RE-INVESTIGATIONS OF THE MIDRIB OF BAMBOO LEAVES[1]

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Introduction

It is generally believed that the traditional classification of the Gramineae based on gross morphology is unnatural. The anatomical or cytological studies have provided a great deal of valuable information for taxonomical work during recent years. Brown (1958), Metcalfe (1956), and Tateoka (1956, 1958) suggested that the microscopical characters visible either in the leaf epidermis or in the transverse sections through the lamina are of considerable importance in the classification of the Gramineae. This is also true in the anatomy of bamboo leaves. For instance, from the detailed work of Ohki (1929, 1932) and Prat (1936), it is apparent that the characters shown on the epidermis are useful for identifying species. From the contributions of Brandis (1906), Metcalfe (1956), Page (1947), and Wu (1958), it is clear that the characters shown in the cross section of lamina: including the layers of chlorenchyma in the mesophyll, the presence or absence of the enlarged mesophyll cells which are called "translucent fusoid cells" by Metcalfe (1956), the number of cells between the two "translucent fusoid cells," and the various patterns of midrib, are important for distinguishing species. The above papers show that the characters of the leaf are comparatively more important than those of the other vegetative organs, though the microscopical characters of other organs are also valuable for classification.

Since the writer's previous investigation on bamboo leaves in 1958, the complex structure of the midrib has continued to attract her special attention. Owing to the various patterns provided by the sections of different species, it is assumed that major diagnostic characters for classification may lie in the midrib. This hint urges the writer to continue working on the anatomy of bamboo midrib. The purpose of the present paper is to summarize the recent re-investigations on the structure of the midrib of bamboo leaves and the differentiation of its vascular system as well.

(1) Acknowledgment is made to Dr. Charles E. DeVol for his sincere criticism, and to Miss Nora K. L. Chen for her assistance to the slides and drawings.

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Material and Method

The materials for the present study were all collected in Taiwan, and 16 species belonging to 8 genera were used. Among them one species, *Schizostachyum diffusum*, is a vine; the rest are shrubs or trees. The Chinese *Schizostachyum* and *Phyllostachys* were collected and studied by McClure (1935, 1956). The following table gives a list of the species studied and the localities from which they were collected.

Species No.	Name of species	Localities	Date of collection
201	*Bambusa Oldhami* Munro	Yanmingshan, Taipei	April 15, 1959
202	*Phyllostachys Makinoi* Hay.	Yanmingshan, Taipei	April 15, 1959
203	*Bambusa multiplex* (Lour) Raeusch	Yanmingshan, Taipei	Aprli 15, 1959
204	*Phyllostachys edulis* (Carr.) Riviere	Chungli, Taipei	May 8, 1959
205	*Dendrocalamus latiflorus* Munro	Agr. Coll. Taichung	May 11, 1959
206	*Ischurochloa stenostachya* (Hack) Nakai	Agr. Coll. Taichung	May 11, 1959
207	*Bambusa vulgaris* Shr.	Keelung, Taipei	June 10, 1959
208	*Pleioblastus Kunishii* (Hay) Ohki	Yanmingshan, Taipei	June 21, 1959
209	*Indocalamus niitakayamensis* (Hay.) Nakai	Pa-Hsien-Shan, Taichung	June 24, 1959
210	*Bambusa floribunda* (Zoll.) Nakai	Pi-Yun Sze, Tainan	June 28, 1959
211	*Bambusa dolichoclada* Hay.	Min-Hsion, Chiayi	June 29, 1959
212	*Pleioblastus Usawai* (Hay) Ohki	Shihlin, Taipei	July 6, 1959
213	*Bambusa Beishitiku* Keng (*Leleba Beishitiku* Odashima)	Yanmingshan, Taipei	July 18, 1959
214	*Shibataea Kumasasa* (Zoll) Nakai	Yanmingshan, Taipei	Aug. 6, 1959
217	*Bambusa naibunensis* Nakai	Keng-Ting, Hengchuan	Jan. 8, 1960
298	*Schizostachyum diffusum* Merr.	Keng-Ting, Hengchuan	Jan. 8, 1960

The slides used for the present research were prepared by the paraffin method and were stained by Delafield's hematoxylin and safranin. Transverse sections were cut at different levels of the lamina. At least three sections were made of each leaf at the different levels, namely the tip, the middle, and the base. Usually two more sections were cut at the levels between the middle and the base. Thus a series of slides were prepared from each leaf and several leaves of each species were used for the present purpose. At the very base of the leaf just above the petiole-like sheath, there is a triangle zone in which the vascular system is much more complex and somewhat confused, but it is good for reference. No paraffin sections were made of this triangle zone; only free-hand sections were prepared for a check.

All photographs taken under the microscope were of two magnifications (×150, ×200). All diagramatic drawings were made at a smaller magnification (×50), in order to save space and provide a better comparison. All diagrams were drawn with the aid of the camera lucida.

