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Pharmacognostical Studies on the Crude Drugs of Orchidaceae from Taiwan (VII)[1] On "Kim-sòan-liân"[2] (金線連) (2)

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"Kim-sòan-liân", as found on the Taiwan market, has been assumed to be derived from the entire plant or the aerial part of *Anoectochilus formosanus, A. koshunensis* and *Zebrina pendula* as was reported in the previous paper.

The present report is concerned with the histological studies of "Kim-sòan-liân" derived from *Goodyera* plants and with the comparison between them and 7 species of *Goodyera* plants found in Taiwan.

The results of our studies show that "Kim-sòan-liân" may also be derived from the entire plants or the aerial part of *Goodyera matsumurana, G. daibuzanensis* or some mixture of them.

The morphological characteristics of "Kim-sòan-liân" and *Goodyera* species from Taiwan are shown in Table I.

In the previous paper, it was reported that the drug "Kim-sòan-liân", sold on the Taiwan market, is derived from the entire plants of the aerial part of *Anoectochilus formosanus, A. koshunensis, Zebrina pendula* and *Goodyera* plants.[1]

In this paper, the histological studies of "Kim-sòan-liân" derived from *Goodyera* plants and of 7 species related plants of *Goodyera* distributed in Taiwan were made.

Experimental

Materials

The samples were collected from the following stores:

1. San-hun Chinese Herb Store (三豊中薬房), Taichung, April 12, 1978. (The samples are identified as "Kim-sòan-liân" F.)
2. Ji-yuan Chinese Herb Store (吉元中薬房), Shipan, Changhua Hsen, April 10, 1979. (The samples are identified as "Kim-sòan-liân" E.)
3. Sao-an Herb Store (兆安青草舗), Cholan, Miaoli Hsen, May 4, 1978. (The samples are identified as "Kim-sòan-liân" D.)

Comparative plants

1. *Goodyera matsumurana* Schltr. (Japanese Name: Kagome-ran)
Miaoli Hsen, Cholan (卓蘭), May 10, 1978.
2. *G. daibuzanensis* Yamam. (Japanese Name: Ōnagaba-uzura)
Nantou Hsen, Chitou (渓頭), Feb. 5, 1979; Miaoli Hsen, Cholan (卓蘭), May 10, 1978.
3. *G. procera* (Ker.) Hook. (Japanese Name: Kingin-sō)
Pingtung Hsen, Taiwusan (大武山), July 16, 1968.
4. *G. bilamellata* Hay. (Japanese Name: Nagaba-uzura)
Taoyuan Hsen, Nanchatienshan (南插天山), Oct. 9, 1979.
5. *G. foliosa* (Lindl.) Hook. f. (Japanese Name: Takane-shusuran)
Hualien Hsen, Nanhutashan (南湖大山), Oct. 9, 1979.

1) Part VI: C. C. Lin and T. Namba, *Shoyakugaku Zasshi*, **35**, 262(1981).
2) A part of this work was presented at the 100th Annual Meeting of the Pharmaceutical Society of Japan, Tokyo, April 4, 1980.
3) Location: *2630, Sugitani, Toyama, 930-01 Japan.*

6. *G. nankoensis* Fuk. (Japanese Name: Usuyuki-shusuran)

Hualien Hsen, Nanhutashan (南湖大山), August 21, 1969.

7. *G. velutina* Maxim. (Japanese Name: Shusuran)

Pingtung Hsen, Taiwushan (大武山), Oct. 30, 1969; Tao-yuan Hsen, Nanchatienshan (南插天山), Oct. 9, 1979.

