrangement of vessels and tracheids.

As mentioned above, the arrangement of these two elements can not be separately discussed. The fundamental types of arrangement are established on the basis of combinations of various patterns in the distribution of vessels and of tracheids.

a. *Wikstroemia*-type: Pores are evenly distributed, a few to several in groups, forming clusters or short files or chains, sometimes solitary. In cross sections, the vessels (pores) are distinctly distinguishable from fiber-tracheids, while the vasicentric tracheids are indistinguishable from the former. Growth rings are usually indistinct or vague except in *Edgeworthia chrysantha.*

Wikstroemia, *Rhmnoneuron* (ex LECOMTE's figures), *Eriosolena* and *Edgeworthia* belong to this. In the latter two, the number of vessels in each group or cluster is generally fewer (mostly 2-3) than in the others. The 'diffuse' arrangement in *Linodendron* (RECORD and HESS 1949) also may be the same as this type.

A striking feature to characterize *Edgeworthia chrysantha* is the presence of two sizes of vessels. The early wood vessels are of large diameter and with angular lumina in cross sections, while the late wood vessels are of distinctly small diameter and with round lumina. The walls of the latter are much thicker than those of the former. The transition between both is usually abrupt. This remarkable feature may be related with the difference in the rate of growth before and after the peculiar trichotomy of this species occurring in early summer. But I could not find the same feature in a 2-year-old branch of *E. Gardneri* which is another *Edgeworthia* actually studied. Furthermore, the tracheids are fewer in that species than in other genera, perhaps with relation to its mostly solitary arrangement of vessels.

b. *Diplomorpha*-type: The arrangement of vessels in cross sections is usually a diffuse type; solitary or in clusters of some few vessels, and often in radial or oblique streams. Early wood vessels may be arranged in close initial 1-2 rows especially in narrow growth rings. Tracheids are arranged in terminal bands of 1-6 (rarely more) rows. Irregular tangential bands of tracheids or thick-walled fiber-tracheids also are occasionally observed. The elements of these bands are frequently transitional to fiber-tracheids. Instead of the terminal bands, tracheids are often arranged in inwards directed groups or rows and intermingled with small vessels. The latter condition suggests an intimate relation of this type to the next. Growth rings are usually distinct.

Diplomorpha belongs to this, but *D. Chamaedaphne* and *D. canescens* are doubtful yet.

According to the observations on the hand sections of slender or young branches, *Championi*, *Ambigua* and *Diarthron* also may belong to either this or the preceding type. LÉANDRI described that, in *Stellera* and *Diarthron*, vessels are scattered solitarily or in clusters of 2-3. In these, having no spiral thickenings, the presence of tracheids is as obscure as in *Diplomorpha Chamaedaphne*. *Stellera Chamaejasme* has stems and radices of peculiar structure according to JOSHI (cf. METCALFE and CHALK). In these organs, concentric zones of xylem and phloem (including numerous fibers) are separated from one another by parenchyma. This peculiar structure is likewise observed in *S. rosea*. The annual shoots of these two species are usually straw-like and of special structure. In consequence, we can not discuss the structure of them at the same level with the wood of the other genera or species, but it may promise a generic position to the *Chamaestellera*-group if it is common in this group. It may be to some extent recognized in *Diarthron*, too.

c. *Daphnimorpha*-type: The arrangement of vessels in cross sections is fundamentally the same as the preceding. Because growth rings are usually narrow, however, early wood vessels tend to be gathered in small clusters. Late wood vessels are usually very small. Tracheids are arranged in short or long radial groups or narrow terminal bands. Beside these, narrow tangential bands often connect one radial group with another, and solitary cells or small groups are diffuse or contiguous to the vessels. The radial groups tend to be contiguous to the early wood vessels or vessel groups in the next rings, and intermingled with small vessels. In such cases, the terminal bands are occasionally absent at long tangential intervals. Growth rings are usually distinct, but in part obscure because of the absence of terminal bands of tracheids or those of parenchyma and initial vessels.

This type is very similar to the preceding especially in the arrangement of vessels, but that of tracheids suggests an intimate relationship to the next type. When the aggregation of vessels and tracheids is advanced, it may result in the appearance of *Daphne*-type.

Daphnimorpna alone belongs to this.

d. *Daphne*-type: Vessels usually together with tracheids are arranged in flame-shaped or dendritic groups. The groups are sometimes very long in radial or oblique direction, sometimes are scattered as small masses or short tangential tracts. Rarely vessels alone are arranged in small clusters or solitarily. Because the pores are often not very distinct from fiber-tracheids, the growth rings are obscure. The flame-shaped groups are as obviously observed in the species with slight or no spiral thickenings as in those with conspicuous thickenings.

All sections of *Daphne* except *Championi* belong to this.

LÉANDRI distinguished four types of vessel arrangement on the basis of his studies on the axes less than 1 cm in diameter. Concerning the *Daphneae* his result is as follows:

a) vaisseaux isolés ou par groupes 2 ou 3: *Diarthron* and *Stellera*.

b) vaisseaux tendant à se disposer en files radiales: (*Phaleria*), *Daphne*, *Edgeworthia*, *Rhamnoneuron*, *Wikstroemia* and *Linodendron*.

c) vaisseaux tendant à se disposer en files tangentielles: *Pentathymelaea*.

d) des files radiales et des files tangentielles: *Eriosolena.*

It is evident from the above-mentioned, however, that this assortment of his gives an unfair picture except *Diarthron* and *Stellera* in which the branches are annual. It is not an uncommon case with vessels that they are radially arranged (within narrow intervals of rays) in one or some few growth rings contiguous to the pith before taking the pattern of distribution in the adult wood. So the radial arrangement in such condition is not necessarily considered as the characteristic feature. It has been rather noticed in this study that even in such inner growth rings, in some species of *Wikstroemia, Edgeworthia* and others, the arrangement of vessels shows nearly the same pattern (not radial) as in more outer rings.

According to METCALFE and CHALK (Fig. 282, G and L) and others, *Phaleria* shows a similar distribution of vessels (and parenchyma) to that in *Wikstroemia,* and *Passerina* shows the dendritic type (with spiral thickenings, too) as observed in *Daphne. Passerina* belongs to the *Gnidieae,* the most-progressed tribe in DOMKE's sense, while the *Phalerieae* are remarkable by 2-carpelled ovaries and are regarded as a group being in the lower stage of progress at least than the *Daphneae.* From this knowledge, we may suppose a series of progress from *Wikstroemia*-type to *Daphne*-type through the other two, so far as the arrangement of vessels and tracheids is concerned. But the direct connection between *Wikstroemia*-type and *Diplomorpha*-type is somewhat difficult of deduction, while that between the latter and *Daphne*-type through *Daphnimorpha*-type is easy.

The formation of the terminal bands of tracheids or thick-walled fiber-tracheids in *Diplomorpha* is probably related to that of distinct (annual) growth layers and, to some extent, to the appearance of spiral thickenings. If this supposition is admitted, we may further presume a derivation of the latter three (b, c and d) types from *Wikstroemia*-type nearly in the same geological time when the peculiar late wood of *Edgeworthia chrysantha*—and the linear thickenings of tracheary elements in *E. Gardneri*—began to be formed. This presumption should be, of course, fully compared with the other characters and the geographical distribution of genera and species.

(ii) Spiral thickenings of tracheary elements.

The spiral thickenings of the tracheary elements mainly in leaves were examined in the previous paper (1955 b). It has been noticed from the wood anatomical studies that the degree of their conspicuousness in the tracheary elements of wood is entirely the same as that in leaves, as briefly mentioned in it. If present, the thickenings are generally most conspicuous on the walls of small vessels and tracheids. On the vessels of large diameter, they are slight or entirely absent, and, in the former case, are observed partially in the vessel members, especially on the tails. They are likewise present on some of fiber-tracheids.

Generally the examination on the spiral thickenings is easiest about the tracheary elements in the secondary xylem of the axes, and those in the foliar bundles also are useful enough if the materials are taken from the petioles. But, as the materials of the Chinese pentamerous species of *Daphne* and *Wikstroemia* (specimens in A) and others were only the remainders of those studied on the internal phloem—that is, the middle part of midribs of leaves—, most of them contain only tracheary elements which have annular, helical or reticulate thickenings and no pits. The results of examination on them are consequently of no certainty.

The presence or absence of spiral thickenings is as follows:

a. Spiral thickenings absent: *Wikstroemia, Rhamnoneuron, Eriosolena, Edgeworthia chrysantha, Dolicantha* (?), *Diplomorpha Chamaedaphne* and *D. canescens, Diarthron, Ambigua, Penicillata* (?), *Gemmata, Wang* (?), *Championi* and *Daphne Gnidium* (?).

b. Spiral thickenings conspicuous or slight: *Edgeworthia Gardneri* (linear thickenings), *Diplomorpha* (often slight), *Chamaestellera* (conspicuous in the annual shoots, but absent in the radices or subterraneous stems), *Daphnimorpha* and nearly all sections of *Daphne* (in *D. Cneorum* often very slight).

As understood from this assortment, the occurrence of spiral thickenings is not limited to special genera. The genera in which the presence of spiral thickenings was ascertained (cf. METCALFE and CHALK 1950) are comparatively few in this family and are scattered in each tribe of the Thymelaeoideae in DOMKE's sense. It is consequently sure that the spiral thickenings are not important for phylogenetic consideration at least in this family.

(iii) Bordered pits on the walls of vessels.

In *Daphne* (except *Genkwa* and *Championi*) only, the vessels in the stem wood have round bordered pits with small (mostly ca. 1-3 μ) round apertures. These pits are generally large (ca. 5-10 μ in diameter) and sparse; their outline seldom becomes angular through crowding. In other genera, the pits usually become oval or angular through crowding; the apertures are horizontally lenticular and included or screwhead or often coalescent. These pits are usually somewhat smaller than those in *Daphne*, but in *Edgeworthia* as large as the latter. Because the apertures are likewise lenticular in the root wood of *Daphne*, and because there is not any sharp difference between these two shapes of pits, it is not necessary to give them any special evaluation.

(iv) Outline of pores.

The transverse outline of vessels is generally round in *Wikstroemia* except the intervascular walls. It is, on the other hand, somewhat angular in other genera, so far as the adult wood of the Japanese species is concerned. In some species among the latter, e. g. in *Daphne Genkwa* and *Diplomorpha sikokiana*, the outline is usually likewise round. Since the studies of BAILEY and his colleagues, the round outline of vessels has been considered as a more specialized character than the angular. But it is considered that such trend of specialization observed in the whole dicots is not always in evidence for the groups of lower rank within a family just as it is. That is, the direction of the minor trend seen in the *Daphneae* is reverse to that of the major trend. It may rather be said that this difference is likely related with the usually thin walls of the tracheary elements.

(v) Length of fiber-tracheids.

The fiber-tracheids are usually longer in *Wikstroemia* and *Edgeworthia* than in *Daphnimorpha* and *Daphne.* Their shape in the former is somewhat similar to that of libriform fibers, while in the latter, especially in *Daphnimorpha* and the subsect. *Pseudo-mezereum* of *Daphne,* they are short or nearly fusiform. In *Diplomorpha,* fiber-tracheids of both shapes exist together, or one or another shape is exclusive in each specimen.

Beside the visual difference in the shape, the length of fiber-tracheids was compared with that of parenchyma cells, because it was generally considered that the latter retain almost the same length as the fusiform initials (CHALK et al. 1955). The ratio of the maximum lengths of both kinds of cells (fiber-tracheids/parenchyma cells) was tentatively calculated for each specimen, for I did not practise sufficient statistic examination. The mean of them in each species is shown in Table 1.

Though there may be naturally some questions against this treatment and the data themselves, the result appears to suggest something important. On the other hand, the similar kind of ratio between vessel members and parenchyma cells is generally close to 1 in every genus, though it is self-evident.

We have been learning from the studies of BAILEY et al. that the vessel members

Table 1. The elongation ratio of fiber-tracheids

Average in genus		Mean in species	
Wikstroemia	3.7 (−4.2)	W. pseudoretusa	3
		W. retusa	4.3
		W. Junghuhiniana	5.9*
Edgeworthia	3.3	E. chrysantha	3.3
Diplomorpha	2.6	D. trichotoma	2.2
		D. albiflora	2.4
		D. Ganpi	2.5
		D. pauciflora	2.7
		D. yakushimensis	3
		D. sikokiana	2.8
Daphnimorpha	1.7	D. Kudoi	1.7
		D. capitellata	1.5 (−1.8)
Daphne	2.7	D. pseudo-mezereum	2.3 (−2.6)
		subsp. jezoensis	2.3 (−3)
		D. Miyabeana	2.4
		D. kiusiana	3
		D. odora	2.8

* after JANSSONIUS (1930)

generally pursue the course of shortening in the major trend of specialization in the whole dicotyledons. In the *Daphneae,* however, the length of vessel members is not of remarkable tendency, and the difference in it seems rather to be related with the difference of individuals than that of genera. (The perforations also are simple in all the species.) On the other hand, the elongation ratio of fiber-tracheids appears to show a conspicuous trend of reduction from one genus to another in the average value, and consequently it is very suggestive about the direction of progress in this tribe.

Probably under such reduction in the elongation, the radial storied structure becomes more apparent in some species, especially in *Daphnimorpha* and *Daphne* subsect. *Pseudo-mezereum.* It may be said in this connection that the storied structure itself is often regarded as a more-specialized feature.

3. **Wood parenchyma.**

(i) Wood parenchyma pattern.

a. Paratracheal abundant—mostly abundant on the abaxial side, short aliform or often irregularly confluent, scanty on the adaxial side: *Wikstroemia* and *Rhamnoneuron* (ex LECOMTE).

b. Confluent or short aliform narrow, and apotracheal narrow or scanty—in the late wood often forming narrow concentric bands, and less abundant in the early wood: *Edgeworthia* and *Eriosolena* (?).

These genera can be separated from the preceding by this character, though both have similar pattern of vessels and tracheids.

c. Terminal narrow and paratracheal narrow or scanty—the paratracheal parenchyma contiguous to the flame-shaped groups of vessels and tracheids, sometimes forming small masses, sometimes short aliform to confluent; often single cells sparsely scattered: *Daphne* (*Daphnanthoides, Alpinae, Cneorum* and *Genkwa*). *Laureola* and *Mezereum* are included either in this or in the next.

d. Terminal narrow, and occasional cells contiguous to the large early wood vessels or the diffused vessels: *Diplomorpha, Daphnimorpha* and *Daphne* (*Pseudo-mezereum*). In some growth rings contiguous to the pith, the paratracheal parenchyma cells are often more numerous. Therefore, it can not be decided to which type the following groups belong, since they were examined only about slender branches: *Diplomorpha Chamaedaphne, D. canescens, Championi, Ambigua, Chamaestellera* and *Diarthron.*

KRIBS considered that the vasicentric abundant type is the highest-specialized one in the major trend of specialization in the wood parenchyma, and that the terminal parenchyma results from a specialization due to reduction. If his hypothesis is followed, it should be considered that the said b- and c-type are less-specialized than a- and d-type. For the vasicentric abundant type is also recognized in the *Phalerieae,* however, I rather suppose a reduction series of

$$\begin{tikzcd} a \arrow[r] & b \arrow[rr] \arrow[dr] & & d, \\ & & c \arrow[ur] & \end{tikzcd}$$

or

$$\begin{tikzcd} a \arrow[r] & b \arrow[r] \arrow[dr] & c. \\ & & d \end{tikzcd}$$

The fact that the paratracheal parenchyma in c- and d-type is somewhat more abundant in the anomalous wood, in the vicinities of foliar rays or in a few growth rings contiguous to the pith, than in the other parts, appears to support this presumption, because it is said that such parts usually retain or revive vestigial features of the antique structure.

(ii) Abundance of parenchyma strands.

Individual parenchyma cells are usually fusiform in most groups. In the others, numerous strands of 2-5 cells are found. Though the ratio in number of strands to all parenchyma strands and fusiform cells within one tangential section is variable with specimens or parts, it shows comparatively constant value or constant variation of the value for each genus. And the strands composed of more than 2 cells are generally more numerous in the wood in which the parenchyma strands are predominant, while very rare in the wood with few strands.

a. Parenchyma strands predominant, nearly 80%: *Wikstroemia*, *Rhamnoneuron* (ex LECOMTE), *Eriosolena* and *Championi* (?).

b. Parenchyma strands a few to at most 50% or rarely predominant: *Edgeworthia*, *Diplomorpha* and *Ambigua*.

c. Parenchyma strands very few to at most 20% or less: *Daphne* (except *Championi*) and *Daphnimorpha*.

The general line of specialization in this character is not known yet, but it is nearly in parallel with the above-mentioned line in the parenchyma pattern. There is in general no remarkable difference in the length between parenchyma strands and fusiform cells.

4. **Wood rays.**

The rays are mostly uniseriate and only in part 2(-3)-seriate in some genera, while in the others the multiseriate rays also are very numerous. They are generally homogeneous in most genera, while the heterogeneous rays tend to be numerous or predominant in *Eriosolena* and *Edgeworthia*. But the difference of homogeneous and heterogeneous rays is indistinct in the *Daphneae*. The ray cells are predominantly procumbent, but square or upright cells may appear in marginal or sometimes in central rows. Both sorts of cells are usually transitional to each other.

Therefore, the width in number of cells alone plays an important rôle in this discussion.

a. Multiseriate rays numerous—the maximum width in number of cells is about 6: *Wikstroemia*, *Rhamnoneuron*, *Eriosolena* and *Edgeworthia*. In the last, the rays are at most 2 cells wide, and in some cases uniseriate rays are predominant.

b. Uniseriate rays predominant or exclusive—in part 2-3-seriate: *Diplomorpha*, *Diarthron* (?), *Chamaestellera*, *Ambigua* (?), *Daphnimorpha*, *Championi* (?) and all other sections of *Daphne*. In some species of *Diplomorpha* biseriate rays are often very numerous by the parts of specimens.

In *Phaleria*, too, the rays show the former type. It may be consequently supposed that the groups showing the latter type are more specialized than those showing the former, and this supposition nearly agrees with KRIBS's hypothesis (1935). On the other hand, since the rays are mostly uniseriate in *Aquilaria*, which is a less-progressed genus taking a position in the beginning of this family, I consider that this reduction series in the width is presumed only for the groups examined in this study. The line of the reduction agrees to some extent with that of the parenchyma strands.

5. **Crystals.**

Druses occur or are recorded in *Edgeworthia* and *Eriosolena*. In *Edgeworthia chrysantha*, the crystalliferous cells occur in the pith, the xylem- and phloem-rays, the phloem parenchyma, the cortex and the mesophyll of leaves. They are usually solitary, but in the pith several or more numerous crystalliferous cells often constitute a long axial row.

VAN TIEGHEM (1893 b) mentioned: "une seule fois, j'ai vu dans un rameau de l'année du *Daphne Mezereum*, coupée en hiver au-dessous du bourgeon terminal, chaque cellule du parenchyme des diverses régions renfermer un très petit cristal prismatique ou lenticulaire d'oxalate de chaux, ou plusieurs cristaux plus fins groupés autour d'un centre." SUPPRIAN (1894) found numerous druses and a few single crystals in the spongy tissue of leaves (but absent in the cortex) in *Wikstroemia indica*. Furthermore, according to him and GILG (1894 b), the occurrence of crystals is very irregular and variable with seasons or parts of plants in some species of the other tribes. These facts were used by GILG as one of the reasons to reject the taxonomic value of the anatomical characters, since he merely regarded the crystals as a kind of physiological or metabolic by-product. The occurrence in those two species, however, seems very rare or casual, and consequently the presence or absence of them is often very helpful for diagnostic purpose at least in the *Daphneae*. On the other hand, the shape of crystals is not of taxonomic importance, as SOLEREDER (1908), and METCALFE and CHALK (1950) mentioned.

§ 3. Interrelationships of Genera and Groups of Lower Rank

Principal characters mentioned in the preceding sections are made into Table 2. Beside these, several other characters have been used by other taxonomists to diagnostic purpose for exceptional groups, but those are usually of no importance for the main subjects of phylogenetic discussion.

1. **Line of specialization and progress in the family.**

As mentioned in the beginning of this part, all genera of the tribe *Daphneae* sensu DOMKE—with exception of *Daphnopsinae*—are included in this study in order to seek out the natural relationships between them, for such relationships can not be detected from the study on the Japanese genera alone. The important characters mentioned above have been marked from the comparison between those genera, and examined about their aspects in each group.

Table 2. Principal characters mentioned in the text

	Characters / Groups	1	2	3	4	5	6	7	8	9	10	11	12
Daphne	Pseudo-mezereum	a	4	a	r	b	c	d	++	d	–	u	–
	Daphnanthoides	a	4	a	r	b	c	d	++	c	–	u	–
	Alpinae	a	4	?	r	b	c	d	++	c	–	u	–
	Oleoides	a	4	a	?	b	c	?	+∼–	?	?	u?	–
	Cneorum	a	4	a	?	?	c	d	++∼+	c	–	u?	–
	Laureola (Collinae)	a′	4	a	r	b	c	d	++	c?	–	u	–
	Mezereum	a′	4	a	r	b	c	d	++	c?	–	u	–(+)
	Genkwa	a	4	a	r	b∼s	c	d	++	c	–	u	–
	Championi	d?	4	a	?	?	c	a?	–	c?	++	u?	–
	Aurantiaca	d?	4	c	?	?	?	?	?	?	?	?	?
	Wang	a	4	a∼b	?	s?	c	?	–?	?	?	?	?
	Pentathymelaea etc.	a	5(4)	b	r	s, b?	c	?	–?	?	?	?	?
	Ambigua	a	5	b	?	?	b	b?	–	c?	–	u?	–
	Daphnimorpha	a	4	b	s	s	c	c	++	d	–	u	–
	Diplomorpha	b	4	c	r	s	b∼c	b	++∼–	d	–∼+	u	–
	Dolicantha	b	5(4)	c	r	s	b?∼c	b?	–	?	?	?	–?
	Dendrostellera	b?	4	a∼b	?	s	(c)	b?	?	?	?	?	?
	Circinata (Diffusa)	b?	5	b∼c	r	s	?	?	?	?	?	?	?
	Diarthron	b	4	a	?	s	c	b?	–	c?	?	u	–
	Chamaestellera	b?	5(4)	a∼b	?	s	c	b?	$\overset{++}{-}$	?	+?	u	–
	Edgeworthia	c	4	a	r	b∼s	a	a	+∼–	b	+	u∼m	+
	Eriosolena	c	4	a	?	d	a?	a	–	b	++	m	+
	Rhamnoneuron	c	4	a	?	s?	a?	a	–	a	++	m	–?
	(Linodendron)	c?	5	a	?	s	a?	a?	?	?	?	?	?
	Wikstroemia	a	4(5)	c	r	b	a	a	–	a	++	m	–(+)

Explanation of the Table 2.