Observation

I. Anatomy of the midrib:

It is clearly seen that there is a prominent distinct midrib in the medium position of a leaf. This midrib is not uniform in thickness. Usually the midrib is as thin as the blade at the tip of the leaf, but it increases in thickness as it runs toward the base of the leaf. The midribs of different species also vary in their thickness. The midribs of some species are very conspicuous, whereas those of some other species are somewhat obscure. Metcalfe (1956) mentioned that *Merostachys riediliana* has no well defined midrib. At any rate, the external appearance is only of very little value, but the internal structure as shown by transverse sections of the different species gives diagnostic characters of importance.

The internal structure of the midrib is very complex. The degree of complexity depends upon the level at which the section is made. Generally the nearer the base, the more complex is the structure. The internal structure of midrib is not uniform, but it varies from the tip to the base. Though the midribs of other grasses, aside from bamboos, also become complex at the base, they are not so complex as those of bamboos. This is one reason why bamboo is peculiar when compared with other grasses.

The midrib is a region which usually consists of colorless parenchymatous cells in addition to the vascular system and sclerenchyma. It is usually limited laterally by the "translucent fusoid cells". As they collapse at maturity, the section is usually cut through the intercellular spaces left by them and in such case the lateral extent is clearly limited by the "apparent cavities" named by Brandis (1906). If the "translucent fusoid cells" are absent in some species, such as *Indocalamus niitakayamensis* and *Phyllostachys edulis*, the lateral extent of the midrib can still be seen by the distinct line where the chlorenchyma ends and the colorless parenchyma begins (Plate I, Fig. 3, 7). The internal structure of midrib varies at different levels. In case a section is cut at the tip, the midrib contains no colorless parenchyma, but contains a single medium major vascular bundle adjoining both adaxial and abaxial strands of sclerenchyma. The vascular bundle is clearly surrounded by double bundle sheaths, an outer parenchymatous sheath and an inner sclerenchymatous sheath (Plate I, Fig. 1, 5, 6). This double sheath is a typical character of festucoid grasses. But if a section is cut at the middle, or at the base of the leaf, the midrib consists of a mass of colorless parenchyma as a ground tissue within which a number of vascular bundles are arranged in two series, adaxial and abaxial, and each bundle is embedded in two disconnected girders of sclerenchyma. In addition to these, the midrib also contains a band of chlorenchyma next to each epidermis. This band is about 2-3 cells in thickness and cell margin is not so deeply as the chlorenchyma in the blade. The number of vascular bundles in each series increases, and the extent of colorless parenchyma enlarges, as the section is cut nearer the base. In the present study, the number of vascular bundles in the midrib varies from 1 to 22 and it is possible that they may be more in other species.

II. Differentiation of the midrib

The different species studied and the slides made from the different levels from the same species show the midribs have very different patterns. But the careful study of the midribs of these 16 species show there is a general plan of differentiation. Starting from the tip and proceeding to the base the following steps are found.

1. A section cut at the tip of leaf shows that the midrib without exception only contains one major vascular bundle which adjoins the abaxial and adaxial sclerenchyma. There is no colorless parenchyma. This major bundle may be larger or about the same size as the other major vascular bundles of the blade (Plate I, Fig. 1, 5; Plate III, Fig. 6, 9, 13; Plate IV, Fig. 1).
2. A section cut a little farther back from the tip shows that major vascular bundle is larger and one or two minor bundles appear above it. These three bundles, one major and one or two minor bundles, are embedded in the same band of sclerenchyma (Plate I, Fig. 6: Plate II, Fig. 2, 8; Plate III, Fig. 1, 14).
3. A section still farther back shows that these three bundles begin to separate into two series and move toward the adaxial and abaxial epidermis. The upper two minor bundles are embedded in a narrow strand of sclerenchyma in the adaxial series; the major one adjoins a strand of sclerenchyma in the abaxial series. A band of colorless parenchyma separates the two series and begin to extend laterally (Plate I, Fig. 7; Plate IV, Fig. 2).
4. The next section gives a figure in which the two series are further apart, and one or two more minor bundles appear on each side of the major vascular bundle in the abaxial series. Usually two new minor bundles, one on each side of major vascular bundle, appear at first in the same strand of sclerenchyma in which the major bundle is embedded. Thus there are five vascular bundles in the midrib (Plate III, Fig. 2; Plate IV, Fig. 9, 10). Then two more new minor bundles appear and these are embedded in the separated strands of sclerenchyma. At this moment the midrib consists of seven vascular bundles, namely five as a whole in the abaxial series and two in the adaxial series (Plate I, Fig. 3, 4; Plate II, Fig. 1, 9; Plate III, Fig. 16).
5. The basal section through the midrib shows that more minor bundles may appear in the adaxial series (Plate II, Fig. 4, 5; Plate IV, Fig. 6, 7), and

also that more new bundles may appear on each side of the major vascular bundle in the abaxial series (Plate II, Fig. 4, 5, 6; Plate III, Fig. 4, 17). Very often more major vascular bundles may appear besides the first one in the abaxial series (Plate I, Fig. 8; Plate IV, Fig. 11). In the adaxial series more minor bundles may be added, but never major ones. The two vascular series are widely separated by a broad band of colorless parenchyma.