External morphology

1. "Kim-sòan-liân" D and F-1 (Fig. 1-A)

The drug is sold as a mass of the dried or fresh entire plant or the aerial parts of the plant as a compressed herb, about 6 to 20 cm tall. The leaves are usually 3, ovate or ovate-oblong in outline, from 3.5 to 6.5 cm long and 2 to 2.5 cm wide, acute at the apex, with 5 to 7 veins; the margins are entire. They are brown when dried but green when fresh, with elegant white vein-network, and their base are rounded and contracted suddenly to the petiole. The petiole is from 1.5 to 2.5 cm long. The stem axis is green to brown green, about 2 to 4 mm in diameter. The root attains a diameter of about 2 to 4 mm, with root hairs.

The drug has no marked odour and taste.

2. "Kim-sòan-liân" E and F-2 (Fig. 2-A)

The drug is a dried or fresh entire plant or the aerial parts of the plant, about 20 to 40 cm tall. The leaves are about 4 to 7, oblong to elliptical in outline, from 4 to 7 cm long and 2 to 3 cm wide, acute at the apex, with 9 veins; the margins are entire. There is an irregular white blotches scattered on the surface when fresh and with vein-network. The leaf base is cuneate. The petiole is from 2 to 5 cm long. The stem attains a diameter of about 2 to 5 mm. The root is slender, from 1 to 4 mm in diameter, with root hairs.

The drug has no marked odour and taste.

3. *G. procera*

The stem is about 15 to 30 cm tall, with many leaves on the lower part. The leaves are lanceolate to oblong, from 7 to 15 cm long and 2 to 4 cm wide, acuminate at the apex, with 5 to 7 veins. The margins are entire and the leaf base is cuneate. The petiole is from 2 to 6 cm long, shortsheathing at the base. The stem attains a diameter of up to 3 to 4 mm. The root varies from 1 to 2 mm in diameter, with many root hairs.

4. *G. bilamellata*

The stem is about 3 to 10 cm tall, with several leaves in a basal rosette. The leaves are broadly lanceolate or elliptical, from 3.5 to 8 cm long and 1 to 2 cm wide, acute at the apex, with 9 veins, cuneate at the base, vein-network absent; and the margins are subentire or more or less denticulate. The petiole is from 2 to 3 cm long. The stem is from 1 to 2 mm in diameter. The root attains a diameter of 1 mm, with many root hairs.

5. *G. foliosa*

The stem is about 7 to 15 cm tall, with a long creeping base, leaf throughout. The leaves number from 4 to 6, obliquely elliptical, from 4 to 7 cm long and 2 to 2.5 cm wide, acute at the apex, with 7 to 8 veins, attenuate to rounded at the base, with entire or slightly crisped margins, vein-network absent. The petiole is from 1 to 2 cm long. The stem attains a diameter of about 2 to 3 mm. The root is from 1 to 1.5 mm in diameter, with many root hairs.

6. *G. nankoensis*

The stem is about 5 to 7 cm long, basally 4 to 5 leaved. The leaves are ovate, from 1.5 to 3 cm long and 1 to 2 cm wide, acute at the apex, cuneate at the base, with denticulate or entire margins, with 5 to 7 veins, the blade having one white band along the middle vein, and vein-network absent. The petiole is about 1 to 1.5 cm long. The stem attains a diameter of about 1 to 1.5 mm. The root is about 1 mm in diameter, with many root hairs.

7. *G. velutina*

The plant is about 5 to 10 cm tall, with reddish-brown stem. The leaves are ovate to oblong, from 3 to 5 cm long and 1 to 2 cm wide, acute at the apex, rounded at the base, with more or less denticulate or entire margins, having one white band along the middle vein, with 5 to 7 veins, and a vein-network absent. The petiole is short, about 1 to 2 cm long. The stem is about 1 to 1.5 cm in diameter. The root has root hairs.