Characters: **1.** Branching habit and inflorescence, **2.** Pentamerousness and tetramerousness, **3.** Hypogynous discs, **4.** Exine of pollen grains (r: subreticulate, s: smooth), **5.** Fruits (b: berries, s: dry fruits, d: drupe-like), **6.** Internal phloem and fibers in leaves, **7.** Arrangement of vessels and tracheids, **8.** Spiral thickenings, **9.** Parenchyma pattern, **10.** Abundance of parenchyma strands, **11.** Wood rays (u: uniseriate predominant, m: multiseriate numerous), **12.** Druses.

Literal signs not defined above are those (or head letter) in the text. ++, + and – : from abundant (or conspicuous) to absent.

The line and direction of specialization in each of those characters have been discussed to some extent. But in order to decide whether or no the line (and the character) is truely of phylogenetic significance, it should be compared with the line of progress in the group of higher rank and also with those of specialization in principal characters the latter shows. Here, DOMKE's classification system seems less artificial and consequently is more useful for this purpose than that of GILG—these two systems are representative among those published hitherto. I accordingly follow the classification of DOMKE, but the part with respect to the *Daphneae* is rather thoroughly amended in this study. It is different from that of GILG mainly in the phylogenetic evaluation of the number of carpels (or locules) and of the petaloid scales. If we attach more importance to the petaloid scales than he, as GILG did, the classification may be considerably different from DOMKE's system. But there is not any accepted opinion about the origin or morphologic significance of this organ, and in consequence his classification can be on the whole regarded as an adequate one so far as the other characters are concerned.

For reference, the conspectus of DOMKE's system is cited here.

1) Subfam. Gonystyloideae.
2) Subfam. Aquilarioideae (incl. 3 general tribes).
3) Subfam. Gilgiodaphnoideae.
4) Subfam. Thymelaeoideae.
    1. Trib. *Dicranolepideae* (incl. 2 subtribes).
    2. Trib. *Phalerieae* (incl. 2 subtribes).
    3. Trib. *Daphneae*.
        i. Subtrib. *Wikstroemiinae*: *Wikstroemia*.
        ii. Subtrib. *Dendrostellerinae*: *Dendrostellera* and *Diarthron*.
        iii. Subtrib. *Daphnopsinae*: *Daphnopsis*, *Funifera*, *Schoenobiblus*, *Ovidia*, *Lagetta* and *Dirca*.
        iv. Subtrib. *Daphninae*: *Daphne*, *Eriosolena* and *Edgeworthia*.
        v. Subtrib. *Rhamnoneurinae*: *Rhamnoneuron*.
    4. Trib. *Gnidieae* (incl. 6 subtribes).

According to DOMKE, the specialization of the following characters nearly agrees in the line with the order of subfamilies or tribes in this conspectus:

Fruits: capsule→indehiscent fruits (nearly drupe-like fruits or berries→dry fruits).

Flowers: pentamerousness predominant→tetramerousness predominant.

Floral tubes: absent (sepals not connate)→cylindraceous (not articulate)→cylindraceous (obviously articulate).

Androecium (stamens): numerous→10→8→4→2.

Gynoecium (locules): 12→8→3→2→1.

I also mentioned briefly about some of these characters in the preceding section.

Beside these, according to my opinion, two important anatomical characters agree with the above-mentioned in the line of specialization.

Included phloem of wood: present→absent.

Internal phloem in foliar bundle: present→absent.

The lines of specialization in these seven are not always straight or simple, and include many exceptions. But it should be considered that these characters suggest mainly the major lines of specialization, and that the occurrence of such exceptions does not necessarily reduce their value for phylogenetic discussion. Hereupon, the last character concerning the foliar bundles is especially against DOMKE's classification in some parts, but such disorders can be nearly removed and that character may become more important than the others if the classification of the *Daphneae* is properly amended.

Still more, it can be understood that these specializations are mostly due to reduction.

Considering these characters with respect to the subfamily Thymelaeoideae, it is as follows:

Indehiscent fruits: all Thymelaeoideae.
  Sclerotic or fleshy pericarp: *Dicranolepideae*, *Phalerieae* and some of *Daphneae*.
  Membranaceous pericarp: some of *Daphneae* and most of *Gnidieae*.
Flowers, pentamerousness predominant: *Dicranolepideae* and *Phalerieae*.
  Tetramerousness predominant: *Daphneae* and *Gnidieae*.
Floral tubes, cylindraceous: all Thymelaeoideae.
  Not articulate: the former three tribes.
  Articulate: most of *Gnidieae*.
Stamens, 10: *Dicranolepideae*, most of *Phalerieae* and some of *Daphneae* and of *Gnidieae*.
  8: most of *Daphneae* and some of *Gnidieae*.
  Less than 8: some of *Gnidieae*.
Locules, 2: *Phalerieae*.
  1: the other tribes.
Included phloem of wood, present: most of *Dicranolepideae*.
  Absent: the other tribes (In *Phaleria*, *Dirca* and *Gnidia*, the secondary wood of the branches includes the bands of 'parenchyme cellulosique', but this tissue lacks sieve elements, according to LÉANDRI), except *Stellera Chamaejasme* and *S. rosea* according to JOSHI (cf. METCALFE and CHALK).
Foliar bundles, internal phloem present: most of *Dicranolepideae*, some of *Phalerieae*, nearly half of genera of *Daphneae*.
  Absent: the rests of the above-mentioned tribes, and *Gnidieae*.

In these circumstances, it is considered that the *Phalerieae* is generally less-progressed than the *Daphneae* and that the *Gnidieae* is generally more-progressed than the latter.

In this place, it is very important for the phylogeny of the *Daphneae* that *Wikstroemia* sensu stricto is very similar in the anatomical and even in some exomorphic characters to *Phaleria* in the *Phalerieae* as DOMKE also pointed out, and that *Daphne* seems to be similar to some of the *Gnidieae* in the anatomical characters. It is consequently reasonable to consider that *Wikstroemia* preserves most numerous antique characters among the genera of the *Daphneae* and that the other genera have been derived from the prototype close to it. In fact, as mentioned in the preceding sections, most of the anatomical characters show the specialization in the same line and direction from *Wikstroemia* to *Daphne* through the others as if they support that presumption.

Thus, it can be admitted that the above-mentioned line is probably closest to the line of progress in the *Daphneae*. In some cases, the line is in contradiction to the hypotheses of BAILEY and his colleagues and of KRIBS, but this results from the difference between the major trend in the whole dicots and the minor line in a small group such as a tribe.

2. **Line of specialization and progress in the tribe.**

Among the characters discussed in the preceding sections, the following are consistent with the above-mentioned condition. Here it should not be forgotten that these are not entirely the same with the characters used for the consideration on the progress within the family but are in the lower stage than the latter.

Internal phloem and fibers of foliar bundles: abundant→poor (fibers few)→absent.

Arrangement of vessels and tracheids: *Wikstroemia*-type (→*Edgeworthia*-type) →*Diplomorpha*-type→*Daphnimorpha*-type→*Daphne*-type.

Elongation ratio of fiber-tracheids: large→small.

Wood parenchyma pattern:

$$\begin{tikzcd} a \arrow[r] & b \arrow[rr] \arrow[dr] & & d & \text{or} & a \arrow[r] & b \arrow[r] \arrow[dr] & c \\ & & c \arrow[ur] & & & & & d \end{tikzcd}$$

Abundance of parenchyma strands: parenchyma strands predominant (ca. 80%) →few to at most 50%→very few to at most 20%.

Wood rays: multiseriate numerous→uniseriate prodominant or exclusive.

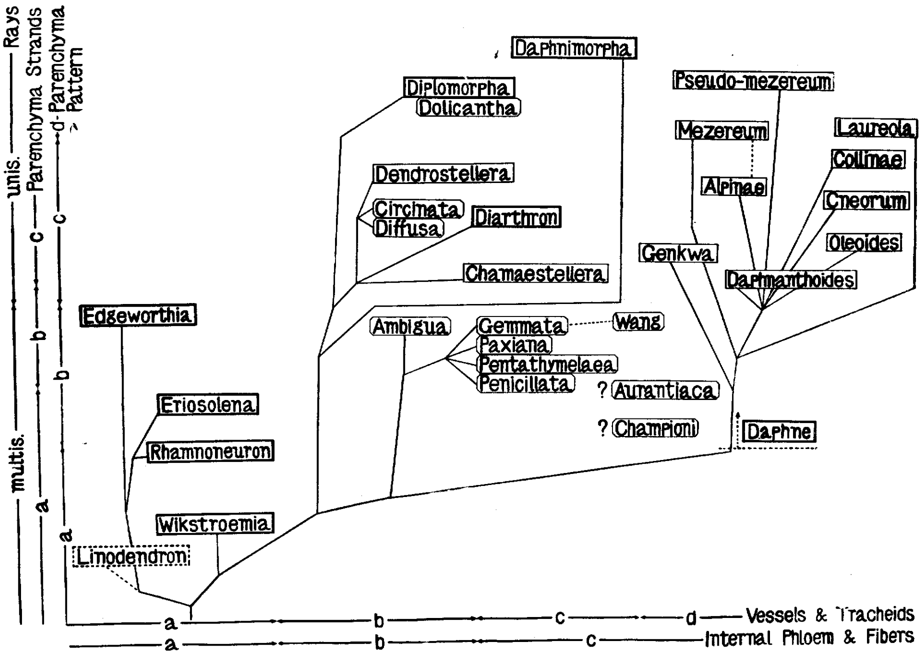

Fig. 7. Schema showing probable interrelationships between groups.

All of these are anatomical ones. On the other hand, the exomorphic characters not only seldom agree with those lines, but also there is not any common line of specialization between themselves. The excessive evaluation on any one of them is consequently very unreasonable and too artificial. So far as this tribe is concerned, the branching habit, the pentamerousness, the shape of hypogynous discs and the sort of fruits and others are respectively helpful only for the diagnosis of some few sections or genera.

The schema showing probable interrelationships between genera or groups is given in Fig. 7. The phylogenetic position of each group is at first decided on the basis of the anatomical characters, but some of the exomorphic characters, especially the branching habit and the inflorescence, are suggestive of connections between such positions.

This schema may unfortunately include some weak points, because the knowledge of the wood anatomical characters are lacking about the groups of pentamerous species, *Stellera* and others, and because the subtribe *Daphnopsinae* have never been examined on the actual materials in this study. But with respect to the latter, I consider that it is another branch derived from the common ancient prototype with the groups examined in this study. Every genus in it includes species with vestigial petaloid scales. A line or lines of specialization mainly of the anatomical characters found in it seem to be similar to the above-mentioned of the *Daphneae*. The exomorphic characters in the *Daphnopsinae* are considerably different from those of the other subtribes. The former groups—*Stellera*, *Diarthron* and the others of pentamerous species—are tentatively arranged in the present positions, but these may be not so distant from the true phylogenetic positions that the full knowledge of them thoroughly explodes the schema.

The geographical distribution of genera also generally plays an important rôle for the consideration on their phylogenetic relationships. But, in this tribe, any serious contradiction against the schema shown above can not be found among the geographical relations.

3. Conspectus of the *Daphneae* sensu stricto.

DOMKE divided this tribe into four subtribes, i. e. *Wikstroemiinae*, *Dendrostellerinae*, *Daphninae* and *Rhamnoneurinae*—excl. *Daphnopsinae*—, but perhaps there may be no need of such subdivisions. If divided against the intimate relation, four new subtribes, which are entirely different from DOMKE's ones in the conceptions or in the appellations, shall be admitted, and the following names of subtribes are tentative and taxonomically informal since some groups remain unknown or unexamined yet.

1) Subtrib. *Wikstroemiinae*.

1. *Wikstroemia* ENDL.

This corresponds to the section *Euwikstroemia* in the sense of other taxonomists. It is enough worth of a separate genus on the ground of the uniformity of all species and of the distant relation to *Diplomorpha* and the others.

2) Subtrib. *Rhamnoneurinae.*

2. *Rhamnoneuron* GILG.

3. *Eriosolena* BLUME.

These two are very close to each other, and their difference was discussed by LECOMTE (1915 b). The former is similar to *Aquilaria* in the parallel lateral veins of leaves and this fact suggests an antique origin of it. The involucre consists of 2-4 membranaceous bracts.

4. *Edgeworthia* MEISSN.

The involucre in this consists of 7-9 bracts in form of diminutive leaves.

A similar genus, *Linodendron,* grows in the New World and is pentamerous. This may lie phylogenetically between the *Daphnopsinae* and the other subtribes of the *Daphneae.*

3) Subtrib. *Diplomorphinae.*

The conception of this subtribe is incomplete yet, because many of the members have been insufficiently examined.

5. *Diplomorpha* MEISSN.

Most species of this are tetramerous, but some pentamerous species (belonging to *Dolicantha*) also are obviously included in this. This genus is never consolidated into a common genus with *Wikstroemia.*

6. *Daphnimorpha* NAKAI.

By the exine with no sculpture of pollen grains, this is remarkable.

7. *Diarthron* TURCZ.

D. linifolium alone is haplostemonous. This and *Stellera* may be the most-progressed groups in this tribe.

8. *Stellera* LINN. (sect. *Chamaestellera* C. A. MEYER).

Two species examined are remarkable by the peculiar structure in the radices and subterraneous stems—concentric zones of xylem and phloem, separated from one another by parenchyma. These also are pentamerous.

8′. *Dendrostellera* VAN TIEGHEM.

All species are tetramerous, and this may include the pentamerous groups, *Circinata* and *Diffusa*, too. The difference between *Chamaestellera* and *Dendrostellera* seems to be considerably clear in the life form. But that between the latter and *Diplomorpha* is ambiguous. In fact, REGEL felt it difficult to identify *Stellera Alberti* REGEL. I expect further investigations about the true conceptions of these groups, especially those other than *Diplomorpha* and *Daphnimorpha.*

4) Subtrib. *Daphninae.*

9. The groups of pentamerous species: *Ambigua, Gemmata, Paxiana, Pentathymelaea* and *Penicillata.*

These are tentatively arranged in this subtribe. Almost all of them are pentamerous. If the present positions in the schema are close to their true phylogenetic positions, they may be consolidated into a genus with the name of *Pentathymelaea* LECOMTE. The relation between them and the groups *Circinata* and *Diffusa* also is unclear.

Wang may be included in this, though it is tetramerous.

10. *Daphne* LINN.

All species are tetramerous. The division of sections and subsections in this is very difficult and the conceptions of them differ with taxonomists. I have been able to examine only one or a few species for each foreign section or subsection, and consequently I follow the classification of DOMKE except a serious difference, in this place.

i) Sect. *Genkwa* BENTH. et HOOK. f.

Only a species *D. Genkwa* SIEB. et ZUCC. Pericarp is thinly fleshy; leaves are usually opposite. This was included in *Wikstroemia* sensu lato (subgen. *Diplomorpha*) by DOMKE.

D. Championi should be excluded from this.

ii) Sect. *Daphnanthes* MEISSN.

a. Subsect. *Daphnanthoides.*

b. Subsect. *Alpinae.*

c. Subsect. *Pseudo-mezereum.*

This is remarkably different from sect. *Daphne* (sect. *Mezereum*) in its branching habit.

d. Subsect. *Oleoides.*

e. Subsect. *Collinae.*

f. Subsect. *Cneorum.*

iii) Sect. *Laureola* MEISSN.

iv) Sect. *Daphne* (sect. *Mezereum* SPACH).

The branching habit of each section was discussed already. There are different opinions in reference to the division of subsections in the section *Daphnanthes*, and consequently their phylogenetic relations in the schema are tentative.

5) The groups with obscure relationship.

Daphne Championi BENTH.

The true phylogenetic position of this is very obscure. Though DOMKE included this in *Eriosolena*, only a similar character between them is found in the long styles. The inflorescence and the characters of leaves (the occurrence of sclerenchymatous fibers in *Eriosolena*, etc.) are very different between these two. If the wood anatomical characters are fully examined, a monotypic genus may be established for this species.

Daphne aurantiaca DIELS.

I know nearly nothing about the anatomical characters of this.

Part III. SYNOPSIS OF THE JAPANESE THYMELAEACEAE

Full bibliography and descriptions were already given in the previous paper (1955 b), and consequently supplements and revisions for them are offered in this part.

Fam. **Thymelaeaceae** [nom. conserv.] MEISSN. in DC., Prodr. **14**(2): 493 (1857)—GILG in ENGL., Bot. Jahrb. **18**: 488 (1894)—DOMKE in Bibl. Bot. Heft **111**: 1 et 101 (1934)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 68 (1955).

Subfam. **Daphnoideae** SUPPRIAN in ENGL., Bot. Jahrb. **18**: 340 (1894)—HAMAYA, 1. c. 68 (1955).

Thymelaeoideae GILG in ENGL., Pfl.-fam. **3-6a**: 216 (1894); 1. c. 511 (1894)—DOMKE, 1. c. 41 et 104 (1934).

Trib. **Daphneae** MEISSN., Pl. Vascul. Gen. 330 (1836-'43), p.p.—C. A. MEYER in Ann. Sci. Nat. sér. 2, **20**: 46 (1843)—GILG, 1. c. 513 (1894)—DOMKE, 1. c. 105 (1934)—HAMAYA, 1. c. 68 (1955).

Trib. *Lagetteae* MEISSN., 1. c. 330 (1836-'43), p. p.

Keys to genera.

1. **Key** based on the exomorphic characters.

a₁ Hypogynous discs scaly, subulate, liguliform or half-cylindraceous. Leaves opposite or alternate.
  b₁ Exine of pollen grains subreticulate. Fruits succulent or dry.
    c₁ Fruits succulent. Peduncles persistent. Leaves opposite. i. *Wikstroemia.*
    c₂ Fruits dry. Peduncles falling together with the upper parts of branchlets. Leaves opposite or alternate.……………………………………iii. *Diplomorpha.*
  b₂ Exine of pollen grains smooth. Fruits dry. Peduncles persistent. Leaves alternate, densely arranged. 2 localities in Kiushu. ……iv. *Daphnimorpha.*
a₂ Hypogynous discs annular or cup-shaped. Leaves alternate or rarely opposite. Fruits succulent or thinly so.
  b₁ Inflorescences involucrate, long pedunculate, capitate. Styles very long. Endosperm rich. ……………………………………………………ii. *Edgeworthia.*
  b₂ Inflorescences not-involucrate, peduncles usually short. Styles usually short. Endosperm poor or nearly absent. ……………………………………v. *Daphne.*

2. **Key** based on the anatomical characters.

a₁ Druses abundant in pith, wood rays, bark and mesophyll. Vessels diffused. Internal phloem fibers in leaves moderately present. ……………ii. *Edgeworthia.*
a₂ Crystals absent.
  b₁ Vessels evenly distributed or diffused.
    c₁ Wood parenchyma paratracheal abundant; parenchyma strands predominantly numerous. Wood rays 1-4-seriate. Internal phloem fibers in leaves abundant.……………………………………………i. *Wikstroemia.*

c₂ Wood parenchyma terminal narrow; parenchyma strands usually few or less numerous. Wood rays mostly uniseriate.

d₁ Tracheids usually arranged in terminal bands. Internal phloem in leaves containing a few or no fibers. ··················iii. *Diplomorpha.*

d₂ Tracheids arranged in radial or tangential groups. Internal phloem entirely absent in leaves. ·································iv. *Daphnimorpha.*

b₂ Vessels and tracheids arranged in flame-shaped groups. Wood parenchyma terminal narrow and/or paratracheal narrow or scanty. Wood rays uniseriate. Internal phloem entirely absent in leaves. ··················v. *Daphne.*

i. Wikstroemia [nom. conserv.] [ENDL., Prodr. Fl. Norfolk, 47 (1833); Icon. Gen. Pl. 22 (1838)]*—MEISSN., Pl. Vascul. Gen. 331 (1836-'43)—HILLEBR., Fl. Haw. Isl. 384 (1888)—GILG in ENGL., Bot. Jahrb. **18**: 513 (1894)—ROCK, Indig. Trees Haw. Isl. 316 (1913)—LECOMTE in Not. Syst. **3**: 207 (1916), p. p.—DOMKE in Bibl. Bot. Heft **111**: 105 et 124 (1934), pro subgen. *Euwikstroemia* tantum, cf. tab. in p. 59 —HAMAYA in Bull. Tokyo Univ. Forests **50**: 88 (1955); non *Wikstroemia* SCHRADER 1821 nec SPRENGEL 1821 (non 1826) (cf. BLAKE, SPRAGUE 1922).

a₁ 2-year-old branches pubescent around leaf-scars. Petioles and midribs sparsely pubescent. Peduncles 1-7 mm long; pedicels 1-2 mm long. Floral tubes densely pubescent. Ovaries densely pilose. ···································1) *W. pseudoretusa.*

a₂ 2-year-old branches entirely glabrous. Petioles and midribs usually glabrous. Peduncles 7-30 mm long; pedicels 1-3 mm long. Floral tubes sparsely pubescent. Ovaries pilose only at the top. ··························2) *W. retusa.*

1) **Wikstroemia pseudoretusa** KOIDZ. in Bot. Mag. Tokyo **33**: 119 (1919)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 89 (1955).

Nom. Jap. *Munin-aoganpi.*

Distr. *Bonin.*

2) **Wikstroemia retusa** A. GRAY in Jour. Bot. **3**: 303 (1865)—SONOH., TAWADA et AMANO ed. WALKER, Fl. Okinawa 108 (1952)—MASAMUNE in Sci. Rep. Kanazawa Univ. **3**(2): 274 (1955)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 89 (1955)—HONDA, Nom. Pl. Jap. ed. emend. 170 (1957).

Nom. Jap. *Ao-ganpi, Kgjigii* (vernacular). (Fig. 8).

Distr. *Riukiu*: Isl. Okinawa, Isl.

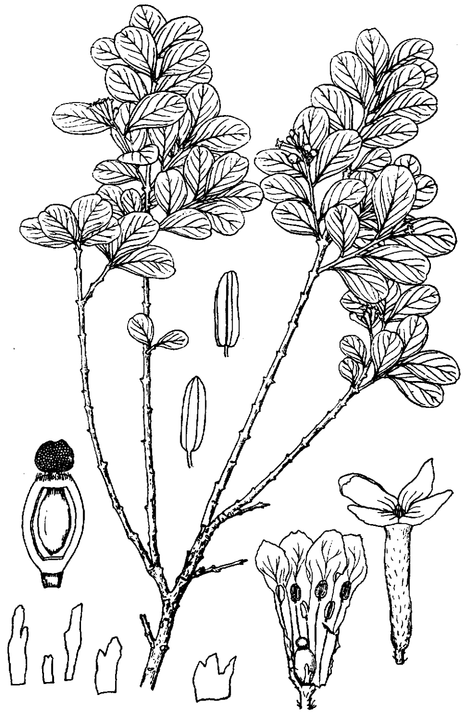

Fig. 8. *Wikstroemia retusa* A. GRAY.