It is possible to verify this general plan of differentiation of the midrib by figures *Phyllostachys edulis*, *Indocalamus niitakayamensis* (Plate I, Fig. 1–3 & 5–7), *Shibataea kumasasa* (Plate III, Fig. 1–5), *Bambusa Beishitiku* (Fig. 6–8), *Bambusa floribunda* (Fig. 9–12), *Ischurochloa stenostackya* (Fig. 13–18), *Schizostachyum diffusum* (Plate IV, Fig. 1–8), and *Pleioblastus Usawai* (Plate IV, Fig. 9–12). But one thing, which should be borne in mind, is that these steps are not necessarily present in every species. Some species may stop at the first step and thus midrib contains a single vascular bundle throughout its length, whereas the others may continue on until the last step and thus become a complicated midrib. Therefore, the figures provided by the midribs are not constant throughout the Bambuseae; the various patterns may be represented by the different species.

Besides, the way of appearance of new bundles is usually definite and symmetrical, though they may not arise at the same level. In case one vascular bundle appears first on one side, the other one can be imagined to appear on the other side. This is always true since one can find the other section at the lower level. This helps the worker to determine the number of vascular bundles in the midrib.

III. General patterns of the midrib

The midribs of the different species may be classified into several general patterns, based on (1) number of vascular bundles present in the adaxial and the abaxial series, (2) presence or absence of the colorless parenchyma, and (3) two series connected or disconnected by the sclerenchyma. Since the structure of the midrib of the same species is changeable from the tip to the base, the pattern shown by the base is more reliable for anatomical comparison. But if a section is cut at the very base within the triangle region next to the petiole-like sheath, the pattern becomes more complicated and sometimes somewhat confused. As for the structures in this region, they are valuable for comparison with those higher up. The general patterns of the midribs are given for the base of leaves a little above the triangle region.

A. Pattern 1—Three vascular bundles are present in the midrib. This pattern is the simplest form and is found in *Bambusa floribunda*, *Bambusa multiplex* and *Indocalamus niitakayamensis* (Plate I, Fig. 7; Plat II, Fig. 3; Plate III, Fig. II). The midrib contains a large medium major vascular bundle embedded in a strand of sclerenchyma in the abaxial series and two small minor bundles embedded in a common strand of sclerenchyma in the adaxial series. These two strands of sclerenchyma are connected together to form a continuous band from the upper to the lower epidermis (Plate II, Fig. 3; Plate III, Fig. 11), but they are separated by a band of colorless parenchyma in the case of *Indocalamus niitakayamensis* (Plate I, Fig. 7).

If a section is cut within the triangle region, then the midrib consists of 5 vascular bundles: two minor bundles in the adaxial series, one major bundle and two minor bundles in the abaxial series. The two series are separated by a band of colorless parenchyma (Plate III, Fig. 12).

B. Pattern 2—Seven vascular bundles are present in the midrib. This is a common pattern and is seen in most bamboos, such as *Phyllostachys edulis, Phyllostachys Makinoi, Bambusa Beishitiku, Bambusa dolichoclada, Bambusa naibunensis, Bambusa Oldhami, Bambusa vulgaris, Ischurochloa stenostachya* and *Shibataea kumasasa*. There are two minor vascular bundles in the adaxial series, and one major and four minor vascular bundles in the abaxial series. In the abaxial series one major and two minor vascular bundles are embedded in a continous strand of sclerenchyma except in the cases of *Phyllostachys Makinoi* and *Bambusa Oldhami*. The other two minor bundles are embedded in a separate group of sclerenchyma which may or may not connect with the lower epidermis. In the adaxial series two minor vascular bundles are embedded in a common strand of sclerenchyma. Two series of vascular bundles are separated by a band of colorless parenchyma. The lateral extent of the midrib is bounded by either the translucent enlarged, mesophyll cells or the colored, chlorenchyma cells.

Pattern 2 may be subdivided into two groups. Though these nine species mentioned above show the same pattern near the base, in the triangle zone they fall into two groups. Pattern 2a—In the first group including *Phyllostachys edulis* and *Phyllostachys Makinoi*, the midrib consists of a figure of 9 vascular bundles. In addition to the original 7 vascular bundle pattern, two more major vascular bundles, one on each side, appear in the abaxial series. Pattern 2b—In the second group including the rest 7 species, the midrib in the triangle zone consists of a figure of 13 vascular bundles (Plate III, Fig. 18; Plate IV, Fig. 13) or even 18 vascular bundles in the case of *Bambusa dolichoclada* (Plate

IV, Fig. 14). Both the cases show that, in addition to the original 7 vascular bundle pattern, there are two more minor vascular bundles in the adaxial series, and two more major bundles and several new minor bundles in the abaxial series. But the change from 7 to 13 or 18 vascular bundles is gradual and thus a figure of 9 vascular bundles (Plate III, Fig. 4, 17), of 10 vascular bundles (Plate II, Fig. 4, 6), and of 11 vascular bundles (Plate III, Fig. 5, 8) can be traced.

C. Pattern 3—Eleven vascular bundles are present in the midrib. This pattern can be seen in *Dendrocalamus latiflorus*, *Pleioblastus Kunishii*, and *Pleioblastus Usawai*. There are usually 3 minor vascular bundles in the adaxial series and these three bundles may be crowded in a common strand of sclerenchyma (Plate II, Fig. 7) or in the separate strands of sclerenchyma (Plate I, Fig. 8). In the abaxial series there are three major and five minor vascular bundles. Each vascular bundle is embedded in a separate strand of sclerenchyma except the two minor bundles under the medium major vascular bundle. The two series are well separated by a broad band of colorless parenchyma (Plate I, Fig. 8; Plate II, Fig. 7; Plate IV, Fig. 11).

This pattern may be better subdivided into two groups based on the structure of midrib in the triangle zone. They may have the same number of vascular bundle, but they are different in the arrangement and number of major bundles. Pattern 3a—In this group including *Dendrocalamus latiflorus*, the midrib consists of 18 vascular bundles, 5 minor bundles in the adaxial series, and 3 major and 10 minor bundles in the abaxial series. There are still 3 major vascular bundles in the abaxial series, though the minor bundles increase in both series.

Pattern 3b—In this group which includes *Pleioblastus Kunishii* and *Pleioblastus Usawai*, the midrib also contains 18 vascular bundles, but there are 5 major bundles in the abaxial series. Plate IV, Fig. 12 shows a section at the upper level. Though it shows less minor vascular bundles in both series, five major vascular bundles are clearly indicated.

D. Pattern 4—More than 11 vascular bundles are present in the midrib. This pattern is the most complex of all studied in this paper. The midrib is the thickest one which is about 4 times the size of a common bamboo midrib. This pattern is shown in *Schizostachyum diffusum*, which is a vine that climbs among the trees. The internal structure of its midrib is peculiar; the difference between this pattern and the others lies in that there are more minor bundles in the adaxial series, less minor bundles in the abaxial series, and more sclerenchyma tissue to connect the vascular bundles of both series together. Therefore two series are not completely separated by colorless parenchyma in the sections above the triangle zone. A section cut at the middle level shows 10 vascular—5 minor bundles in the adaxial series, and 1 major and 4 minor bundles in the abaxial series (Plate IV, Fig. 4). If a section is cut at the base above the triangle region, a pattern of 13 or 14 vascular bundles can be detected (Plate II, Fig. 5; Plate IV, Fig. 5, 6). Usually there are 6 minor bundles in the adaxial series, 1 major and 6 or 7 minor bundles in the abaxial series. In the adaxial series, 3 or 4 minor bundles are embedded in a common strand of sclerenchyma and the others are in separate masses of sclerenchyma. In the abaxial series one major and two minor bundles are embedded in the same strand of sclerenchyma, and the rest are embedded in separate masses of sclerenchyma.

But a section cut within the triangle region shows a figure of 22 vascular bundles (Plate IV, Fig. 8). In the adaxial series, there are 6 minor bundles in a common strand of sclerenchyma, two pairs of minor bundles above the other two major vascular bundles, and one more minor bundle in separate mass of sclerenchyma. In the abaxial series there are 3 major vascular bundles located in three different positions and 8 minor bundles distributed between them. Each bundle is embedded in its own sclerenchyma except that one major and two minor bundles adjoin the same sclerenchymatous strand in the medium position of the series. As a whole, there are 11 vascular bundles in the adaxial series and 11 in the abaxial series. Two series of vascular system are separated by a band of colorless parenchyma.

Discussion and Conclusion

The structure of midrib has attracted many workers who are interested in the anatomy of bamboo leaves (Brandis, 1906; Matcalfe, 1956; Wu, 1958), since it shows the most complex vascular system among the Graminae. Even though some of the species of the tribe Oryzeae may also show quite complicated vascular system in the midrib, yet they are not so complex as those of bamboos. The bamboo midrib generally consists of a large number of vascular bundles arranged in adaxial and abaxial series, and each vascular bundle is embedded either in a separate or in a continuous band of sclerenchyma. The number of vascular bundles and the condition between the two series make it possible to arrange the midribs into a number of different patterns, which are thought to be useful for diagnostic criteria. In order to reach this purpose, the following conclusions based on the results of the present investigations are provided for references.

1. A single section made from the midrib of a leaf can not represent the pattern of that particular species, since the pattern of midrib varies from the tip to the base. A midrib of a certain leaf can show many patterns, depending on the level at which it was cut. Therefore the exact level at which the section is taken is very important. Furthermore, if the sections are cut at a standard level—midway between the apex and the base—of different species, a comparison is still not very accurate for two reasons. First, it is very difficult to get the exact middle level. Since the veins are continuously entering into the midrib, the number of vascular bundles increases gradually toward the base. Thus the sections, little above or below, may give different patterns. Second, the entrance of vascular bundle into the midrib may occur sooner or later in the different species. For instance, in ***Bambusa naibunensis*** the section at the middle level shows a figure of 3 vascular bundles—two minor bundles in adaxial series and one large major bundle in abaxial series. These three are embedded in a continuous strand of sclerenchyma ajoining the upper and lower epidermis (Plate II, Fig. 8). In ***Bambusa Oldhami*** the midrib at the middle level shows a pattern of 7 vascular bundles—two minor bundle in the adaxial series, and one major and four minor bundles in the abaxial series. Two series are separated by a band of colorless parenchyma. These two species show quite different patterns at the middle level, but the sections at the base have the same pattern.