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* The literature shown in the bracket was not actually referred to.

Miyako, Isl. Ishigaki, Isl. Iriomote and Isl. Amami-ohshima (?). Formosa (?). (Map I···●).

ii. Edgeworthia MEISSN. [in Denkschr. Bot. Gesel. Regensb. **3**: 380 (1841)]; Pl. Vascul. Gen. 330 (1836-'43)—GILG in ENGL., Bot. Jahrb. **18**: 513 (1894)—DOMKE in Bibl. Bot. Heft **111**: 107 et 131 (1934)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 90 (1955).

1) **Edgeworthia chrysantha** LINDLEY in Jour. Hort. Soc. London **1**: 148 (1846)—LECOMTE in Not. Syst. **3**: 131 (1915)—HAMAYA, l. c. 90 (1955)—HONDA, Nom. Pl. Jap. ed. emend. 170 (1957).

'*E. Gardneri* MEISSN.'; LECOMTE in Not. Syst. **3**: 217 (1916), p. p. (?).

Nom. Jap. *Mitsumata, Musubigi.* (Fig. 9).

Distr. From southern China to Himalaya. Cultivated in Japan. According to DOMKE, NAKAI supposed the spontaneity of this species on Mt. Kirishima, Kiushu.

iii. Diplomorpha [MEISSN. in Denkschr. Bot. Gesel. Regensb. **3**: 289 (1841), in nota]—C. A. MEYER in Ann. Sci. Nat. sér. 2, **20**: 45 et 50 (1843), p. p.—HAMAYA in Bull. Tokyo Univ. Forests **50**: 80 (1955); in Jour. Jap. Bot. **30**: 329 (1955).

Wikstroemia ENDL.; LECOMTE in Not. Syst. **3**: 207 (1916), p. p.

W. subgen. *Diplomorpha* DOMKE in Bibl. Bot. Heft **111**: 59 (1934), p. p.

a₁ Branchlets, leaves and flowers usually glabrous. Leaves usually opposite, membranaceous or chartaceous. Floral tubes rather caducous. Ovaries sparsely pilose.

Fig. 9. *Edgeworthia chrysantha* LINDL.

b₁ Branchlets ramose. Spikes terminal and axillary, paniculiform in all. Pedicels less than 1 mm long. Flowering in VIII-IX. Floral tubes 6-8(-11) mm long; lobes 1-2 mm long.

c₁ Branchlets, leaves and flowers glabrous. ····················1) *D. trichotoma.*

c₂ Branchlets, leaves and flowers pilose. ····························1-a) f. *pilosa.*

b₂ Branchlets simple. Umbels 1-4 (mostly 2)-flowered, terminal. Flowering in V-VII. Pedicels 1-7 mm long. Floral tubes 8-10.5 mm long; lobes 2-3 mm long.··2) *D. albiflora.*

a₂ Branchlets, leaves and flowers usually pubescent. Leaves alternate. Floral tubes usually persistent. Ovaries densely pilose.

  b₁ Branchlets ramose. Spikes in all paniculiform or fastigiate. Flowering in VII-IX.

    c₁ Stems indistinct, decumbent. Branchlets fastigiate, densely and spirally foliate. Leaves elliptic. Spikes in all paniculiform or fastigiate.

      d₁ Divisions of branchlets short, less numerous. Leaves oval to oblong. Flowers white to light or purplish pink; tubes 7-12 mm long. ··4) *D. Ganpi.*

      d₂ Divisions of branchlets long, numerous. Leaves ovate-oval. Flowers light greenish yellow; tubes 5-7 mm long. ·········5) *D.* ×*ramulosa.*

    c₂ Stems distinct, upright. Branchlets erect-patent, distichous-like foliate. Spikes in all sparsely paniculiform.

      d₁ Leaves rather membranaceous. Divisions of branchlets slender and long, often somewhat apart from leaf-axils. ······3) *D. ohsumiensis.*

      d₂ Leaves nearly chartaceous. Divisions of branchlets somewhat stout, always axillary.

        e₁ Leaves small (up to 5 cm long), sparsely arranged, ovate; apices acute; bases truncate or cuneate. Panicles sparse, leaves in them gradually diminishing from those on the lower part in size. Prov. Idzu.·····································6) *D. pauciflora.*

        e₂ Leaves large (up to 7-10 mm long), overlapping one another. Panicles very dense, intermingled with much smaller leaves than those on the lower parts. Kiushu.

          f₁ Leaves distichous-like arranged; lanceolate or ovate, apices acuminate, bases round or obtuse; among inflorescences very small and bract-like. ··················7) *D. yakushimensis.*

          f₂ Leaves spirally arranged; oval or ovate-oblong, short acute at both ends, among inflorescences small.

8) *D. phymatoglossa.*

  b₂ Branchlets simple and bearing terminal heads. Flowering in V-VI(-VII).

9) *D. sikokiana.*

1) **Diplomorpha trichotoma** (Thunb.) Nakai, Fl. Sylv. Kor. **17**: 39, t. 10 (1928)—Hamaya in Jour. Jap. Bot. **29**: 123 (1954) et **30**: 331, fig. 3, a-c (1955); in Bull. Tokyo Univ. Forests **50**: 81 (1955)—Honda, Nom. Pl. Jap. ed. emend. 170 (1957).

Nom. Jap. *Ki-ganpi, Kiko-ganpi.* (Pl. X, C).

Distr. *Honshu*: Yamashiro, Tamba, Settsu, Kii, Iwami, Suwô and Nagato. *Shikoku*: Awa, Iyo and Tosa. *Kiushu*: Tsushima, Buzen, Chikuzen, Chikugo, Hizen, Higo, Hiuga, Satsuma and Ohsumi. Corea: S. Kyengsang and S. Chella. (Map II···●).

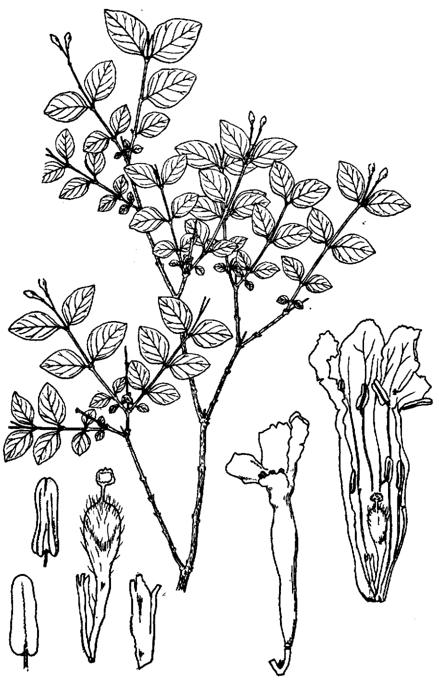

Fig. 10. *Diplomorpha albiflora* NAKAI.

1-a) *Diplomorpha trichotoma* f. **pilosa** HAMAYA in Bull. Tokyo Univ. Forests **50**: 82 (1955); in Jour. Jap. Bot. **30**: 331 (1955) —HONDA, Nom. Pl. Jap. ed. emend. 170 (1957).

Nom. Jap. *Usuge-kiganpi*.

Hab. *Kiushu*, Prov. Hiuga: Masaki (K. MAEBARA, Aug. 1935—type in TOFO) and Prov. Higo: Hitoyoshi Aida. (Map II…□).

2) **Diplomorpha albiflora** (YATABE) NAKAI in Jour. Jap. Bot. **13**: 881 (1937) et **15**: 78 (1939)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 82 (1955)—HONDA, Nom. Pl. Jap. ed. emend. 169 (1957).

'*Wikstroemia japonica* MIQUEL'; LECOMTE in Not. Syst. **3**: 130 (1915), ad FAURIE, no. 3691 (Sobosan, co-specimen in KYO).

Nom. Jap. *Miyama-ganpi*, *Hiô*. (Fig. 10).

Hab. *Honshu*, Prov. Yamato: Mt. Ohdaigahara-yama; Prov. Ise: Ohsugidani. *Shikoku*, Prov. Tosa: Mt. Yokogura-yama and Nanokawa-mura. *Kiushu*, Prov. Bungo: Mt. Sobosan and Mt. Katamuki-yama; Prov. Hiuga: Mt. Ohkue-yama. Also recorded in Prov. Kii: Nachi; Prov. Tosa: Mt. Tebako-yama (ex MAXIMOWICZ); Prov. Iyo: Mt. Omogô-yama. (Map II…▲).

Notes. This species is usually distinguished from its closely related species *D. trichotoma* as shown in the key. When plants of the latter grow at the higher altitude, however, their branchlets in that year are often simple, bearing terminal and short spikes only, and their flowers are as large as those of the former. Thus, it may become difficult to distinguish them from *D. albiflora* whose umbels also are occasionally irregular and in the form of 3- or 4-flowered corymboses.

On the other hand, the seasons of florescence and fructescence are clearly different between both species. Furthermore, the above-mentioned specimens difficult of identification are usually accompanied by specimens or various forms transitional to the typical *D. trichotoma* which were collected in the same localities and often by the same collectors. I consider, in consequence, that those obscure specimens are merely a mountain type of *D. trichotoma* and that *Wikstroemia* (*Diplomorpha*) *ellipsocarpa* MAXIM. which was already marged into *D. trichotoma* in my previous report (Jour. Jap. Bot. **29**: 121; 1954) might be described on the basis of one of such forms.

As described in the part of the anatomical study, a wood material of *D.*

trichotoma collected at Hôrigawa (alt. ca. 800 m), the base of Mt. Ohkue, Prov. Hiuga (cf. HAMAYA, l. c.) shows values as small as those of *D. albiflora* in the height of wood rays and in the mean length of phloem fibers. This fact may suggest that *D. albiflora* perhaps had been derived from the prototype of *D. trichotoma* in a form of mountain race, and that then it had been built up as a separate species which blooms in an entirely different season and, in the typical form, has few (2)-flowered umbels on simple branchlets. But there remains a slight doubt that such shortening in wood rays and phloem fibers is merely an epharmonic phenomenon.

The localities where the above-mentioned obscure specimens were collected but the occurrence of the typical *D. albiflora* is very doubtful, are as follows: *Shikoku*, Prov. Iyo: Mt. Sasa-yama. *Kiushu*, Prov. Bungo: Mt. Gongen (Gozen)-dake; Prov. Hiuga: Iwato-mura and Mt. Ishidô-yama. (Map II…△).

3) **Diplomorpha ohsumiensis** (HATUS.) HAMAYA, comb. nov.

Wikstroemia ohsumiensis HATUSIMA in Jour. Jap. Bot. **29**: 232 (1954).

Diplomorpha trichotoma var. *ohsumiensis* (HATUS.) HAMAYA in Bull. Tokyo Univ. Forests **50**: 82 (1955); in Jour. Jap. Bot. **30**: 331, fig. 3, d-f (1955)—HONDA, Nom. Pl. Jap. ed. emend. 170 (1957).

Nom. Jap. *Takakuma-kiganpi*.

Hab. *Honshu*, Prov. Tamba: Amata-gun Mt. Muroyama; Prov. Settsu, Toyono-gun Mino-o, Kawabe-gun Hanayashiki and Higashidani-mura, Mt. Rokkô. *Kiushu*, Prov. Hizen: Mt. Tara-dake; Prov. Higo: Hitoyoshi Aida; Prov. Satsuma: Isa-gun Honjô-mura; Prov. Ohsumi: Mt. Takakuma (KAWAGOE, Aug. 18, 1912—type in KAG). (Map II…□).

Notes. Since the publication of new combination of *D. trichotoma* var. *ohsumiensis* (1955 c), I have had oppotunities of examining its type specimen and many other similar ones. As shown in the original description, these are usually pilose and with alternate leaves. After the examination of them and many specimens of *D. trichotoma* and *D. Ganpi*, I have been assured of the following facts:

① Among the typically glabrous specimens of *D. trichotoma*, sometimes there could be found ones of branchlets bearing entirely alternate leaves (e. g. Mt. Takakuma, Prov. Ohsumi, Z. TASHIRO, Jul. 24, 1913—KYO). ② Nearly all specimens of *D.* (*Wikstroemia*) *ohsumiensis* are indeed similar to *D. trichotoma* in the conditions that, except the hairs, the branchlets have no scabridulous impression such as seen in the other hairy species—this is perhaps due to the longitudinal (microscopically observed) furrows on the cuticle, which is nearly flattened or very shallowly furrowed in *D. trichotoma* and its allies—, that the major and ultimate divisions of branchlets are more slender, longer and more patent, that the leaves are more sparsely arranged and the rachises of spikes are usually more slender and longer in autumn, and consequently, that the general appearance of branches is much sparser than in *D. Ganpi*. ③ The divisions of branchlets in *D. trichotoma* and *D. ohsumiensis* are frequently above away from the axils of leaves and become lateral, while such cases are never observed in the hairy species in Japan. This phenomenon is likewise seen in the Chinese specimens (in A) of **Diplomorpha dolicantha** m. comb. nov. (*Wikstroemia dolicantha* DIELS) which includes a pubescent variety (var. **pubescens** (DOMKE) m. comb. nov.)—its leaves nearly alternate—as well as a nearly glabrous one (var. **diffusa** (REHDER) m. stat. nov.). ④ The floral tubes of *D. ohsumiensis* are 4-6 mm long, though in most specimens of it the flowers are not completely opened. Those of *D. trichotoma* are 6-8 mm long—if unopened 4-6 mm long—, while in *D. Ganpi* 7-12 mm long. ⑤ The shape of leaves in *D. trichotoma* is occasionally similar to that in *D. Ganpi*, and that in *D. ohsumiensis* is generally close to the former though likewise variable. ⑥ In *D. trichotoma* f. *pilosa*, the opposite leaves are more predominant than the alternate, therefore this is merely a pubescent form of *D. trichotoma*.

The above-mentioned are convincing evidences to consider *Wikstroemia ohsumiensis* HATUS. as a variety of *Diplomorpha trichotoma* (cf. HAMAYA 1955 b, with regard to the other characters of leaves).

On the other hand, (i) the hairiness of it may result from the hybridization between *D. trichotoma* and *D. Ganpi*. (ii) Except *D. trichotoma*, *D. Ganpi* is an only species, signs of localities of whose specimens are found in the vicinities of nearly all ones of *D. ohsumiensis* in the distribution maps, and actually the habitats of *D. Ganpi* and *D. trichotoma* often overlap one another in part. (iii) Three specimens of *D. ohsumiensis* (Higashidani-mura, Aug. 7, 1933, N. UI, no. 5469; Hanayashiki, Sept. 29, 1935, N. UI, both in Kawabe-gun, Prov. Settsu—KAG; and Mt. Muro-yama, Amata-gun, Prov. Tamba, Aug. 5, 1931, Y. ARAKI—KYO) show an appearance of branchlets similar to those of *D. Ganpi* a little more notably than the other specimens similar to this species.

Consequently, because I have not yet had any oppotunity to see the plants of *D. ohsumiensis* in its natural habitats, here I follow the original opinion of HATUSIMA, in due consideration of the presence of hybrids such as *D.* ×*ramulosa*.

4) **Diplomorpha Ganpi** (SIEB. et ZUCC.) NAKAI in Jour. Jap. Bot. **13**: 883, fig. 4A (1937)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 83, fig. 7 a-b (1955); in Jour. Jap. Bot. **30**: 333, fig. 3 g-i (1955)—HONDA, Nom. Pl. Jap. ed. emend. 170 (1957).

?'*Wikstroemia canescens* MEISSN.'; WINKLER in FEDDE, Rep. Beih. **12**: 442 (1922), ad pl. ex Kobe: Futatabi-san.

W. gampi MAXIM.; MASAMUNE in Sci. Rep. Kanazawa Univ. **3**(2): 274 (1955).

Nom. Jap. *Ko-ganpi, Inu-ganpi*. (Fig. 11-C, Pl. X, D).

Distr. *Honshu*: Kôzuke (Mt. Akagi), Hitachi, Kazusa, Awa, Musashi, Sagami, Idzu, Suruga, Tôtômi, Mikawa, Ohmi, Iga, Ise, Shima, Yamashiro, Yamato, Kii, Idzumi, Kawachi, Tamba, Settsu, Awaji, Inaba, Mimasaka, Bizen, Bitchû, Aki, Suwô and Nagato. *Shikoku*: Sanuki, Awa, Tosa and Iyo. *Kiushu*: Buzen, Bungo, Hizen, Higo, Hiuga, Satsuma, Ohsumi, Isl. Tanegashima and Isl. Yakushima.

Riukiu: Isl. Amami-ohshima. Formosa (Anpin-chin). (Map III…●).

5) **Diplomorpha ×ramulosa** HAMAYA.

Hybr. nov. inter *D. Ganpi* et *D. paucifloram.*

Suffrutex circ. 1(-2) m altus; truncus humilis iis *Diplomorphae Ganpii* similis, luridus glaber; rami hornotini teretes erecti, inferne olivaceo-fusci vel umbrini in sicco, superne pallide virides villosi inferne deinde glabrescentes; ramuli ramusculique multi vulgo erecto-patentes axillares, longiores graciles, pallide virides et in sicco straminei, villosi. Folia alterna subdense spiralia, ovata vel ovalia, apice acuta vel apiculata, basi obtusa vel rotundata, chartacea, supra viridiora sparse pilosa vel glabrescentia, subtus pallide viridia pilosa, costis subtus interdum pallidioribus prominentibus dense villosis, nervis lateralibus utrinque 4-7 subtus conspicuis villosis; ea ramorum 3-4.8 cm longa 1.5-2.8 cm lata, ea ramulorum 1.5-3 cm longa 0.7-1.6 cm lata; petioli dense villosi, 1-4 mm longi. Inflorescentia iis *D. Ganpii* satis similis sed sparsior causa ramusculorum pedunculorumque longiorum patentiorum, pedunculis pedicelisque dense villosis, pedicelis circ. 1 mm longis. Flores pallide viridiflavi; perianthium extus villosum intus glabrum, tubo 5.5-7 mm longo vix 1 mm lato basi angusto, lobis 4 ovatis vel rotundatis 1-2 mm longis exterioribus majoribus; stamina 8, biseriatim disposita, serie superiore paulo exserta, serie inferiore 1.5 mm infra superiorem sita, antheris lineari-oblongis luteis 0.8 mm longis, filamentis brevissimis; pistillum circ. 3 mm longum, ovario oblanceolato dense villoso 2 mm longo, stylo brevissimo, stigmate capitato 0.5 mm in diametro papilloso; squama hypogyna circ. 2 mm longa, vulgo 2-partita, partibus linearibus interdum sublobatis. Fructus ignoti.

Nom. Jap. *Mito-ganpi* (nov.). (Fig. 11-B; Pl. XI, A).

Hab. *Honshu*, Prov. Idzu: Mt. Hottanjô-yama, Mito, circ. 200 m alt. (T. OHMURA, Aug. 26, 1956, typus in TOFO; T. HAMAYA, Aug. 18, 1957—TOFO). (Map IV…×).

This is similar to *D. Ganpi*, in the shrub-form (in spite of the condition that the stem seems to have been cut in the bush-cutting before the plantation) and in the colour of branchlets and of their divisions. But the branchlets are stouter, and as the major and the ultimate divisions are longer and more patent, the inflorescences are much sparser (but denser than *D. pauciflora*) and the outline of the aggregations of inflorescences is depressedly conical. This, on the other hand, is similar to *D. pauciflora* in the colour of flowers and in the length of floral tubes. It also mediates between the two species in the shape of leaves, but the size of leaves seems somewhat larger and the blooming season a little later than those two in the same locality where the three grow together.

The consideration of a new hybrid between *D. pauciflora* and *D. Ganpi* seems thus preferable to the recognition of a stout variety (or form) in *D. Ganpi*.

6) **Diplomorpha pauciflora** (FR. et SAV.) NAKAI in Jour. Jap. Bot. **13**: 883 (1937) —HAMAYA in Bull. Tokyo Univ. Forests **50**: 84, fig. 8 a-b (1955)—HONDA, Nom.

Pl. Jap. ed. emend. 170 (1957).

Nom. Jap. *Sakura-ganpi, Hime-ganpi.* (Fig. 11-D).

Distr. *Honshu*: Idzu and Sagami (Hakone). (Map IV···▲).

7) **Diplomorpha yakushimensis** (MAKINO) MASAMUNE in Trans. Nat. Hist. Soc. Formos. **23**: 205 (1933)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 85, fig. 8c (1955)—HONDA, Nom. Pl. Jap. ed. emend. 170 (1957).

Wikstroemia yakushimensis (MAKINO) NAKAI ex MASAMUNE; MASAM. in Sci. Rep. Kanazawa Univ. **3**(2): 275 (1955).

Nom. Jap. *Shima-sakura-ganpi, Shima-koganpi.* (Fig. 11-E).

Distr. *Kiushu*: Southern Bungo, Eastern Higo, Hiuga, Ohsumi, Isl. Yakushima and the Koshiki Isls. (Map IV···■).

8) **Diplomorpha phymatoglossa** (KOIDZ.) NAKAI in Jour. Jap. Bot. **13**: 882 (1937) —HAMAYA in Bull. Tokyo Univ. Forests **50**: 84, fig. 7d (excl. c) (1955)—HONDA, Nom. Pl. Jap. ed. emend. 170 (1957).

Wikstroemia phymatoglossa KOIDZ., Pl. Nov. Amami-ohshima, 15 (1910)—MASAMUNE in Sci. Rep. Kanazawa Univ. **3**(2): 274 (1955).

Nom. Jap. *Ohshima-ganpi.* (Fig. 11-F).

Distr. *Riukiu*: Endemic in Isl. Amami-ohshima and Isl. Tokunoshima. (Map III···▲).

Notes. On the relation between *Diplomorpha pauciflora, D. yakushimensis* and *D. phymatoglossa.*

According to the further studies on numerous specimens of these three species (cf. 1955c):

① The shrub-form: In the last, the stems are not so short and decumbent as in *D. Ganpi*, but distinct and erect as in the other two. The branchlets in that year are somewhat stouter than those of these two—which are sometimes slightly pendulous—, but it is not a sharp difference, and some specimens of *D. yakushimensis* from the Koshiki Islands are likewise stout.