In ***Phyllostachys edulis*** the midrib at the middle level has a pattern of 3 vascular bundles which are arranged as same as those of ***Bambusa naibunensis***. But these two species show different patterns at the base.

The above three examples prove that the time of entrance of vascular system is different in various species.

2. Sections cut at tips of all the different leaves studied in the present work show nearly the same structure. Therefore the tip has no diagnostic value at all. Owing to the reasons stated above, the sections at the middle level are not safe to make a comparison. Therefore the section made from the basal part from the region just above the triangle zone shows the pattern which is more definite and comparatively more reliable.

3. Though the structure of the midrib is complicate, the different types can be grouped into a few patterns instead of many. In the middle of the leaf they reveal more patterns than nearer the base. The conditions between the two vascular series—continuous or separated—seem characteristic at the middle level, but are not so important at the base, since the two series are always separated at the base except ***Bambusa floribunda***, ***Bambusa multiplex*** and ***Schizostachyum diffusum***. Thus 16 species fall into 4 general patterns as based upon the structure of midrib.

4. The pattern provided by sections made near the base of the midrib

often seems to be useful as a genus character, though there may be some exceptions. As a result of the present study on 16 species of bamboos growing on Taiwan, the following table indicates the general conclusions.

Name of species	Patterns of midrib (at the base)
Bambusa Beishitiku Keng (*Leleba Beishitiku* Odashima)	2b
Bambusa dolichoclada Hay	2b
Bambusa floribunda (Zoll) Nakai	1
Bambusa multiplex (Lour) Raeusch	1
Bambusa naibunensis Nakai	2b
Bambusa Oldhami Munro	2b
Bambusa vulgaris Shr.	2b
Dendrocalamus latiflorus Munro	3b
Ischurochloa stenostachya (Hack) Nakai	2b
Phyllostachys Makinoi Hay	2a
Phyllostachys edulis (Carr.) Riviere	2a
Pleioblastus Kunishii (Hay) Ohki	3a
Pleioblastus Usawai (Hay) Ohki	3a
Schizostachyum diffusum Merr.	4
Shibataea Kumasasa (Zoll) Nakai	2b
Indocalamus niitakayamensis (Hay) Nakai	1

From the above table it can be seen that the genus *Schizostachyum* has a pattern different from any other and *Dendrocalamus* also has a pattern that is distinctive. The two species of *Phyllostachys* have the same pattern and the two species of *Pleioblastus* follow the same pattern. The Bambusa pattern is shared by *Shibataea* and *Ischurochloa*. There are 7 species of *Bambusa*, five follow the distinctive Bambusa pattern, but *Bambusa multiplex* and *B. floribunda* do not. These two species may be considered as exceptions, as compared with other members of *Bambusa*. They have midrib which belongs to "Pattern 1" instead of "Pattern 2b" and mesophyll which contains an occasional "translucent fusoid cells" instead of distinct well-differentiated "translucent fusoid cells". Thus they are different from other species of Bambusa not only in the structure of their midrib, but also in their mesophyll. They themselves are quite similar in their internal structure of leaves. Whether these two species should be taken out from this genus they are now in, or whether they should be put into another genus, needs further anatomical work on the structure of the other vegetative organs, and the flowers.

Similarly, in the genus *Pleioblastus*, *P. niitakayamensis* is an exception, since it contains a midrib which does not follow the usual Pleioblastus pattern, and its mesophyll has no "translucent fusoid cells" which is very distinctive in the other species of the genus. Thus it is not fitting to put in *Pleioblastus*.

In the present paper a synonym *Indocalamus niitakayamensis* is used, but whether this is suitable also needs further study.

竹葉中肋之再度研究

吳 志 英

竹葉中肋之構造，殊爲複雜，其內含許多維管束，通常列爲上下二組。根據維管束之數目、排列、及二組間之連接情况，構成各種不同圖式。此等圖式被認爲可作分類之標準，乃引起作者再度研究之興趣，玆將研究所得結果，簡述于下。

(1) 同一中肋各橫切面所顯示之圖式，自葉尖至葉基，各點均不一律。故單憑一片切面，不能即代表此一物種之圖式。若欲比較各物種之異同，所切地帶，非常重要。

(2) 各不同物種葉尖所顯示之圖式，彼此類似，故葉尖似無分類價值。

(3) 若以中肋中部地帶爲比較標準，則所顯示之圖式，比較基部爲多。因二組維管束間之關係，或分或連，較爲複雜。但在基部，除極少數外，二組完全分開，故本研究就基部構造，酌分爲四種圖式，分列成表（詳見英文結論）。

(4) 中肋基部所示之圖式，雖略有例外，但似可作爲"屬"之特性。表內所列同一"屬"之各物種，具有相同圖式。但在 *Bambusa* 屬內，五種具有同一式樣，二種(*B. multiplex* 及 *B. floribunda*) 不但中肋顯示另一圖式，而且葉肉內含之巨大透明細胞亦大爲減少，此二物種是否應另成一屬，或歸入他屬，則尙待多方面之研究。同樣 *Pleioblastus* 屬之 *P. niitakayamensis* 亦似例外，因它之中肋圖式及葉肉之缺少透明細胞，均和本屬特性不符，因此本篇已遷入 *Indocalamus* 屬，但是否適當，亦需進一步之研究。(摘要)

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Explanation of the Plates

Plate I.

Fig. 1-3. *Phyllostachys edulis* (×200). T. S. midrib at three successive levels, the tip, below the middle, and the base.

Fig. 4. *Phyllostachya Makinoi* (×200). T. S. midrib at the base.

Fig. 5-7. *Indocalamus niitakayamensis* (×200). T. S. midrib at three successive levels, the tip, the middle, and the base.

Fig. 8. *Dendrocalamus latiflorus* (×100). T. S. of midrib at the base.

Abbreviations used in the photos

a—inner sclerenchymatous sheath.	b—bulliform cells.
e—outer parenchymatous sheath.	d—silicon cell.
l—lower epidermis.	M—translucent fusioid cells.
m—chlorenchyma.	p—colorless parenchyma.
s—sclerenchymatous fiber	u—upper epidermis.
v—minor vascular bundle.	V—major vascular bundle.

Plate I.

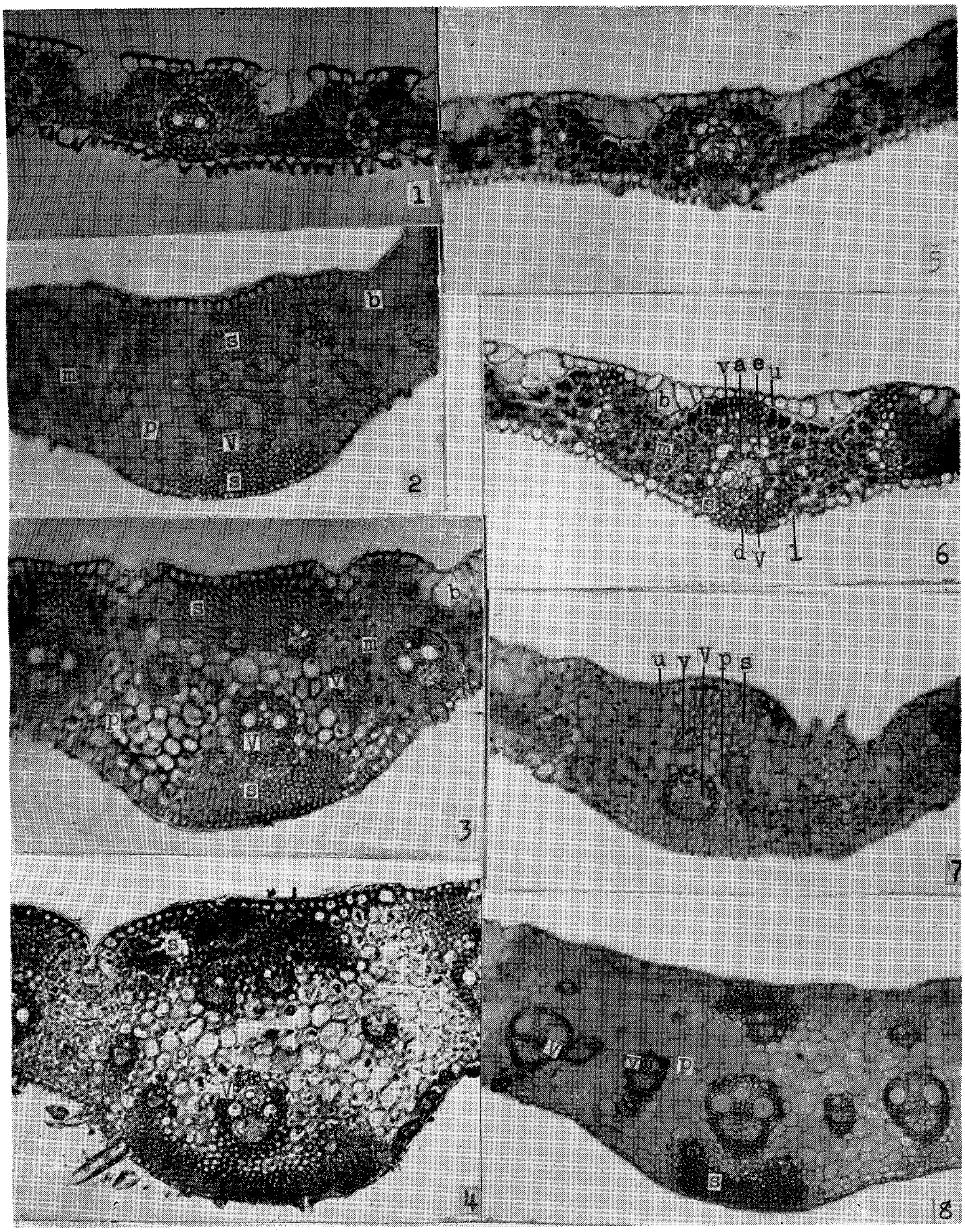

Plate II.