② The hairs and the quality of leaves: In the same seasons, *D. pauciflora* tends to be more hairy on the branchlets, the leaves and the inflorescences than the other two. But this difference as well as that of the quality of leaves is rather epharmonic.

③ The size of flowers: The length of floral tubes is not very different between them as follows: in *D. pauciflora* 5-7 mm, in *D. yakushimensis* 5.5-8(-9) mm and in *D. phymatoglossa* 5-6 mm, and the length of the lobes shows the same condition.

④ The density of inflorescences during and after the top seasons of florescence: In *D. pauciflora,* the floriferous divisions stretch out from the axils of comparatively many leaves on the upper part of a branchlet, and these leaves and those on the divisions are continuously reduced in size from those on the lower part which themselves are generally smaller and sparser. In *D. yakushimensis,* the size suddenly becomes small at such leaves on the upper part, and the leaves on the divisions show a form of floral bracts in their extremity. The inflorescences as a whole, in consequence, give an impression of scattering among leaves in the former species, while they give an impression of a dense aggregate of small spikes or racemes without mixture of leaves and the lowest lateral divisions are, in some cases, shorter than the uppermost of the large leaves in the latter. In *D. phymatoglossa*, on the other hand, the inflorescences are similar to those of *D. Ganpi*. Though the size of leaves varies as suddenly from those on the lower part to those in the panicles as in *D. yakushimensis*, the leaves in the inflorescences are as comparatively large and dense as in *D. Ganpi*. The size of each ultimate spike is not different between the three (or four).

⑤ The shape of leaves (cf. Fig. 11): In *D. pauciflora*, the leaves are long or short ovate, acute at the apex and truncate or cuneate at the base; in *D. yakushimensis* lanceolate or ovate, acuminate (or tailing) at the apex, round or obtuse at the base—such acuminate apex is particularly remarkable on the leaves of round base and almost always found in this species—, while in *D. phymatoglossa* oval or ovate-oblong and short acute at both ends, and this shape is similar to that in *D. Ganpi*, though a little narrower at the apex. Some specimens of *D. yakushimensis* in Prov. Bungo and the Koshiki Islands (Map IV…△) have ovate leaves of acute apex and are similar to *D. pauciflora* in this point. But the other characters are

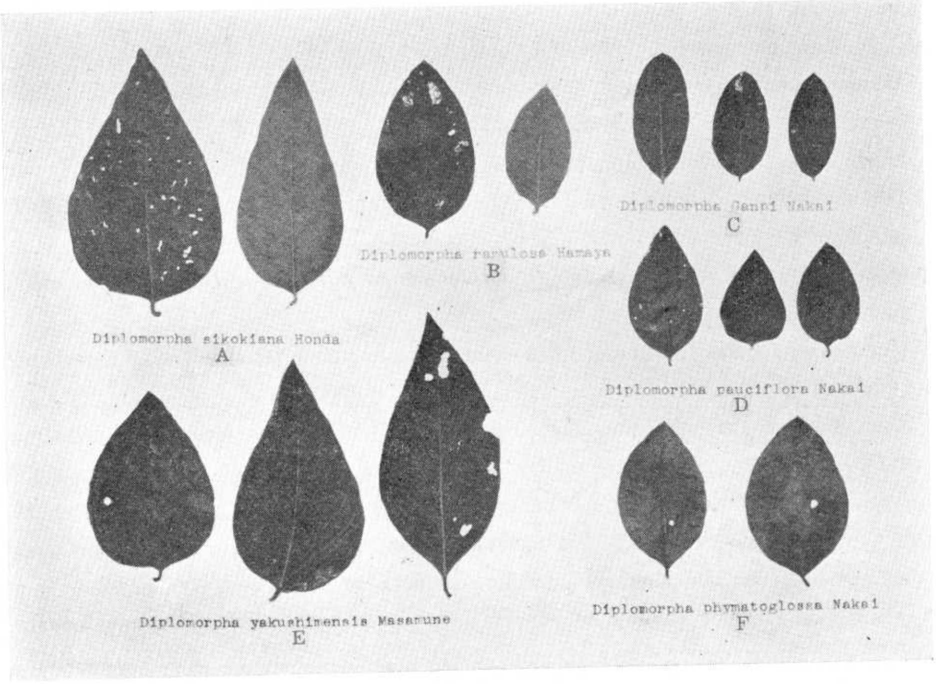

Fig. 11. Leaves of the hairy species of *Diplomorpha*.
A: *D. sikokiana* HONDA. B: *D.* ×*ramulosa* HAMAYA. C: *D. Ganpi* NAKAI. D: *D. pauciflora* NAKAI. E: *D. yakushimensis* MASAMUNE. F: *D. phymatoglossa* NAKAI.

not different from those of the typical *D. yakushimensis*. (These specimens probably did not accept any remarkable hereditary influence from *D. Ganpi*.)

⑥ The size of leaves: In *D. pauciflora* 1-4.5(-5.5) cm (length) ×0.5-2.5(-3.5) cm (width); in *D. yakushimensis* 1.5-7.5(-10) ×0.8-4.2(-4.7); and in *D. phymatoglossa* 2-6(-7.5) ×1-3.2. In other words, the leaves are smaller and more sparsely arranged on the branchlets in *D. pauciflora* than in *D. yakushimensis* where they usually overlap one another. In *D. phymatoglossa*, generally the leaves are larger and densely spirally arranged and do not so become distichous-like through twisting of petioles as in the other two.

Among these six characters the former three can not offer any diagnostic feature, while the others are useful. Though some specimens mentioned above connect between *D. pauciflora* and *D. yakushimensis* at the time of separate comparison of the latter characters, they are sufficiently distinguishable on the synthetic decision. Also considering the fact that the geographical distributions of these two are far distant from one another, the specific rank is consequently kept for the latter. This may be derived from the common prototype with *D. pauciflora* as a stout race. *D. phymatoglossa* seems, on the contrary, to show an intimate relation to *D. Ganpi* in the spiral arrangement and the oval shape of the leaves and in the inflorescences. If one prefers to regard *D. yakushimensis* as a variety of *D. pauciflora*, however, *D. phymatoglossa* also would rather be laid in the same rank, as HATUSIMA did in 1954 (i. e. *D. pauciflora* var. *phymatoglossa* (KOIDZ.) m. in sched.).

The specimens from Mt. Kurokami, Prov. Hizen (in KAG etc.) are undoubtedly included in an entirely different species, *D. sikokiana*.

9) **Diplomorpha sikokiana** (FR. et SAV.) HONDA in Tennen-Kinenbutsu-Chôsa-Hôkoku **10**: 21 (1930); Nom. Pl. Jap. ed. emend. 170 (1957)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 87, fig. 9 et 10 (1955).

Nom. Jap. *Ganpi*, *Kaminoki*. (Fig. 11-A).

Distr. *Honshu*: Kaga, Tôtômi, Mikawa, Owari, Mino, Ise, Shima, Kii, Ohmi, Yamashiro, Yamato, Idzumi, Tamba, Settsu, Tajima, Harima, Bizen, Bitchû, Hôki, Idzumo, Iwami, Aki, Suwô and Nagato. *Shikoku*: Sanuki, Awa, Tosa and Iyo. *Kiushu*: Hizen (Arita and Mt. Kurokami). (Map IV…●).

iv. **Daphnimorpha** NAKAI in Jour. Jap. Bot. **13**: 884 (1937)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 69 (1955).

a₁ Leaves 2-7 cm long, thick. Floral tubes 8-9 mm long, straight. Upper stamens inserted at 3/4 of the tubes in height. Ovaries short stipitate. …1) *D. Kudoi*.

a₂ Leaves 5-18 cm long, thin. Floral tubes 10-13 mm long, bended. Upper stamens inserted at the bending point of the tubes (1/3 in height). Ovaries long stipitate; stipes bended. ……………………………………………2) *D. capitellata*.

1) **Daphnimorpha Kudoi** (MAKINO) NAKAI in Jour. Jap. Bot. **13**: 884, fig. 4E (1937)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 70 (1955)—HONDA, Nom. Pl. Jap. ed.

emend. 169 (1957).

Wikstroemia Kudoi MAKINO; MASAMUNE in Sci. Rep. Kanazawa Univ. **3**(2): 274 (1955).

Nom. Jap. *Shakunan-ganpi, Yakushima-ganpi.* (Fig. 12).

Distr. *Kiushu*: Endemic in Isl. Yakushima (alt. ca. 1400–1900 m). (Map I···■).

2) **Daphnimorpha capitellata** (HARA) NAKAI in Jour. Jap. Bot. **13**: 884, fig. 4D (1937)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 70 (1955)—HONDA, Nom. Pl. Jap. ed. emend. 169 (1957).

Nom. Jap. *Tsuchibino-ki.* (Pl. XI, B).

Distr. *Kiushu*: Endemic in Hôrigawa, Prov. Hiuga (alt. ca. 880 m). (Map I···▲).

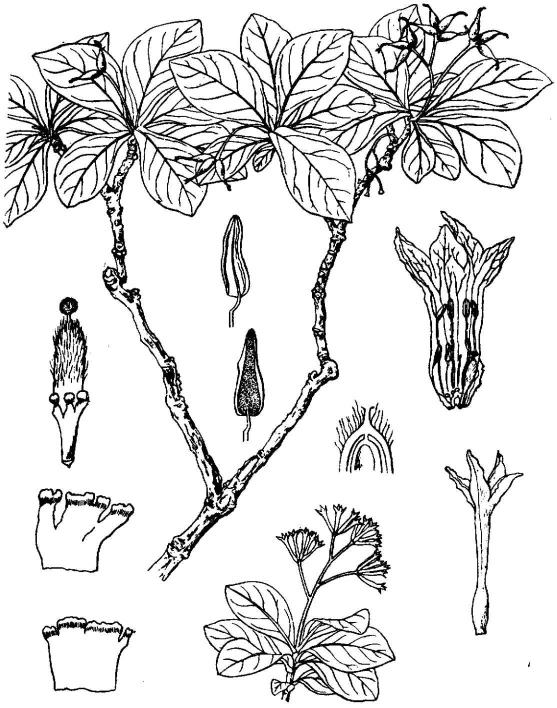

Fig. 12. *Daphnimorpha Kudoi* NAKAI.

v. **Daphne** LINN., Sp. Pl. 356 (1753), p. p.; Gen. Pl. ed. 5, 167 (1754)—SPRENGEL, Syst. Veg. **2**: 236 (1825), p. p.—GILG in ENGL., Bot. Jahrb. **18**: 513 (1894)—LECOMTE in Not. Syst. **3**: 215 (1916)—DOMKE in Bibl. Bot. Heft **111**: 107 et 130 (1934)—HAMAYA in Bull. Tokyo Univ. Forests **50**: 71 (1955).

Daphne (L.) WICKSTROEM; MEISSN., Pl. Vascul. Gen. 330 (1836-'43).

Wikstroemia ENDL. emend. DOMKE in Notizbl. Bot. Gard. Mus. Berlin **11**: 359 (1932), p. p.; l. c. 59 et 124 (1934), p. p.

$\mathbf{a}_1$ Leaves usually opposite. Fruits thinly succulent (?). Spikes ebracteate, terminal. Wood parenchyma terminal narrow and paratracheal narrow or scanty. ·· (i) Sect. *Genkwa.*

$\mathbf{a}_2$ Leaves alternate. Fruits succulent.································ (ii) Sect. *Daphnanthes.*

- $\mathbf{b}_1$ Evergreen shrubs with coriaceous leaves. Heads terminal, often bracteate. Wood parenchyma terminal narrow and paratracheal narrow or scanty. a) Subsect. *Daphnanthoides.*
- $\mathbf{b}_2$ Deciduous shrubs, leaves membranaceous when dry. Clusters of several flowers lateral in the blooming season, ebracteate. Wood parenchyma terminal narrow. ·· b) Subsect. *Pseudo-mezereum.*

(i) Sect. **Genkwa** BENTH. et HOOK. fil., Gen. Pl. **3**-1: 190 (1880), excl. *D. Championi*—HAMAYA in Bull. Tokyo Univ. Forests **50**: 78 (1955).

Wikstroemia subgen. *Diplomorpha* sect. *Tetramerae* Domke in Bibl. Bot. Heft **111**: 59 (1934), ad *W. Genkwa* (S. et Z.) Domke.

1) **Daphne Genkwa** Sieb. et Zucc., Fl. Jap. **1**: 137, t. 75 (1840)—Lecomte in Not. Syst. **3**: 217 (1916)—Winkler in Fedde, Rep. Beih. **12**: 443 (1922)—Hamaya in Bull. Tokyo Univ. Forests **50**: 79 (1955); in Jour. Jap. Bot. **30**: 329 (1955).

D. Genkwa var. *Fortunei* Lindley; Lecomte, l. c. 217 (1916).

Wikstroemia Genkwa (S. et Z.) Domke in Notizbl. Bot. Mus. Gard. Berlin **11**: 363 (1932); l. c. 59 et 125 (1934).

Nom. Jap. *Fuji-modoki, Genkwa.*

Distr. China: Shantung, Honan, Shensi, Kiangsu, Anhwei, Chekiang, Kiangsi, Hupeh, Hunan, Fukien. Southern Corea. Japan (cult.).

1-a) *Daphne Genkwa* f. **taitoensis** (Hayata) Hamaya in Bull. Tokyo Univ. Forests **50**: 80 (1955); in Jour. Jap. Bot. **30**: 329 (1955).

D. taitoensis Hayata in sched.

Nom. Jap. *Taito-fujimodoki.*

Hab. Formosa: Taitung (T. Soma, Mar. 1913, type in TI).

(ii) Sect. **Daphnanthes** C. A. Meyer in Ann. Sci. Nat. sér. 2, **20**: 51 (1843)—Meissn. in DC., Prodr. **14**: 532 (1857)—Benth. et Hook. fil., Gen. Pl. **3**-**1**: 190 (1880)—Gilg in Engl., Pfl.-fam. **3**-**6a**: 238 (1894)—Keissler in Engl., Bot. Jahrb. **25**: 30 (1898)—Domke in Bibl. Bot. Heft **111**: 78 (1934)—Rehder, Bibl. Cult. Tr. Shr. 480 (1949).

Sect. *Eudaphne, Thymelaea* et *Gnidium* Spach, Hist. Nat. Vég. **10**: 438 (1841), p. p.—Jaub. et Spach, Ill. Pl. Orient. tab. 304 (1850-'53).

b. *Eudaphne* β *Daphnanthes* Endl., Gen. Pl. Suppl. **4**-**2**: 69 (1847).

a) Subsect. **Daphnanthoides** (Gilg) Keissler, l. c. 33 (1898)—Domke, l. c. 78 (1934).

Sect. *Daphnanthoides* Gilg, l. c. 238 (1894)—Hamaya in Bull. Tokyo Univ. Forests **50**: 74 (1955).

a$_1$ Short racemes terminal on branchlets in that year, ebracteate, flowering in VI. Peduncles and pedicels long. Flowers small (tubes 5-6 mm, lobes 2 mm long). ··························2) *D. Miyabeana.*

a$_2$ Heads terminal on annotinous branchlets, bracteate, flowering in spring. Peduncles and pedicels very short. Flowers large (tubes 8-10 mm, lobes 4-5 mm long).

b$_1$ Branches slender and sparse. Leaves 4-16 cm long. Floral tubes usually pubescent on the outside. Discs erose at the margin. ······3) *D. kiusiana.*

b$_2$ Branches stout and dense. Leaves 4-9 cm long. Floral tubes glabrous. Discs nearly entire at the margin.

c$_1$ Leaves entirely green.

d$_1$ Flowers red-purple. ··························4) *D. odora.*

d$_2$ Flowers white and light pink on the outside. ·········4-a) f. *rosacea.*

d$_3$ Flowers pure white or yellowish white. ·····················4-b) f. *alba.*

c₂ Leaves yellowish variegated along the margin.·········4-c) f. *marginata*.

2) **Daphne Miyabeana** Makino in Bot. Mag. Tokyo **28**: 35 (1914)—Hamaya in Bull. Tokyo Univ. Forests **50**: 75, fig. 6 b (1955)—Makino et al., Ill. Fl. Jap. Suppl. 1145, fig. 3422 (1956)—Honda, Nom. Pl. Jap. ed. emend. 169 (1957).

D. odora var. *kiusiana* (Miq.) Keissler in Engl., Bot. Jahrb. **25**: 89 (1898), ad specim. ex Jesso leg. Faurie—Domke in Bibl. Bot. Heft **111**: 80 (1934), ad pl. ex Jesso in nota.

D. sinensis var. *flore breviore* Maxim. ex Miyabe in sched.

Nom. Jap. *Karasu-shikimi*.

Distr. *Hokkaidô*: Kitami, Teshio, Ishikari, Hidaka, Iburi, Shiribeshi and Oshima, *Honshu*: Mutsu, Ugo, Uzen, Rikuchu, Rikuzen, Iwashiro, Shimotsuke, Kôzuke, Echigo, Sado, Shinano, Etchû, Kaga, Mino, Ohmi, Yamashiro, Hôki and Isl. Oki. (Map V···▲).

3) **Daphne kiusiana** Miquel, Prol. Fl. Jap. 298 (1867)—Sonoh., Tawada et Amano ed. Walker, Fl. Okinawa, 108 (1952)—Masamune in Sci. Rep. Kanazawa Univ. **3**(2): 275, excl. distr. Hokkaidô—Hamaya in Bull. Tokyo Univ. Forests **50**: 76, fig. 6 a (1955)—Honda, Nom. Pl. Jap. ed. emend. 169 (1957).

D. odora β *kiusiana* (Miq.) Keissler in Engl., Bot. Jahrb. **25**: 89 (1898), excl. specim. ex Jesso—Domke in Bibl. Bot. Heft **111**: 80 (1934), p. p.

Nom. Jap. *Koshôno-ki*. (Fig. 13).

Branches and branchlets often are malformedly fasciate —*D. kiusiana* f. **fasciata** (T. Ito) Hara, Enum. Sperm. Jap. **3**: 232 (1954).

Distr. *Honshu*: Hitachi (Mt. Tsukuba, after reliable literature), Kadzusa, Awa, Suruga, Mikawa, Iga, Yamato, Kii, Kawachi, Idzumi, Tamba, Tango, Tajima, Harima, Awaji, Bitchû, Iwami, Suwô and Nagato. *Shikoku*: Awa, Tosa and Iyo. *Kiushu*: Tsushima, Iki, Chikuzen, Bungo, Hizen, Higo, Hiuga, Satsuma, Ohsumi, Isl. Tanegashima and Isl. Yakushima. *Riukiu*: The Amami Arch., Okinawa. Formosa (var. *atrocaulis* ?). Corea: Isl. Cheju-dô (Quelpaert) (two specimens, floral

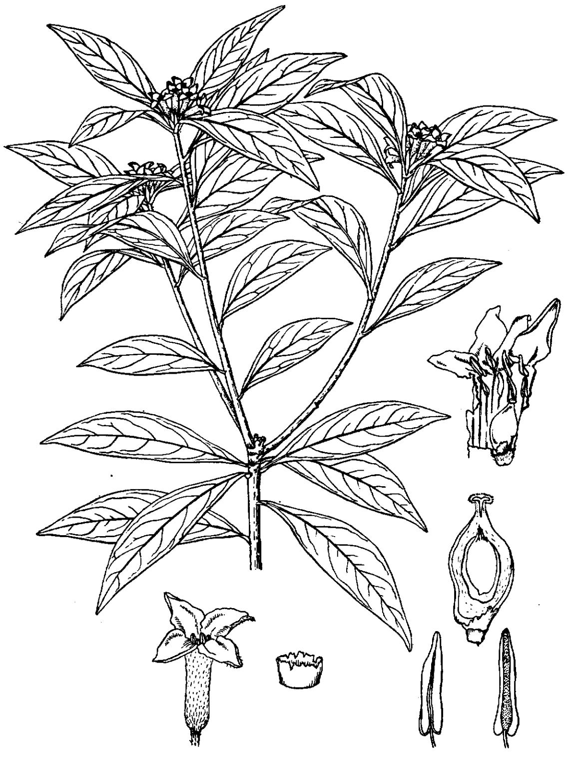
Fig. 13. *Daphne kiusiana* Miquel.

tubes glabrous) and Isl. Koje-dô. (Map V···●).

3-a) *D. kiusiana* var. **atrocaulis** (Rehd.) F. Maekawa in Jour. Jap. Bot. **21**: 45 (1945)—Hamaya in Bull. Tokyo Univ. Forests **50**: 77 (1955).

D. odora var. *atrocaulis* Rehd. in Sarg., Pl. Wilson. **2**: 545 (1916)—Hand.-Mazz., Symbol. Sinic. **7**: 588 (1933)—Kanehira et Hatusima in Trans. Nat. Hist. Soc. Formos. **29**: 157 (1939).

? '*D. odora* Thunb.'; Kanehira, Formos. Trees 482 (1936).

D. odora var. *taiwaniana* Masamune in Trans. Nat. Hist. Soc. Formos. **28**: 140 (1938).

D. taiwaniana Masamune in Trans. Nat. Hist. Soc. Formos. **29**: 239 (1939).

This was ranked in a geographical variety of the species by F. Maekawa. But, as the entities of *D. sinensis* Lam. and *D. odora* Thunb. are very obscure in China, it is very difficult to decide the true taxonomic position of it.

Distr. and Hab. China: Kweichi-hsien Chiarin, Anhwei (F. Maekawa, Feb. 1942 in TI). Formosa (?). (Map V···◓ ?).

4) **Daphne odora** Thunb. in Nova Act. Reg. Soc. Sci. Upsal. (Kaempf. Ill.) **4**: 34 (1783), nom. nud., excl. β; Fl. Jap. 159 (1784), p. p.—Sprengel, Syst. Veg. **2**: 237 (1825)—Lecomte in Not. Syst. **3**: 216 (1916)—Winkler in Fedde, Rep. Beih. **12**: 443 (1922)—Hamaya in Bull. Tokyo Univ. Forests **50**: 75 (1955).

D. triflora Lour.; Sprengel, l. c. 236 (1825).

Nom. Jap. *Jinchôge*. (Pl. X, A).

Distr. Formosa (?), China and Cochinchina. Cultivated in gardens in Japan.

4-a) *Daphne odora* f. **rosacea** (Makino) Hara, Enum. Sperm. Jap. **3**: 233 (1954) —Hamaya, l. c. 78 (1955).

Nom. Jap. *Usuiro-jinchôge*.

Cultivated in gardens.

4-b) *Daphne odora* f. **alba** (Hemsley) Hara, l. c. 232 (1954)—Hamaya, l. c. 78 (1955).