Fig. 1. *Bambusa vulgaris* (×150). T. S. midrib at the base.
Fig. 2–3. *Bambusa multiplex* (×150). T. S. midrib at 2 successive levels at the base.
Fig. 4. *Bambusa dolichoclada* (×150). T. S. midrib at the base.
Fig. 5. *Schizostachyum diffusum* (×150). T. S. midrib at the upper level of the base.
Fig. 6. *Bambusa Beishitiku* (×150). T. S. midrib at the upper level of the base.
Fig. 7. *Pleioblastus Kunishii* (×150). T. S. midrib at the middle level of the base.
Fig. 8. *Bambusa naibunensis* (×150). T. S. midrib at the middle level.
Fig. 9. *Bambusa Oldhami* (×150). T. S. midrib at the upper level of the base.

Plate II.

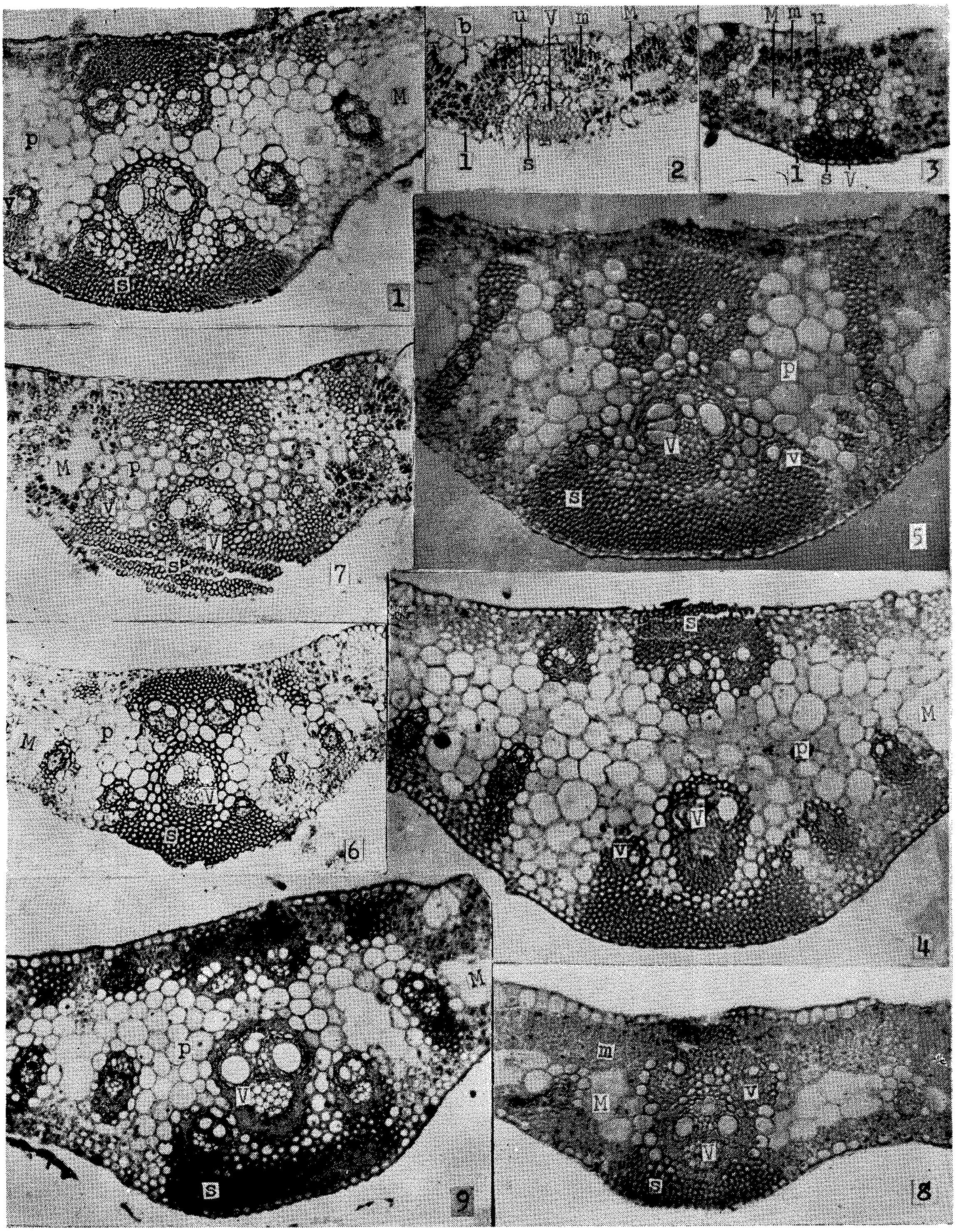

Plate III.

Fig. 1–5. *Shibataea Kumasasa* (×50). A series of midrib (T. S.) at successive levels to show the differentiation of vascular system. 5, a figure shown in the triangle region.