Nom. Jap. *Shirobana-jinchôge*.

Cultivated in gardens.

4-c) *Daphne odora* f. **marginata** Makino in Bot. Mag. Tokyo **23**: 69 (1909)—Hamaya, l. c. 78 (1955).

Nom. Jap. *Fukurin-jinchôge*.

Cultivated in gardens.

b) Subsect. **Pseudo-mezereum** [Nitsche, Beitr. Kennt. Gatt. *Daphne* (1907)]—Domke in Bibl. Bot. Heft **111**: 78 (1934).

Sect. *Eudaphne* Benth. et Hook. fil., Gen. Pl. **3-1**: 190 (1880), p. p.

Sect. *Eudaphne* § 1 *Mezereum* Gilg in Engl., Pfl.-fam. **3-6a**: 238 (1894), p. p.

Sect. *Mezereum* Spach; Keissler in Engl., Bot. Jahrb. **25**: 30 (1898), p. p.—Rehder, Bibl. Cult. Tr. Shr. 479 (1949), p. p.

Sect. *Daphne*, Hamaya in Bull. Tokyo Univ. Forests **50**: 72 (1955), p. p.

a$_1$ Ratio in length of lobes to tubes of flowers $^1/_2$-1. Upper stamens half-exserted from the tube.

  b$_1$ Lateral veins of leaves irregularly branched and winding. The ratio usually close to $^1/_2$. Flowering in II-IV.

    c$_1$ Leaves falling in summer.·······························5) *D. pseudo-mezereum.*

    c$_2$ Leaves falling in winter. ······································5-a) var. *koreana.*

  b$_2$ Lateral veins of leaves simple and smooth. The ratio usually close to 1. Flowering in III-V(-VI). ······································5-b) subsp. *jezoensis.*

a$_2$ The ratio $^1/_3$-$^1/_2$. Upper stamens inserted at $^3/_4$ in height. Flowering in V-VI (-VII). ·· 6) *D. kamtschatica.*

Since the publication of the previous papers (1955 a-b), I have examined further more herbarium specimens and cultivated or wild plants of the species belonging to this subsection. The results of examinations are as follows:

① The branching habit and especially the season of defoliation: I already described, to some extent, about the typical type of the branching habit observed in this group and its variations in the above-mentioned papers. According to the observation at Mt. Bukô in Mar. 1955, the plants of *D. pseudo-mezereum* at the lower altitude (ca. 600 m) had open flowers and entirely unfolded (probably the year before) leaves, while those at the higher altitude (ca. 1200-1250 m) had open flowers and terminal clusters of folded leaves being a few millimeters long. In the latter, on each part of axis between the last persistent bud scales and the lateral inflorescence and between this and the terminal cluster of folded leaves, there could be distinctly observed several leaf-scars. This is also the case with the specimens collected by YAMAZAKI et al. in the South Japan Alps. The plants, which were collected by OHHASHI, SAHO and TAKASUGI in the Minamiyama National Forest (alt. ca. 1650 m) of Mt. Fuji in Novs. 1955 and 1956, had unopened flowers; and among them some had only young leaves (ca. 2 cm long) and others had large ones (6 cm) beside those and, in some cases, several old spring leaves. The cultivated plants got from Mt. Bukô (600 m) had only terminal clusters of folded leaves in Tokyo, in Feb. 1957 (though this might be due to the sever frost).

In these strange plants, the spring leaves, opened by August, are sometimes persistent till late autumn, when almost all leaves in that year perhaps fall.

It can be consequently deduced from these circumstances, that as the altitude of the habitats ascends, the habit of this species gradually turns into the winter-deciduousness. Though the size (and often the number, too) of wintering leaves is variable according to the altitude and other environmental conditions, the time of appearance of unopened flowers is invariably about August or early September except some short delays. As formerly mentioned, such summer-green plants do not always have summer bud-scales, and the parts of shoots above the flowers (or the summer-buds) are much shorter in these plants than in the typical race, while the parts of shoots below are much longer.

These plants grow at some mountains in Chichibu-gun Prov. Musashi, Mt. Fuji, the South Japan Alps and their vicinities—alt. from ca. 600 m, up to 2000 m e. g. at the head of the Ohwi-gawa (MATSUDA leg., TI) and Mt. Senjyoga-dake (MIZUSHIMA in lit.) —, and, according to YOKOUCHI, at Kami-kôchi, too. In the neighbourhoods of the former two localities, there have been found various forms transitional from the typical *D. pseudo-mezereum*. It also is very interesting that these localities except Mt. Fuji (and Kami-kôchi) are known as the calcareous districts.

W. W. SMITH and H. CAVE described a similar case about *Daphne cannabina*, an evergreen species allied to *D. kiusiana*, in the Himalayas (cf. DOMKE, 1934, p. 73). In this species, according to them, the plants are winter-deciduous at the high altitude (ca. 11,000 ft), i. e. var. *gracilis* SM. et CAVE, and there are found nearly all possible forms transitional from the typical evergreen race at the lower altitude (ca. 7-8,000 ft).

Then, in the southern race or species of the subsection *Pseudo-mezereum*, unopened flowers appear simultaneously with new leaves, while in the northern races or species new shoots may develop before the formation of unopened flowers, short as they are. Between these two, however, there is not any significant difference. And in both cases, the part of shoot below the inflorescence is always more or less elongated by the season of flowering.

At the extremity of the above-mentioned variation, we can consequently recognize a winter-deciduous variety (hereditarily doubtful yet) of *D. pseudo-mezereum* corresponding to NAKAI's *D. koreana*, i. e. var. **koreana** (NAKAI) m.

Some examples representing the first stage of this variation are found also in the groups of *D. pseudo-mezereum* in other (southern) mountain regions and furthermore in *D. jezoensis* and *D. kamtschatica*. As to the latter two, I expect further to examine whether or no taxa of infra-specific rank are to be established about the winter-deciduous groups. This tendency is probably more remarkable in *D. kamtschatica*.

② The lateral veins of leaves: The feature of the lateral veins was selected in the previous studies as an important diagnostic character. But some transitional examples have been known within the main range of distribution of each species, though most of others are typical. Especially in var. *koreana*, the variation is larger, though most of the specimens or plants are similar to the typical *D. pseudo-mezereum*. This fact once made me take a specimen from Mt. Shiraiwa-dake, the South Japan Alps, for *D. jezoensis*.

③ The ratio in length of lobes to tubes of flowers: In the case of this character there have been likewise found many transitional examples. I formerly described as follows: the ratio is $1/3$-$1/2$ in *D. kamtschatica*, and $1/2$-1 in the other two. In the latter, it is apt to be close to 1 in the female flowers and to $1/2$ in the male. Consequently it is only comparative that it is close to 1 in *D. jezoensis* and to $1/2$

in *D. pseudo-mezereum*. In var. *koreana* it is in general close to $^1/_2$. (The value of the ratio is usually larger in the unopened flowers, as the tubes develop later than the lobes.)

It is consequently impossible distinctly to distinguish *D. pseudo-mezereum* and *D. jezoensis* by these characters. Moreover, the ranges (of distribution) of them are contiguous to one another in Prov. Iwaki on the Pacific side and probably in Provs. Noto and Kaga on the Japan Sea side, though those are separated into the South and the North Japan.

Because I think the possibility that a winter-deciduous form corresponding to var. *koreana* in subsp. *pseudo-mezereum* may be found in *D. jezoensis* MAXIM., here I wish to consider this as a regional subspecies rather than a variety of *D. pseudo-mezereum* A. GRAY. It is different from the southern race only in the following tendencies: the leaves are widest near the apices which are usually retuse or apiculate, the lateral veins are simple and smooth; and in the seasons of flowering, the leaves are more densely clustered because the shoots are shorter probably due to the northern climate.

D. kamtschatica has leaves similar to those of *D. pseudo-mezereum* subsp. *jezoensis*. The differences from this are as follows: the upper anthers are obviously inserted in the floral tube at the height of $^3/_4$, and the ratio in length of lobes to tubes is as mentioned above. If the specimens have leaves and fruits only, we can hardly identify them (especially near the boundary of the range), as shown in the distribution map (Map VI…△).

The usual colour of flowers varies from light greenish yellow (in autumn) to bright yellow with a slight tinge of orange (in spring) in subsp. *jezoensis*, while from light purple to greenish yellow or light yellow in subsp. *pseudo-mezereum*. The tinge of greenish-purple is often reserved till the next spring in the latter (i. e., f. *atropurpurea* HIYAMA in Jour. Jap. Bot. **32**: 110; 1957). In the South Japan Alps, YAMAZAKI and MATSUDA recorded two sorts of colours of yellow and red (purplish ?) brown (inside green). But this difference is not very significant.

5) **Daphne pseudo-mezereum** A. GRAY, Bot. Jap. 404 (1859)—HAMAYA in Jour. Jap. Bot. **30**: 37, fig. 1 a (1955), excl. syn.; in Bull. Tokyo Univ. Forests **50**: 72, fig. 5 a (1955), excl. syn. *D. koreana* et *D. kamtschatica*—HONDA, Nom. Pl. Jap. ed. emend. 169 (1957).

D. hondoensis OHWI in sched. (TNS).

Nom. Jap. *Oni-shibari, Natsu-bôzu.*

Distr. *Honshu*: Iwashiro, Iwaki, Shimofusa, Kazusa, Awa, Musashi, Sagami, Idzu, Kai, Suruga, Kaga, Mino, Ohmi and Tamba. *Shikoku*: Sanuki and Awa. *Kiushu*: Chikuzen, Hiuga and Higo. (Map VI…●).

5-a) *Daphne pseudo-mezereum* subsp. **pseudo-mezereum** var. **koreana** (NAKAI) HAMAYA, stat. nov.

D. koreana NAKAI in Jour. Jap. Bot. **13**: 880 (1937)—KITAGAWA, Lineam. Fl.

Mansh. 325 (1939).

'*D. kamtschatica* Maxim.'; Nakai, Fl. Sylv. Kor. **17**: 45, t. 13 (1928).

'*D. pseudo-mezereum* A. Gray'; Hamaya in Jour. Jap. Bot. **30**: 37 (1955); in Bull. Tokyo Univ. Forests **50**: 72 (1955), pro syn. *D. koreana*.

Nom. Jap. *Chôsen-naniwazu* (Nakai).

Hab. *Honshu*, Prov. Musashi: Mt. Bukô, Maeshiraiwa Mt. Mitsumine, Mt. Futago and Mt. Shiroishi; Prov. Kai: Kitatsuru-gun Aoiwa, Mt. Mitsutôge, Mikuni-pass, Mt. Mikuni, Mt. Kita-dake and by the Lake Yamanaka-ko; Prov. Suruga: Minamiyama Mt. Fuji, Higashimata on the head of the Ohwi; Prov. Shinano: Mt. Shiraiwa-dake, Shimoina-gun by the Mibu-gawa, Mt. Toyoguchi, Ohshika-mura by the Koshibu-gawa, Shimoina-gun Kaminoishi, Shimoina-gun Kizawa-mura. Corea, N. Hamgyeng: Baekgan, Fluvium Tumingan Distr. Musan, inter Potaesan et Kyokorei; S. Hamgyeng: Kogal-uri; N. Phyengan: Huchang Nansha-Makunaido; N. Kyengsang: Mt. Irwosan (Tei-daigen, Jul. 27, 1937—type of *D. koreana* Nakai in TI); Isl. Cheju-dô (Quelpaert) Mt. Hallasan. (Map VI···○).

5-b) *Daphne pseudo-mezereum* subsp. **jezoensis** (Maxim.) Hamaya, stat. et comb. nov.

D. jezoensis Maxim. ex Regel in Gartenfl. **15**: 34, t. 496, f. 1-3 (1866)—Miquel, Prol. Fl. Jap. 297 (1867)—Franch. et Sav., Enum. Pl. Jap. **1**: 404 (1875), '*jesoensis*'—Maxim. in Mél. Biol. **12**: 542 (1886), in observ., '*yezoensis*'—Matsum., Ind. Pl. Jap. **2-2**: 388 (1912)—Hara in Bot. Mag. Tokyo, **50**: 304 (1936)—Sugawara, Ill. Fl. Saghal. **3**: 1331 (1940), '*jesoensis*'—Hamaya in Jour. Jap. Bot. **30**: 37, fig. 1 b (1955); in Bull. Tokyo Univ. Forests **50**: 73, fig. 5 b (1955)—Honda, Nom. Pl. Jap. ed. emend. 169 (1957).

D. rebunensis Tatewaki in Jour. Sapp. Soc. Agr. For. **34**: 90 (1941).

D. kamtschatica var. *jezoensis* (Maxim.) Ohwi, Fl. Jap. 802 (1953), comb. nud.; in Bull. Sci. Mus. Tokyo **33**: 80 (1953)—Hara, Enum. Sperm. Jap. **3**: 231 (1954)—Makino et al., Ill. Fl. Jap. Suppl. 1144, fig. 3421 (1955).

D. kamtschatica var. *rebunensis* (Tatew.) Hara, l. c. 231 (1954).

'*D. pseudo-mezereum* A. Gray'; Tanaka et al., Useful Pl. Jap. **2**: no. 502 (1891), quoad pl. ex Echigo—Domke in Bibl. Bot. Heft **111**: 76 (1934), ad Faurie, no. 4176.

Nom. Jap. *Naniwazu*. (Pl. X, B).

Distr. S. Saghalin: prope Toyohara, Kami-kimunai, Isl. Kaiba. *S. Kuriles*: Isl. Kunashiri (?). *Hokkaidô*: Kitami (incl. Isl. Rebun and Isl. Rishiri, etc.), Teshio, Ishikari, Hidaka, Iburi, Shiribeshi and Oshima. *Honshu*: Mutsu, Ugo, Uzen, Rikuchu, Rikuzen, Iwashiro, Echigo and Noto. (Map VI···▲).

6) **Daphne kamtschatica** Maxim., Prim. Fl. Amur. 237 (1859)—Hamaya in Jour. Jap. Bot. **30**: 37 (1955); in Bull. Tokyo Univ. Forests **50**: 74 (1955)—Honda, Nom. Pl. Jap. ed. emend. 169 (1957).

Nom. Jap. *Karafuto-naniwazu*, *Kamchakka-naniwazu*.

Distr. N. Saghalin (Mt. Shiretori, Usutomanai, etc.). S. Saghalin (Kimunai, Korsakoff, etc.). *S. Kuriles*: Isl. Etorofu, Isl. Kunashiri and Isl. Shikotan. *Hokkaidô* (?). Kamchatka. Ussuri (?). Amur (?). (Map VI···■).

The hardly identified specimens mentioned above were collected at the following localities: S. Saghalin: Tomarioro, Fukakusa, Takinosawa, E. Coast Ochapoka, Wladimirohuka, Tonnaicha, Ootomari (Korsakoff), Isl. Kaiba. *S. Kuriles*: Isl. Etorofu Shana, Isl. Kunashiri Chibakaribetsu and Furukamappu-mura, Isl. Shikotan Shakotan-Kagenoma and Shakotan. (Map VI···△).

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Explanation of maps and plates

Maps I–VI. Distribution maps.

Map I : ● *Wikstroemia retusa.* ■ *Daphnimorpha Kudoi.* ▲ *D. capitellata.*

Map II : ● *Diplomorpha trichotoma.* ▲ *D. albiflora.* △ Dubious specimens of *D. tricho-*

toma mentioned in the text. □ *D. ohsumiensis* and *D. trichotoma* f. *pilosa*. ◬ Co-existence of ● and △. ◘ Co-existence of ● and □.

Map III : ● *Diplomorpha Ganpi*. ○ Ditto, this locality is based on a floristic record. A specimen of this species from Prov. Hitachi (with no citation of local name) is deposited in TI. ▲ *D. phymatoglossa*.

Map IV : ● *Diplomorpha sikokiana*. ▲ *D. pauciflora*. ■ *D. yakushimensis*. △ Dubious specimens of *D. yakushimensis* mentioned in the text. × *D.* ×*ramulosa*.

Map V : ● *Daphne kiusiana*. ○ Ditto, from Mt. Tsukuba, referred to reliable floristic records. ◓ ? *D. kiusiana* var. *atrocaulis*. ▲ *D. Miyabeana*.

Map VI : ● *Daphne pseudo-mezereum*. ○ subsp. *pseudo-mezereum* var. *koreana*. ▲ subsp. *jezoensis*. ■ *D. kamtschatica*. △ Sterile specimens of either *D. pseudo-mezereum* subsp. *jezoensis* or *D. kamtschatica*.

Plates I–VI. In each plate, A: transverse section, B: ditto, showing parenchyma pattern, C: tangential section, D: radial section, respectively. All figures ×70, but Pl. II, A alone ×28.

Pl. I : A, B, D. *Wikstroemia pseudoretusa*. C. *W. retusa*.

Pl. II : *Edgeworthia chrysantha*.

Pl. III : A. *Diplomorpha trichotoma*. B–D. *D. sikokiana*.

Pl. IV : A, C, D. *Daphnimorpha Kudoi*. B. *D. capitellata*.

Pl. V : *Daphne pseudo-mezereum*.

Pl. VI : A, C. *Daphne odora*. B, D. *D. Miyabeana*.

Plate VII : Transverse sections of bark.

A, B. *Edgeworthia chrysantha*. A (×28), B (×70), phloem groups flame-shaped.

C. *Diplomorpha yakushimensis* (×28), almost all rays narrow.

D. *Daphne kiusiana* (×56), bark spongy.

Plate VIII : A. Tangential section of bark. *Edgeworthia chrysantha* (×70).

B–D. Intervascular pits (×600).

B. *Wikstroemia pseudoretusa*, apertures lenticular.

C. *Edgeworthia chrysantha*, apertures lenticular.

D. *Daphne odora*, apertures small and round; spiral thickenings present.

Plate IX : Transverse sections of distal ends of petioles or basal part of midribs (×530).

A. *Daphne Gnidium*, internal phloem absent.

B. *Daphne penicillata*, ditto.

C. *Diplomorpha canescens*, internal phloem poor, internal phloem fibers absent.

Plate X : A. Axillary bud beneath the terminal inflorescence, bracts removed. *Daphne odora*, Mar. 8, 1957 (×6).

B. Clusters of flowers. *Daphne pseudo-mezereum* subsp. *jezoensis*, Feb. 14, 1957 (ca. ×1).

C. Showing the branching habit of *Diplomorpha trichotoma*, May 3, 1957 (×0.5).

D. Shrub of *Diplomorpha Ganpi*, Aug. 18, 1957 (×0.15).

Plate XI : A. Type specimen of *Diplomorpha* ×*ramulosa* (×0.4).

B. Cult. plant of *Daphnimorpha capitellata*, Jun. 9, 1956 (×0.4).

日本産ジンチョウゲ科諸属及び 2, 3 の外国産属の樹木学的研究（摘要）

——主として解剖学的性質及び系統について——

文部教官　濱　谷　稔　夫

本邦産ジンチョウゲ科樹木の外部形態及び葉・花等各部の解剖学的性質に関する研究結果の一部はすでに予報的に発表した (1955 年)。それによると本邦産諸属の類縁関係は外部形態学的性質のみによつては必ずしもその真に近いすがたをとらえることができない。しかし他の解剖学的性質とくに木材のそれ及び中国産5数性 *Daphne* 及び *Wikstroemia* に関する研究が系統の究明に重要な役割をもつであろうことが予想された。

ジンチョウゲ科の成材以外の部分の解剖学的研究は 2, 3 あるが，いずれも外部形態のみに拠る分類学者には重視されず，むしろその系統学的価値を否定されている。しかし少くともジンチョウゲ連に関しては後に述べるように外部形態に劣らず，かえつてそれ以上に有意義であるといえる。この研究では解剖学的性質を中心として，類縁的に比較的よくまとまつていると思われるジンチョウゲ連——DOMKE の分類による *Daphneae* (但し *Daphnopsinae* を除く)——の系統について調べた。なお DOMKE の分類体系そのものは GILG その他のものより一層自然なものと考えられるので，それを参照した。

I. 日本産種類の解剖学的研究。本邦産各種につき材部（§1）及び靱皮部（乃至樹皮）（§2）の解剖学的研究を行い，やや詳細な記載を附した。材部には各属にそれぞれ特有の性質を見るがそれについては第II部に述べた。靱皮部には分類学上有用な性質は見あたらない。篩部が外方に拡大する放射線間に楔形又は火焔状をなし，多くの繊維を含むことは科の共通特徴とみなされる。又この繊維が実用上重要なので長さ等の測定を行つたが著しい性質の差は見あたらなかつた。ただミツマタの含結晶細胞が紙にすいて後も残り（灰像で確認）ガンピ紙等と異る点は識別に利用できよう。

II. 系統上重要な性質の討議。前報でとりあげた諸性質及び第I部で見出された解剖学的諸特徴の系統・分類上の意義を検討し，それによつて *Daphneae* 内の類縁を論じた。ここで扱つたグループ全部の関係を知ることによつてはじめて日本産5属の真の系統的位置関係が明らかにされるであろう。

§1. 外部形態学的性質。

分枝法，葉序，花序については前報で論じたが，現在では節以上の類縁関係を暗示するものではないと考える。大略3型に分けられたがそれら相互の間に一貫した方向を以て分化した形質ではない。

4及び5数性: 科としては5数性から4数性への進化が認められ，連内にも一部5数性の種がある。DOMKE はこれらを下等として一括 *Wikstroemia* に含めたがこれには同意しがたい。本連はこの性質に関しては過渡的段階にあり例外も多く，少くとも連内の序列を論ずるにはあまりに高次の形質に属するものである。

花盤の形: 盃状乃至輪状，広楔形乃至4角形，狭3角形乃至針状に3大別できるが，多くの移行型の存在と分化に一貫性を欠くことによつて，過去の分類学者のように過大評価されるべきではないと考えられる。

花粉の外層彫紋模様: *Daphnimorpha* の特殊性のみが現在でも認められ，他の属では一様である。

漿果（時に核果様）と乾果の差も連内では有意義でない。その他，花筒の諸性質と小花梗関節，花柱，雄ずいの位置及び胚乳の量はいずれもあまり重要ではない。

§2. 解剖学的性質。

内部篩部: これについてはすでに前報で論じた。ここでは葉についてさらに多くの外国産の種を調べた結果，内部篩部及びその繊維が多量にあるものから全くないものへと一貫した分化（又は減退）の方向を認めた。これに関し LÉANDRI はその研究結果を GILG の体系に機械的にあてはめたため DOMKE 等によつてその系統学的価値を否定されることになつたが，*Daphneae* 内の属の配列を修正して DOMKE 自身の体系にあてはめる時この性質は科内でも連内でも一貫した変化を示すことは明らかである。その方向は他の解剖学的性質のそれとよく一致する。