Fig. 6–8. *Bambusa Beishitiku* (×50). T. S. midrib at the different levels. 7, structure at the base. 8, a figure shown in the upper portion of triangle region.

Fig. 9–12. *Bambusa floribunda* (×50). A series of transverse sections of midrib at successive levels. 12, a figure in the triangle region.

Fig. 13–18. *Ischurochloa stenostachya* (×50). T. S. midrib at successive levels. 18, a figure of 13 vascular bundles in the triangle region.

Plate III.

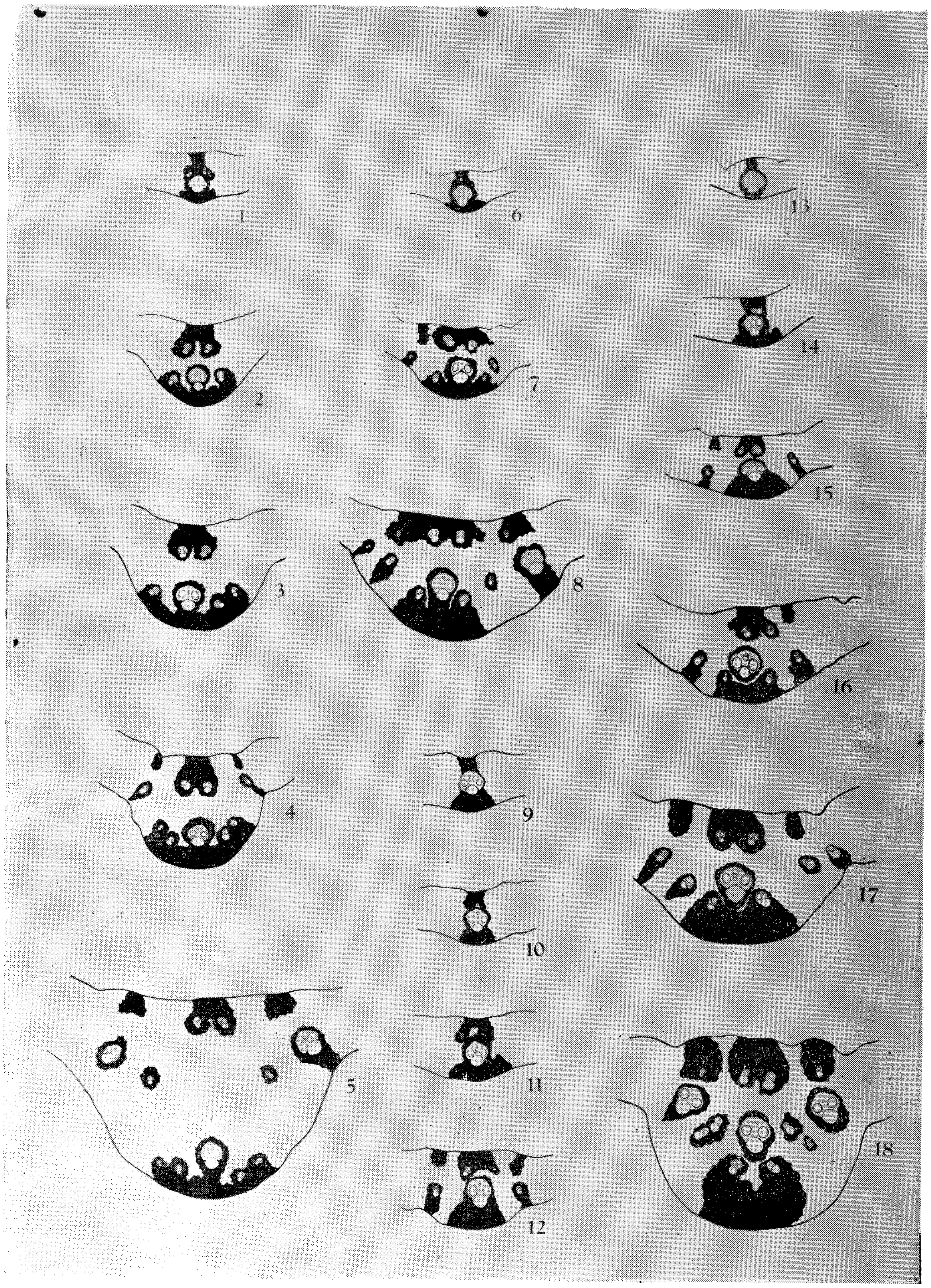

Plate IV.

Fig. 1–8. *Schizostachyum diffusum* (×50). T. S. midrib to show the differentiation of vascular system. 7–8, figures in the triangle region.

Fig. 9–12. *Pleioblastus Usawai* (×50). T. S. midrib at the successive levels. 12, a figure in the triangle region.

Fig. 13. *Bambusa Oldhami* (×50). T. S. midrib to show a typical figure of 13 vascular bundles in the triangle region.

Fig. 14. *Bambusa dolichoclada* (×50). T. S. midrib to show a figure of 18 vascular bundles in the triangle region.

Plate IV.