木部通道細胞。(i) 道管及び仮道管の配列: a—*Wikstroemia* 型—道管及び仮道管は小群として散在し，年輪は不明。しかしミツマタは道管の膜厚と直径が著しく異る春材・秋材の存在によつて特徴づけられる。b—*Diplomorpha* 型—道管は散在し仮道管は年輪界に層をなす。c—*Daphnimorpha* 型—ほぼ b-型に似るが仮道管は放射方向にグループをなすことが多い。d—*Daphne* 型—両者は混在して火焔状乃至樹枝状の配列を示す。これらの型の間には (a→)b→c→d の方向の分化が考えられる。さらに *Daphneae* よりも低位と思われる *Phalerieae*（とくに *Phaleria*）にも a-型の見られることは a-型がこの分化系列のはじめに位置することを示す。

(ii) らせん紋: 前報では重視したが，その存在・顕著さに規則性がなく，識別上はともかく系統的には偶発性のものと思われる。

(iii) 道管の有縁膜孔: 系統的の意義は少いが，孔紋隙の形が *Daphne*（*Genkwa* を除く）で円く，他属では細長で時に連続する。しかし *Daphne* でも根材では後者に近くなる。

(iv) 道管の横断面形: 一般に *Wikstroemia* で円く，他では角張るが著しい差ではない。

(v) 繊維状仮道管: 形の上でも *Daphnimorpha* と *Daphne* の一部では柔細胞形で短く，他では木繊維形で長い。さらに柔細胞（紡錘形始原細胞の長さを保つといわれる）とこの細胞の長さの比（資料の関係で最大長の比）をとつてみると，各属の平均では *Wikstroemia* 3.7(−4.2), *Edgeworthia* 3.3, *Diplomorpha* 2.6, *Daphnimorpha* 1.7, *Daphne* 2.7（*Pseudo-mezereum* 2.3, *Daphnanthoides* 2.7）となる。この繊維状仮道管の伸長率ともいうべき値の減少の系列は BAILEY 等の認めた道管節長の減少とは別の意味で低次の組織分化の方向を示すものと考えられよう。この数値の小さいグループでしばしば材の階段状構造の見られるのも特徴的である。

木部柔細胞。(i) 配列: a—やや多量で翼状 (aliform) 乃至時に連合翼状 (confluent)。b—上に似るが概して狭く，切線状 (apotracheal) のものと共存し時に同心円状 (concentric)。c—終端型 (terminal) の狭い層と近接型 (paratracheal) の狭い列又は散点状をなす。d—終端型の狭い層のみ。この4型が認められ，その分化は

$$\begin{tikzcd} a \arrow[r] & b \arrow[rr] \arrow[dr] & & d \\ & & c \arrow[ur] & \end{tikzcd}$$

又は

$$\begin{tikzcd} a \arrow[r] & b \arrow[r] \arrow[dr] & c \\ & & d \end{tikzcd}$$

の系列にあると考えられる。一部 KRIES の仮説と異る点もあるが少くともこの連ではこの推定が正しいと考えられる他の理由もある。

(ii) 柔細胞ストランドの量: 上の諸形質とほぼ平行に，ストランド（*Wikstroemia* で柔細胞全数の 4/5 以上を占める）が減少し紡錘形柔細胞が大部分を占める方向に変化が認められる。

木部放射線: 同性・異性の別は必ずしも明確ではない。一方単列・多列両型の共存するものから単列放射線のみのものへ分化しているようであるが，これは連内でのみ認められる系列である。

結晶: *Edgeworthia* と *Eriosolena* にのみ金平糖状結晶が認められるが識別的差にすぎない。

§3. 属及びグループ間の類縁関係。

以上に述べた性質と各グループの間の関係は本文第2表に示される。これに基いて連内の系統を求めるにあたり，各性質の系統論上の意義が確められなければならない。この目的のため筆者は DOMKE の体系に従つてまず科内の系統及び形質分化の方向を調べ．*Daphneae* とその近縁連間の系統上の位置の高さを比較した。その際 DOMKE の指摘した外部形態の5性質に筆者はさらに2つの解剖学的性質を加えて科内の系統を示す特徴と考えた。その結果 *Wikstroemia* が *Daphneae* より低位な *Phalerieae* 内の *Phaleria* に酷似する点及びより高位と思われる *Gnidieae* のある属に *Daphne* が似る点より *Daphneae* 内に於て *Wikstroemia* から他属を経て *Daphne* に至る形質進化の方向が想定された。この仮定に立つて次に連内で解剖学的性質の多くが一致して示す方向，すなわち *Wikstroemia—Edgeworthia—Diplomorpha—Daphnimorpha—Daphne* の順に少くとも主な性質は（したがつてある程度系統そのものも）分化乃至進化したものと考えられた。他の属やグループはそれらの間の適当な位置に介在する。他方 *Daphneae* における外部形態学的性質はどれ1つとして明確な系列を示さず，又相互の間に一致をみないので系統推定上何ら重要な意義を有しないものと考えられる。以上の仮定に基いて附図 (Fig. 7) に示すような系統図がつくられた。この図からみちびかれる連内の分類として4亜連 *Wikstroemiinae, Rhamnoneurinae, Diplomorphinae* 及び *Daphninae* を仮に設け，それらに属する属及びグループを本文に述べた。外国産の種及び属について資料が乏しいのでなお多くの欠点はあろうが，

少くとも外部形態の特定の1つ又は 2，3 の性質のみに拠つた *Daphneae* に関する既往の分類方法とは根本的に異るものであり，まず妥当な系統学的評価を与え得たものといえよう。

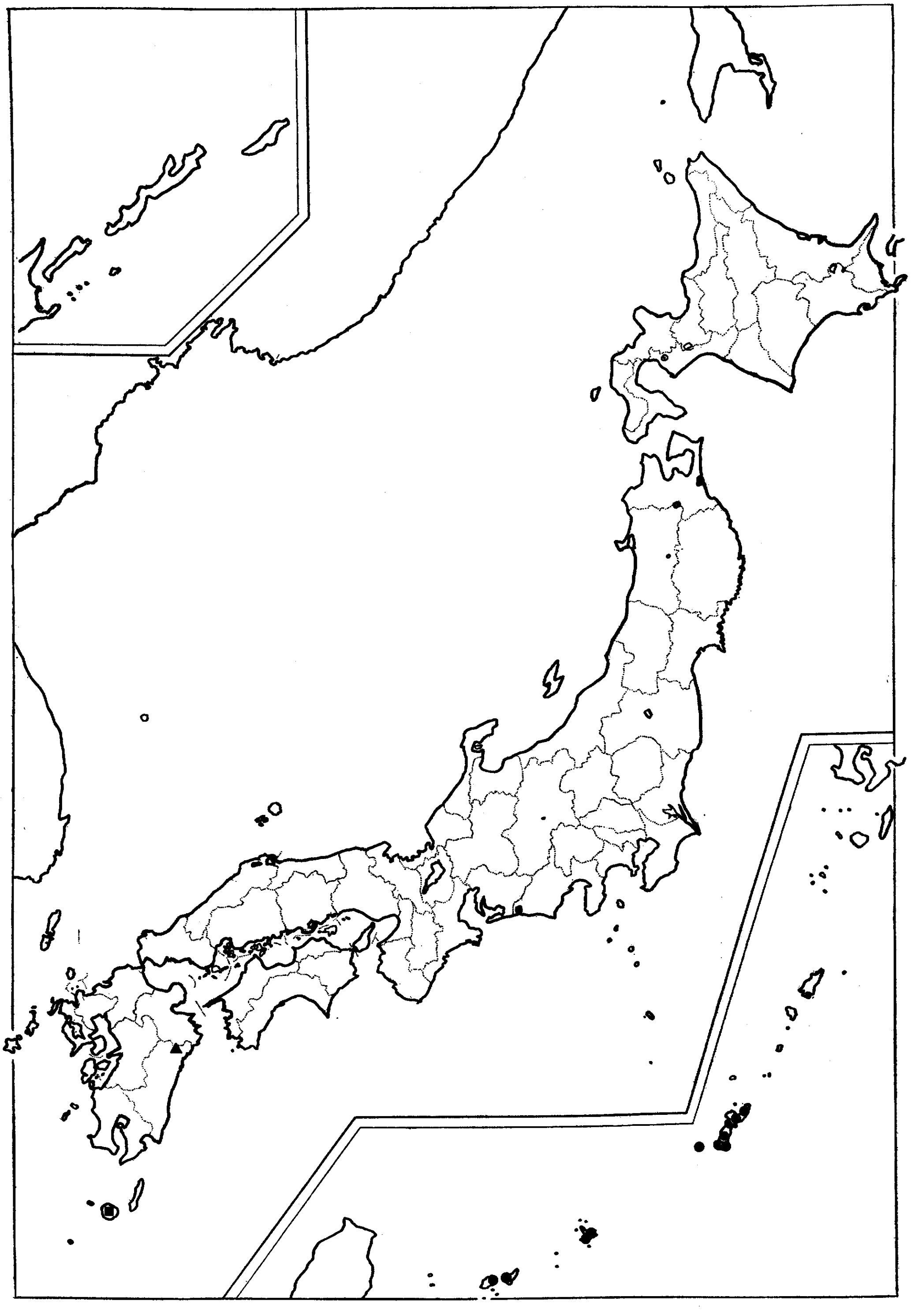
各属乃至グループについての詳しい記述はここではぶき，中国西部産5数性 *Daphne* 及び *Wikstroemia* (Fig. 7 内の *Gemmata* 等) はあるいは一部を除き *Pentathymelaea* LECOMTE という1属に値するものかも知れないことを附記するに止める。しかし木材の材料がないので確実なことはいえない。

Ⅲ. 日本産5属の概説。第Ⅱ部の結果により5属の関係も前報とは若干異るものとなつた。本邦産各種の分類・分布等については国内の主要腊葉庫の標本を検討し，若干の学名の組換えや新記載を行い分布図も改訂した。それらの結果を新しい検索表として示した。これによつて一応本邦産ジンチヨウゲ科の分類に妥当な結論を与えることになると思う。

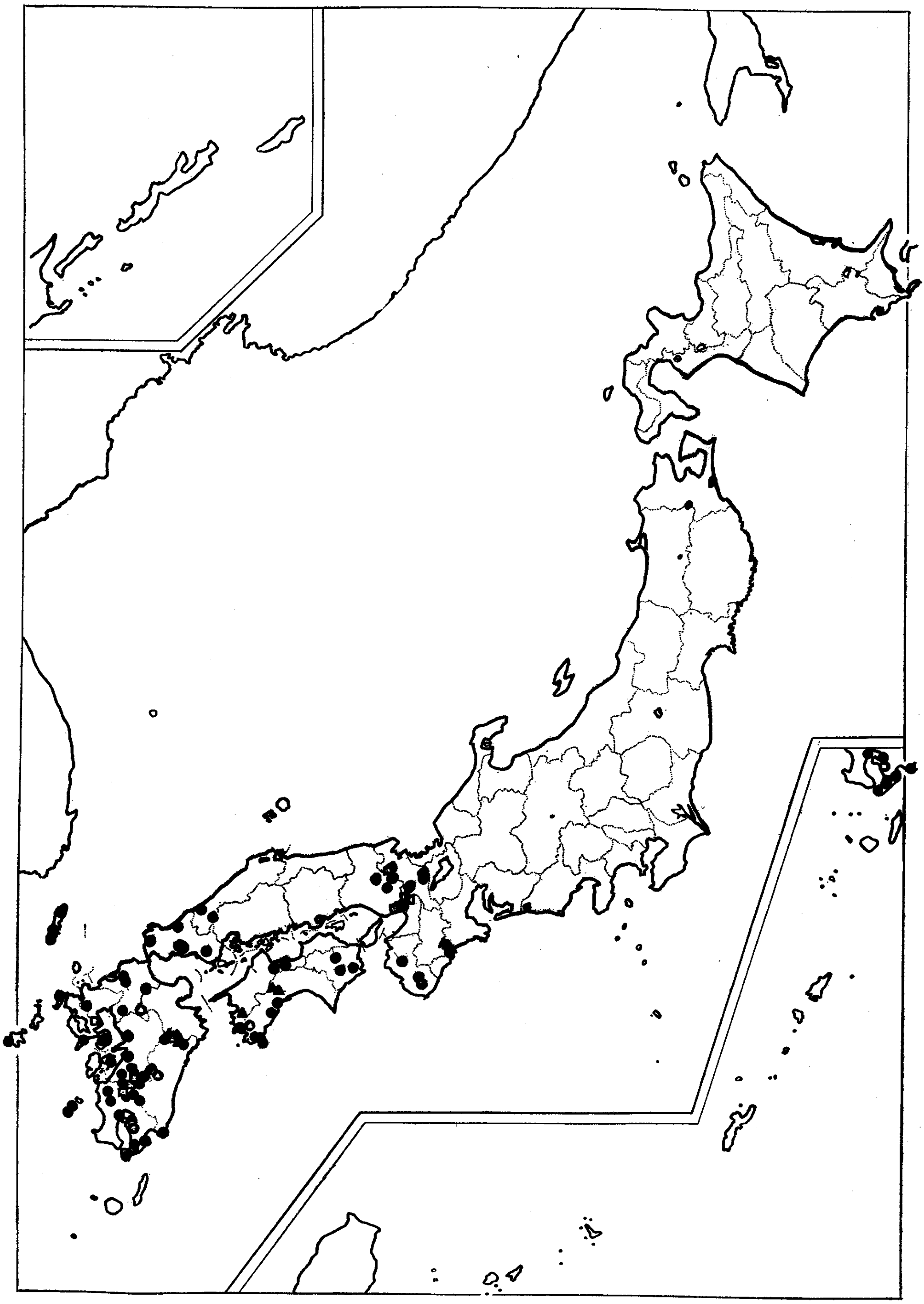
終りに本研究を進めるにあたり常にはげまし指導して下さつた猪熊泰三教授，倉田悟助教授，種々助言を与えられた島地謙氏，又 Arnold Arboretum 腊葉庫に紹介の労をとつていただいた原寛教授，テクニックに関し有益な助言を与えられた亘理俊次助教授，及び腊葉の研究を許された各腊葉庫管理者の各位に心から御礼申し上げる。

(1958年10月31日　東京大学農学部森林植物学教室において)

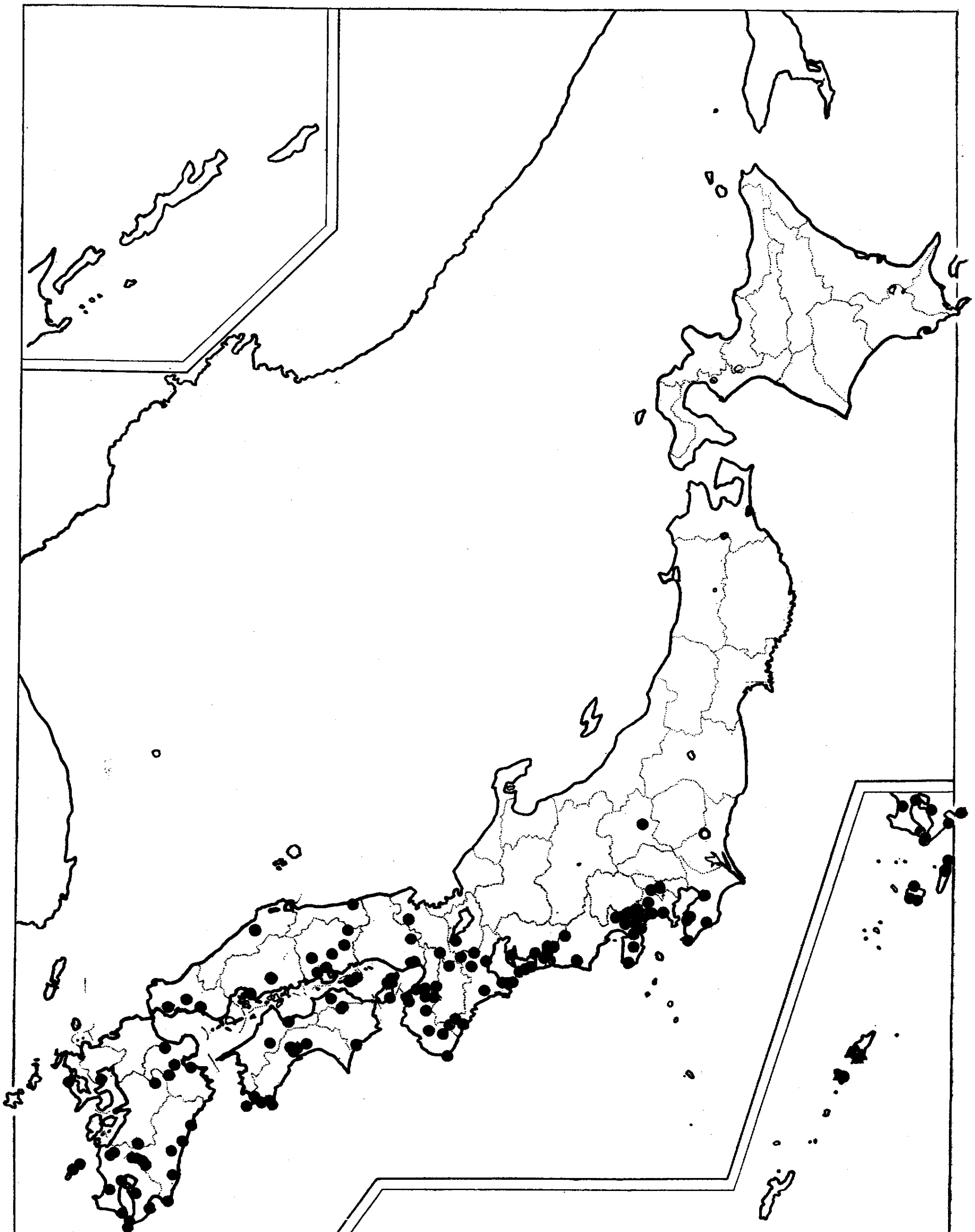
Map I



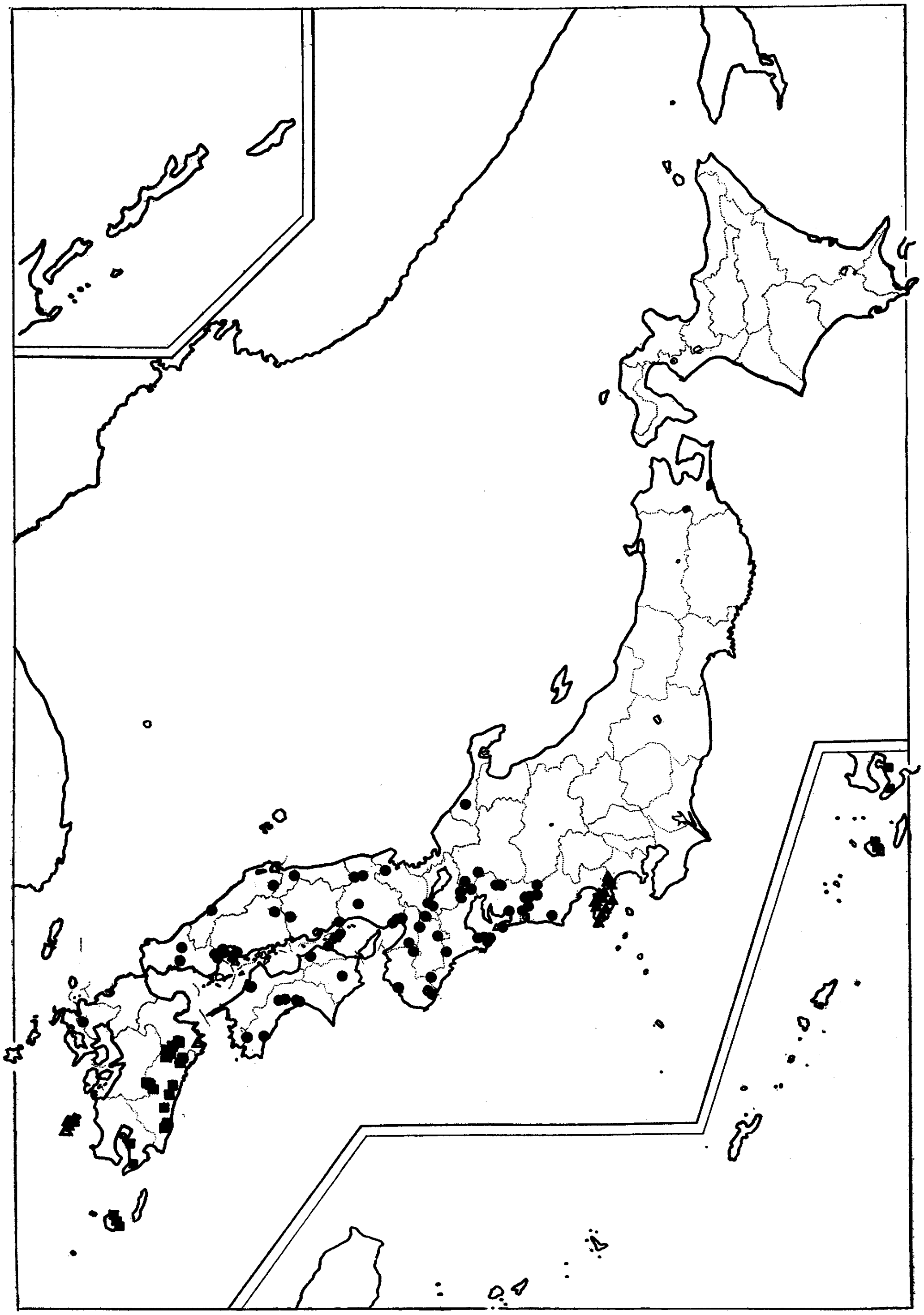
Map II



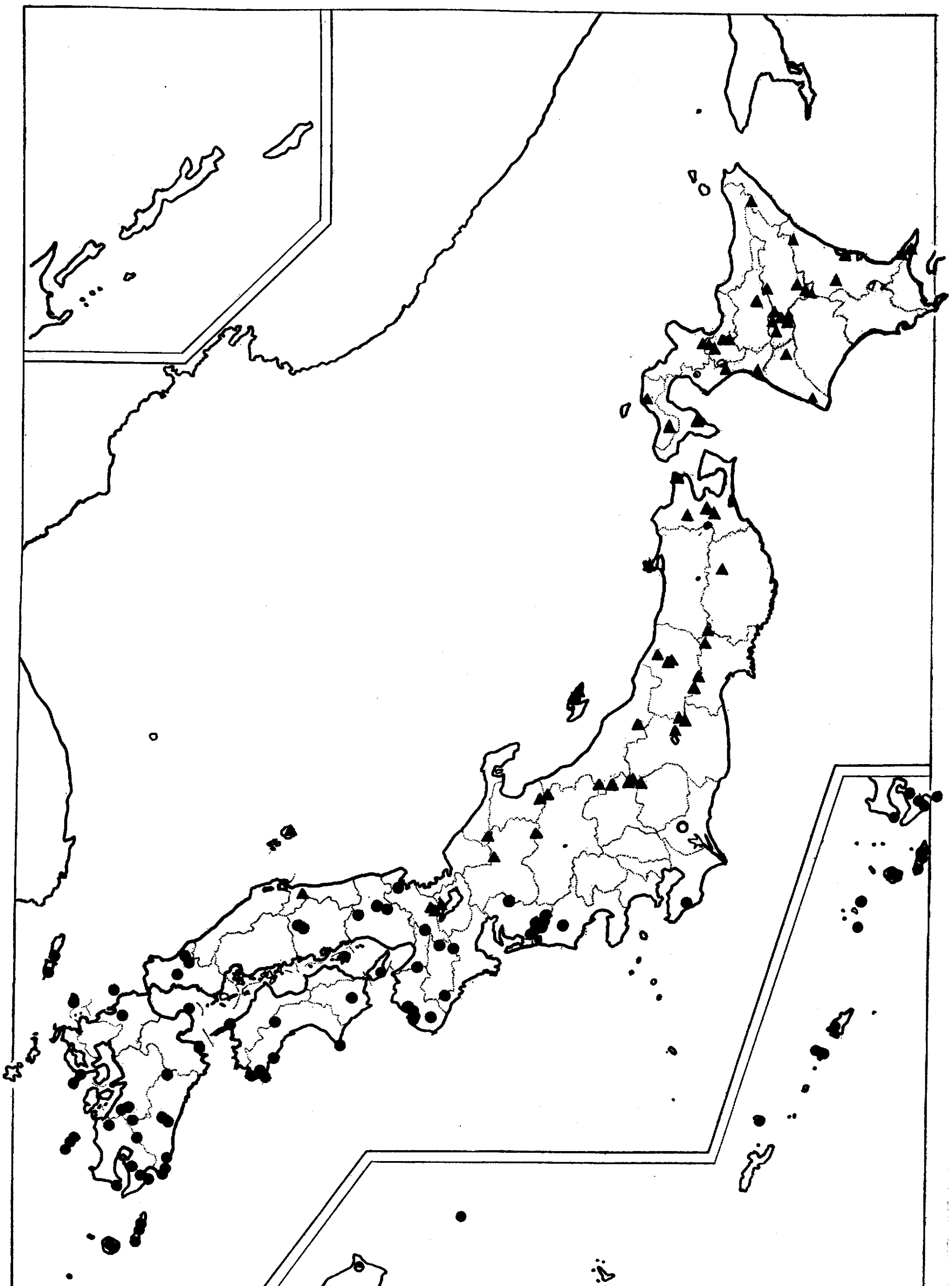
Map III



Map IV



Map V



Map VI

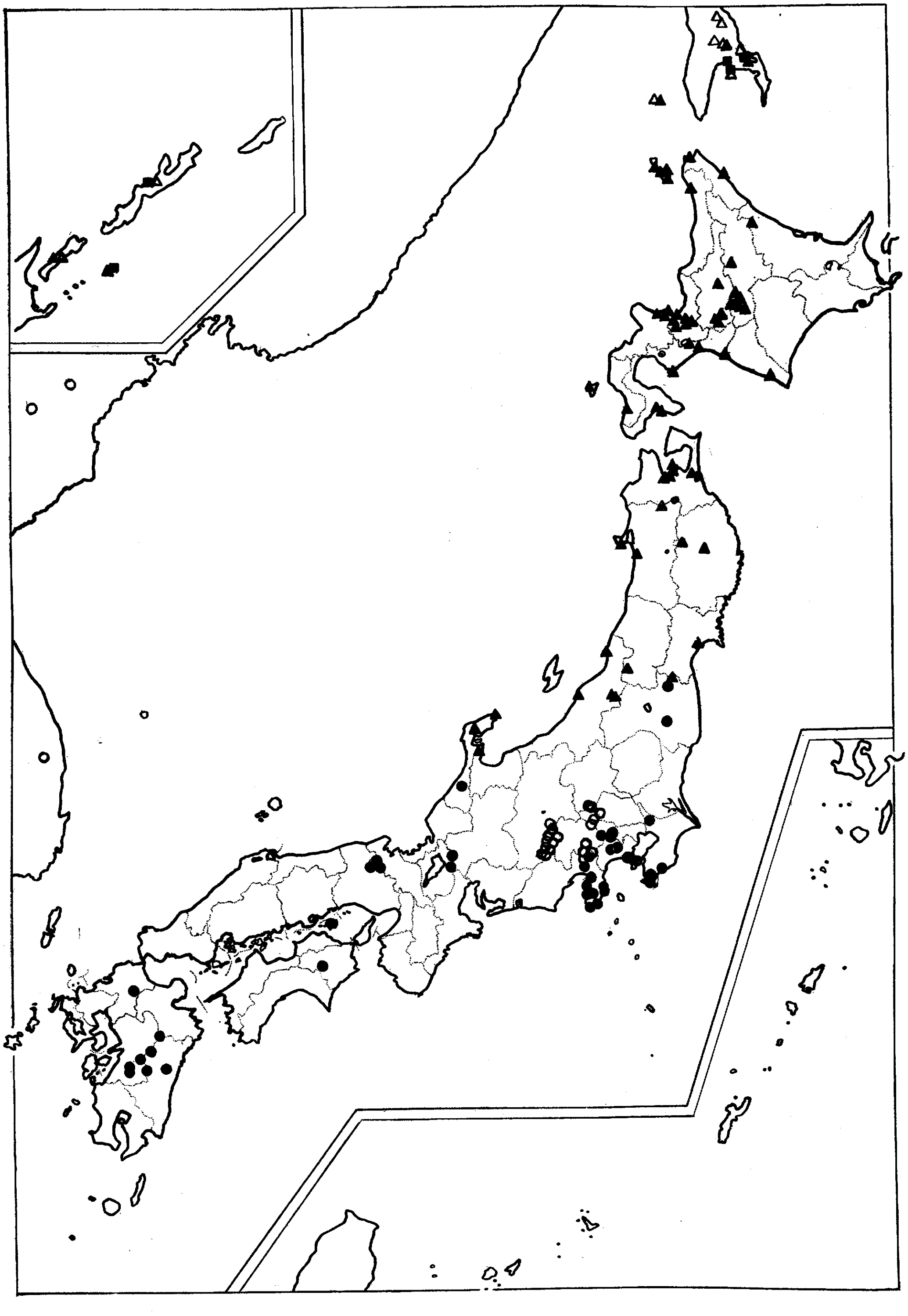


Plate I

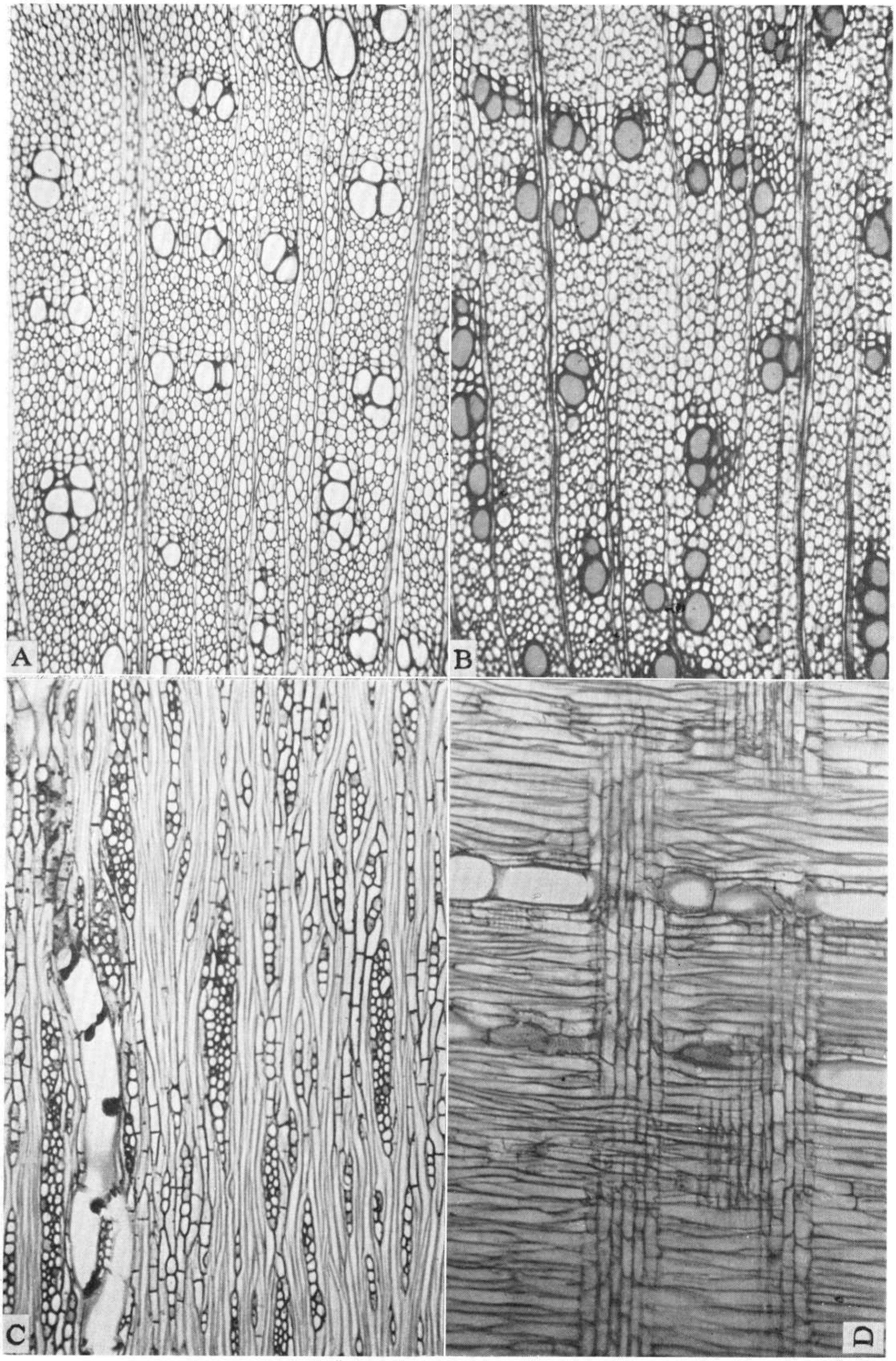
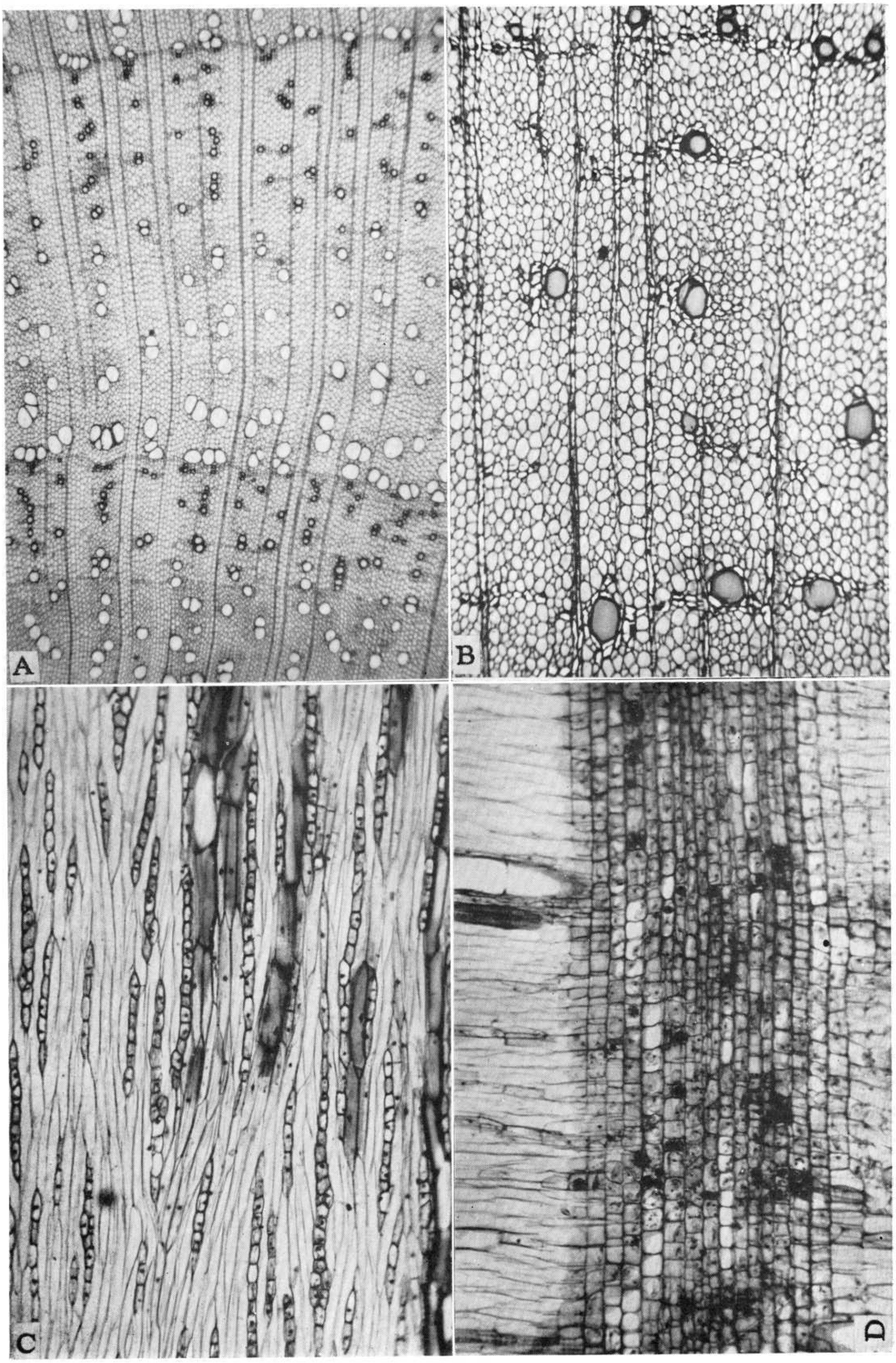


Plate II



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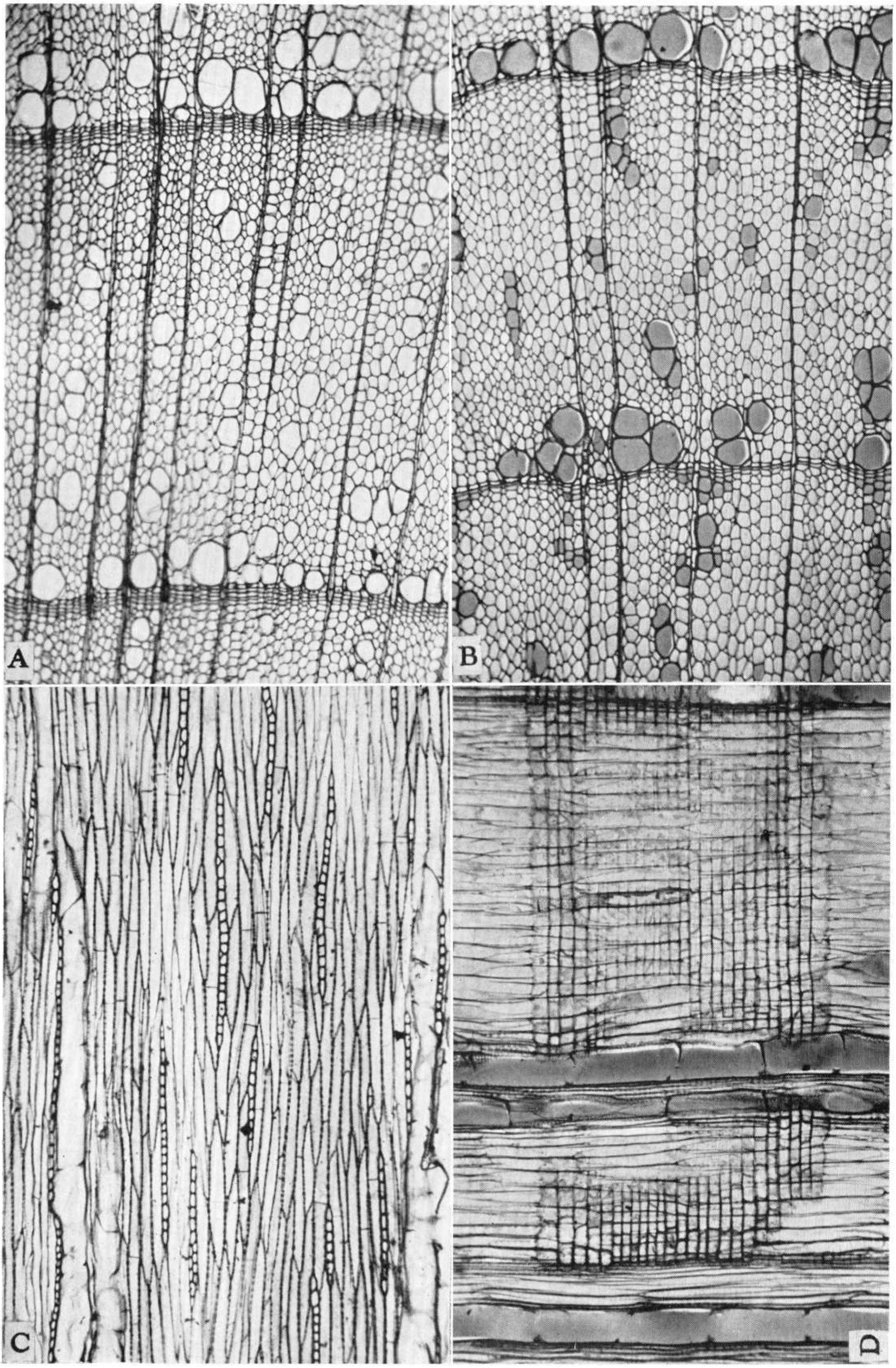

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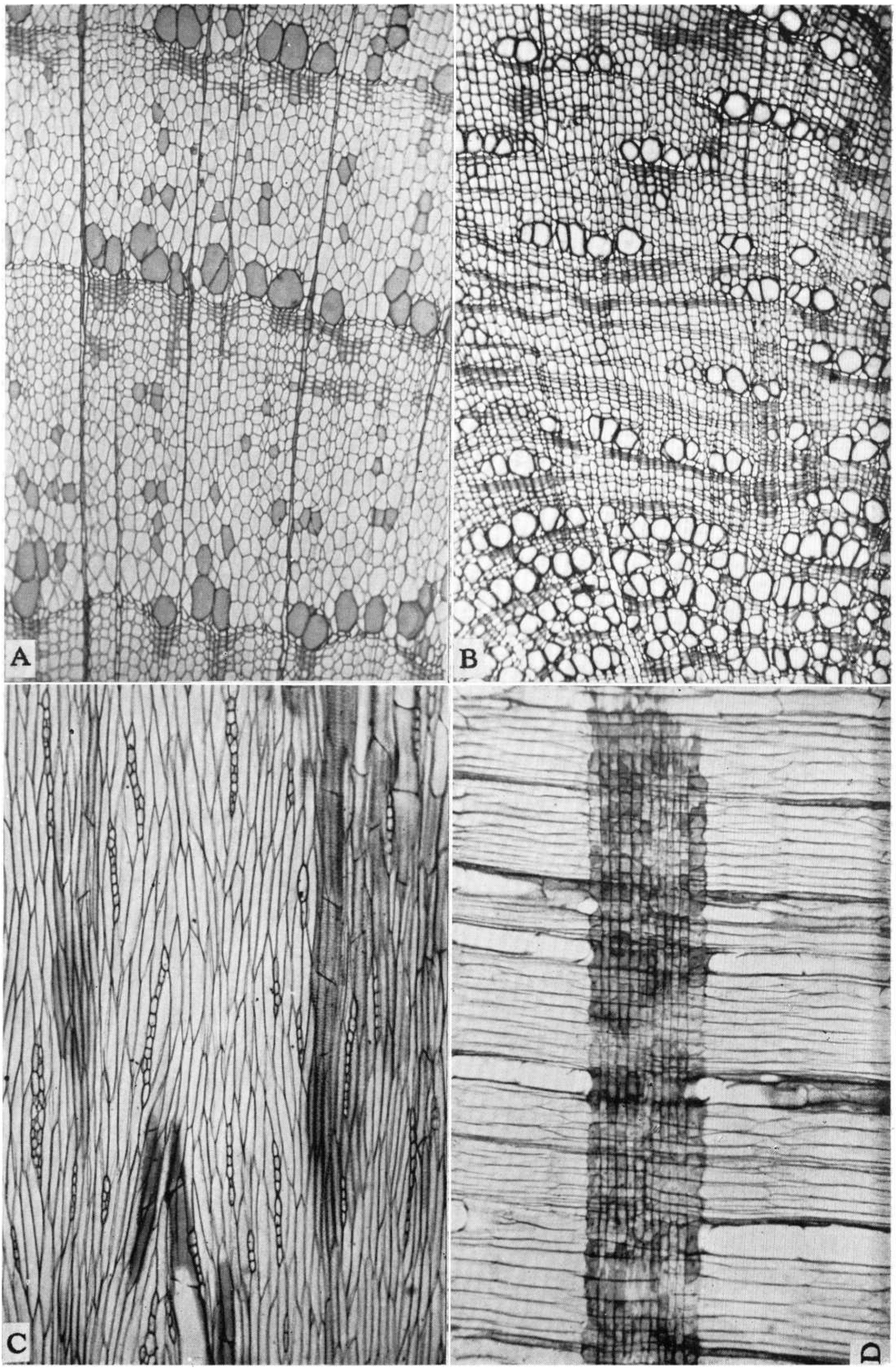
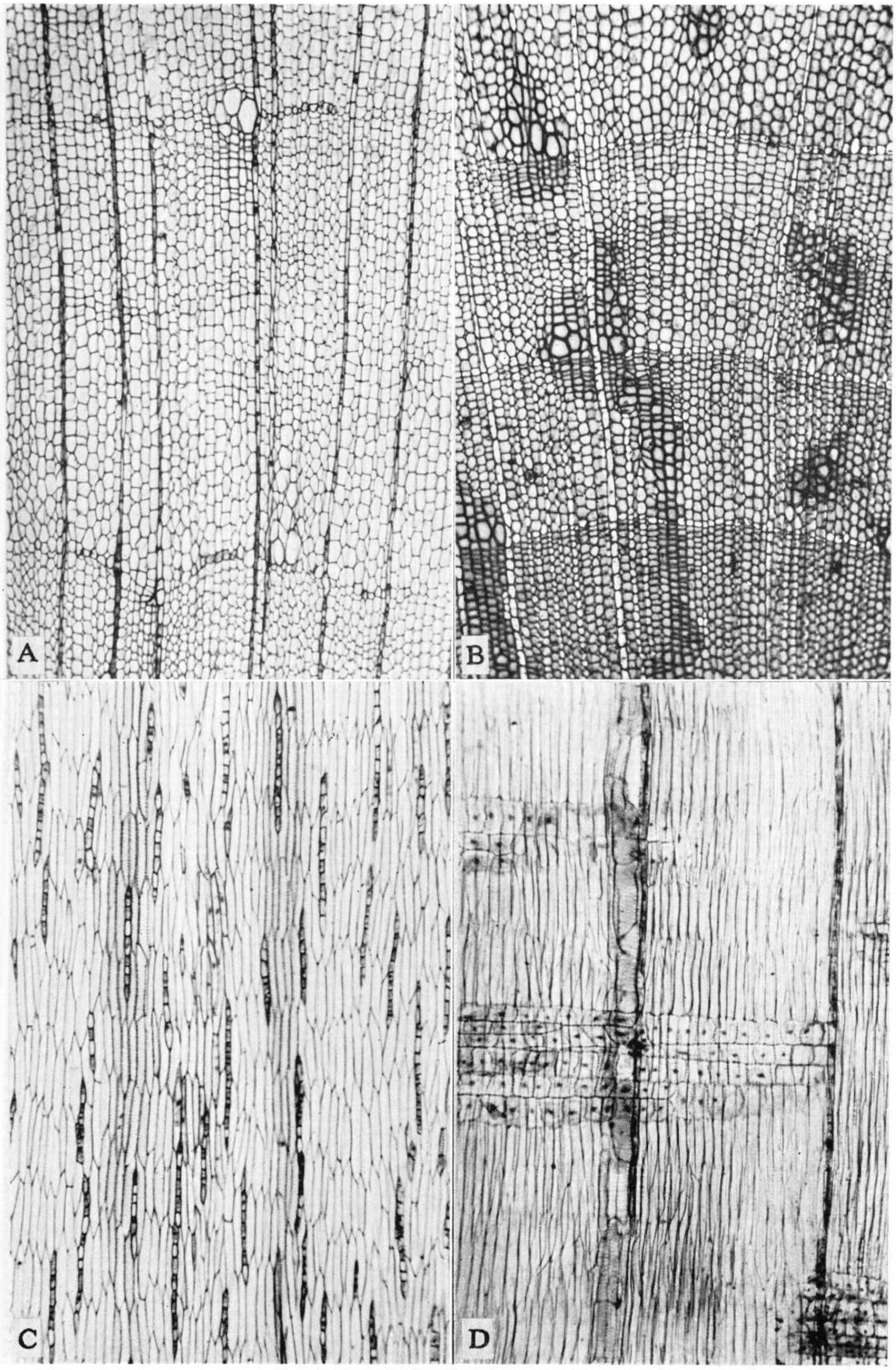


Plate V



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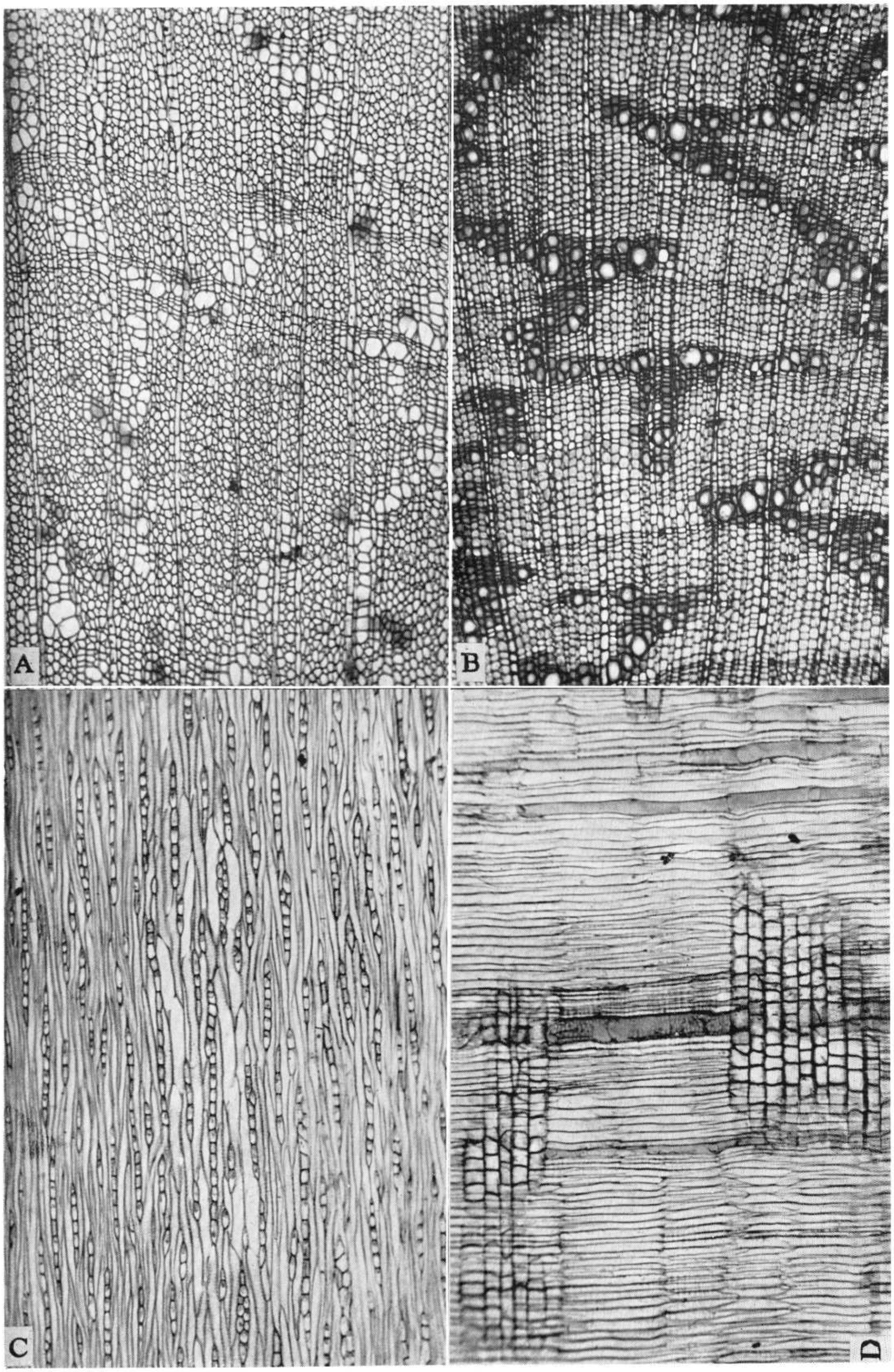

Plate VII

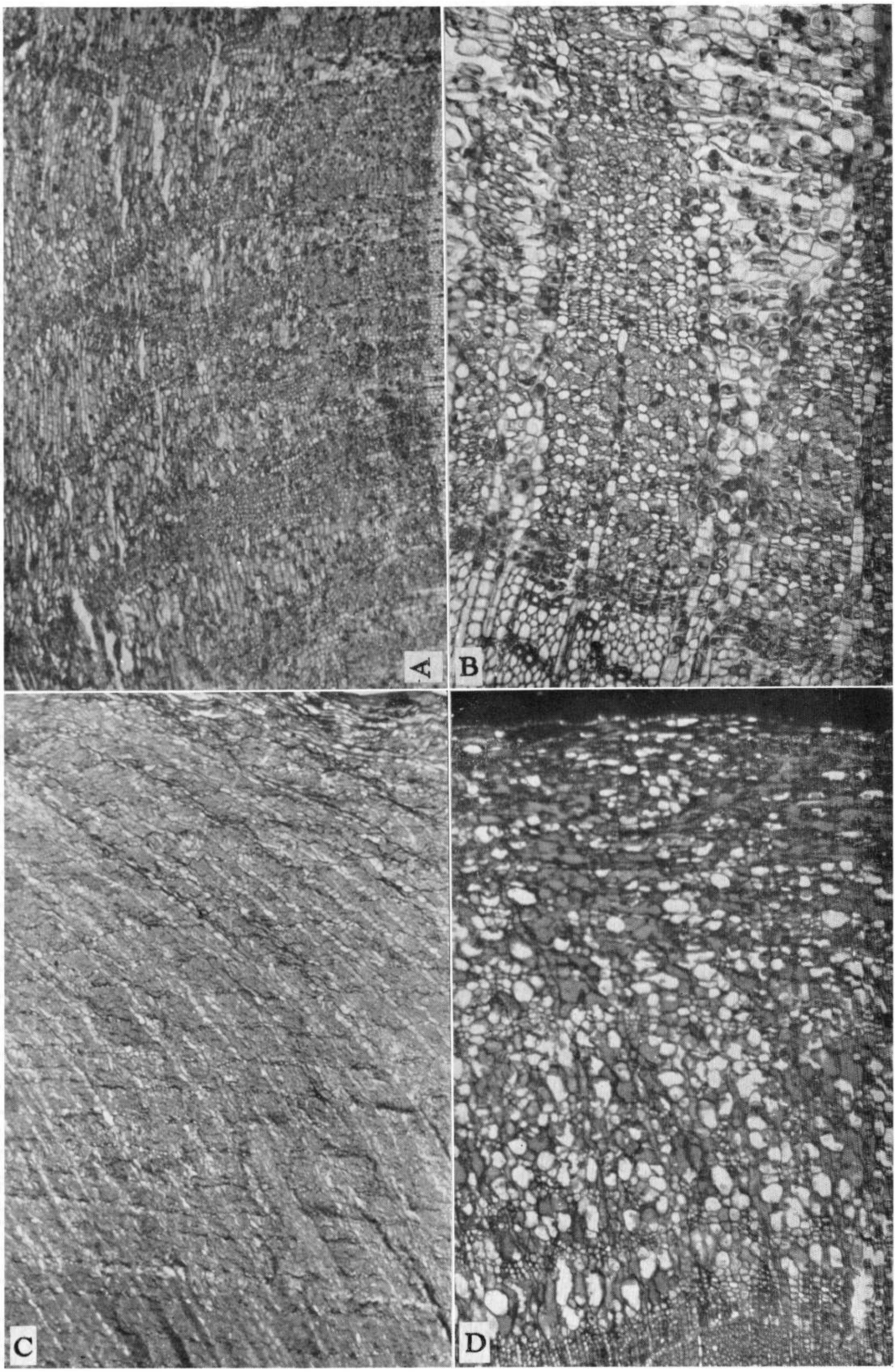

Plate VIII

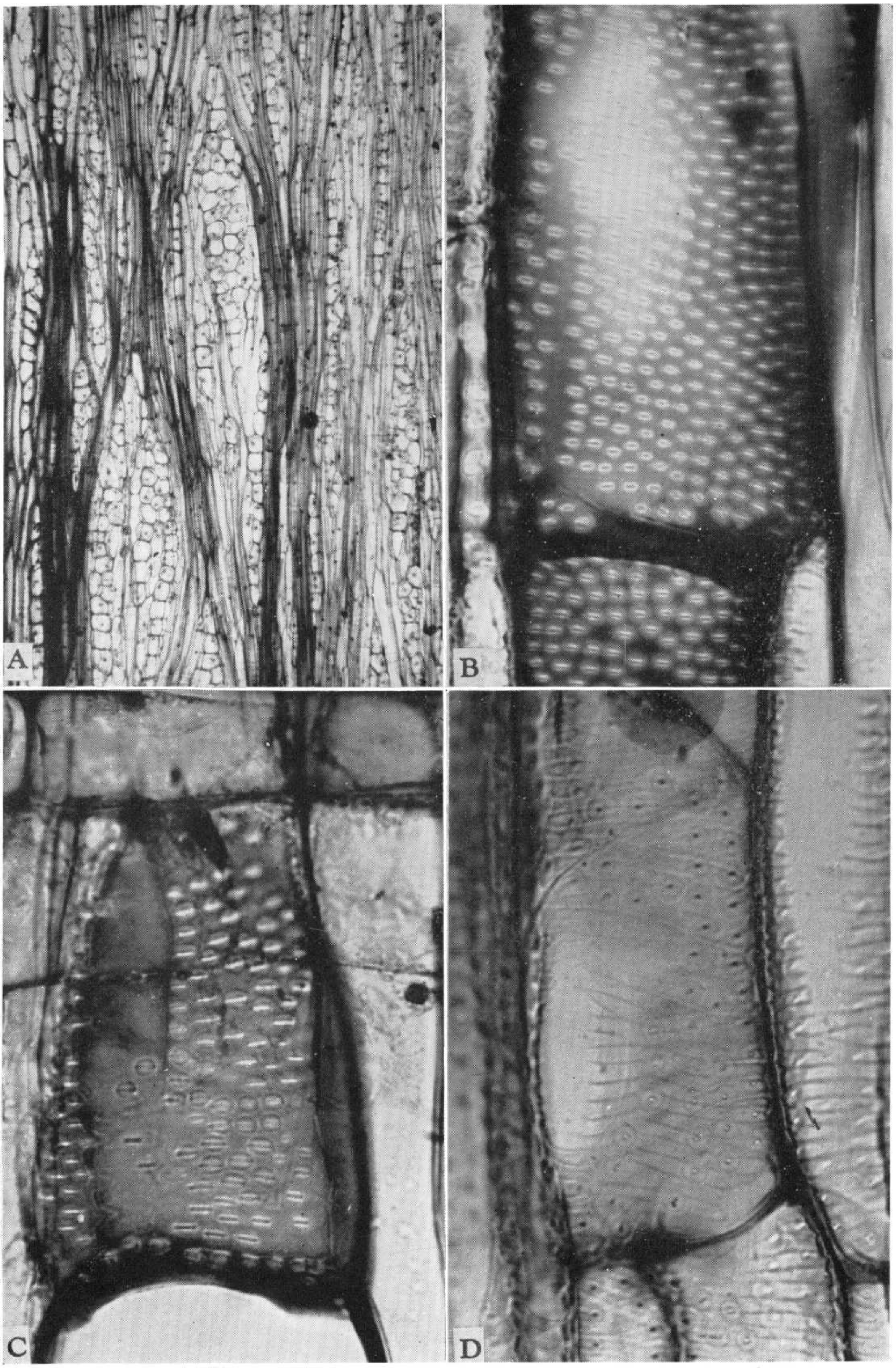

Plate IX

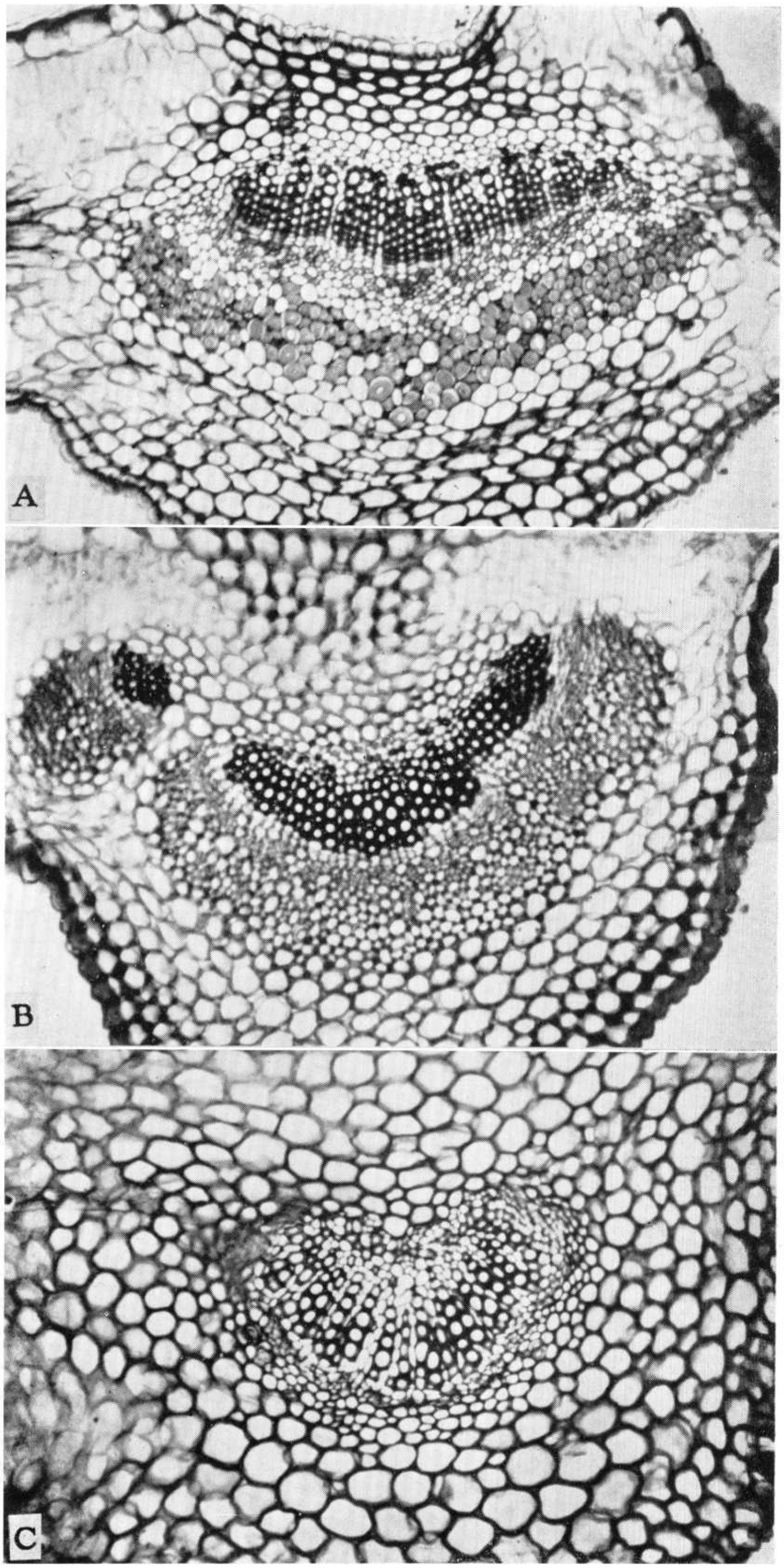

Plate X

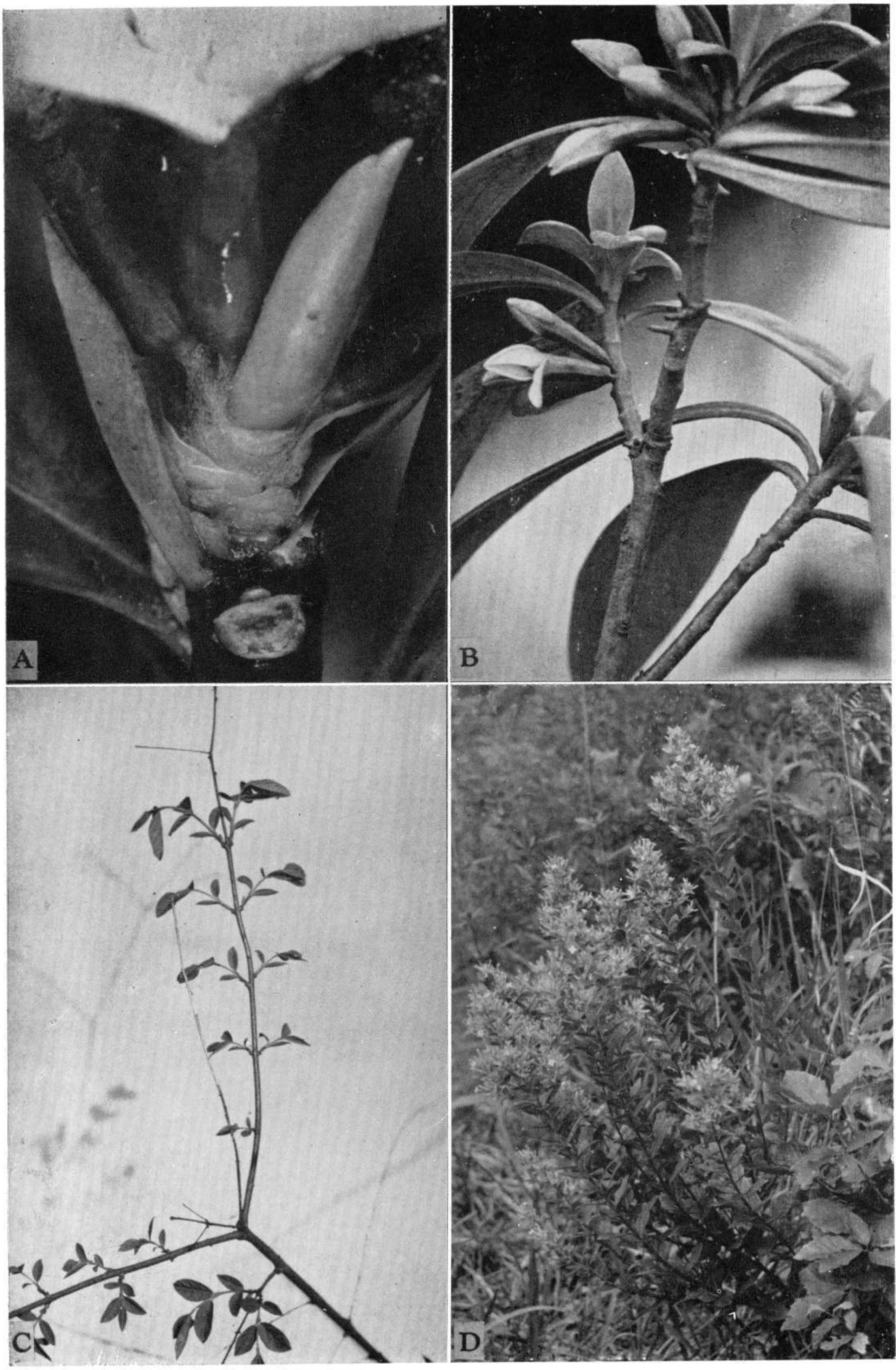

Plate XI