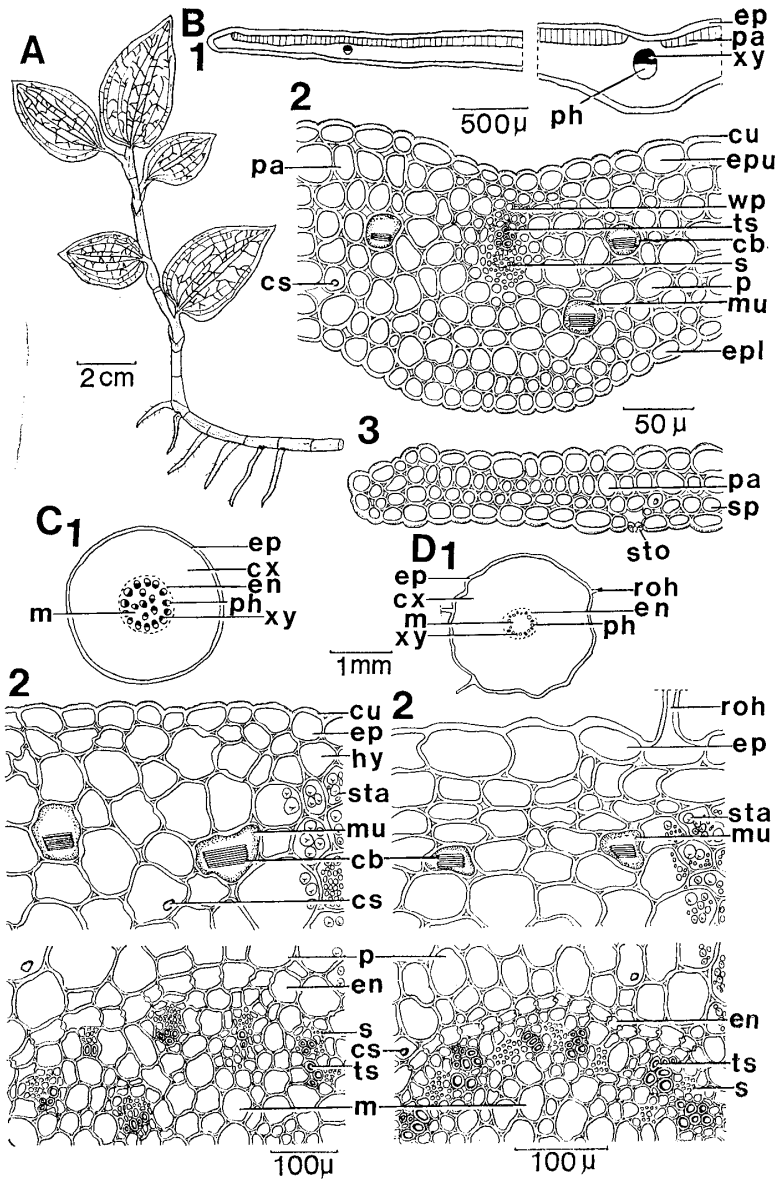

Fig. 1. *Goodyera matsumurana*

A, sketch of the entire plant; B, transverse section of leaf. 1, diagram; 2–3, detailed drawing. C,D, transverse section of stem and root. 1, diagram; 2, detailed drawing.

Internal structures

1. "Kim-sòan-liân" D and F-1

(Leaf) Fig. 1-B

The transverse sections through the midrib and the lamina show that the upper surface of the midrib is slightly concave and the lower surface projects slightly but distinctly. The thickness of the midrib is from 450 to 600 μm. The upper epidermis of the midrib and the lamina consists of a layer of elliptical cells, from 50 to 140 μm in length and 30 to 80 μm in width, which have anticlinal walls covered with a smooth cuticle. The lower epidermis of the midirb is composed of elliptical to circular or more or less pentagonal cells, from 40 to 80 μm in length and 30 to 50 μm in width, having anticlinal walls covered with a smooth cuticle. The lower epidermis of the lamina consists of stomata and elliptical cells having a length of about 40 to 140 μm and a width of about 30 to 50 μm; the walls of these cells are covered with a smooth cuticle. The mesophyll is differentiated into palisade and spongy tissues. The palisade tissues consist of one layer of elliptical cells varying from 50 to 80 μm in length and 40 to 70 μm in width, while the spongy tissues are composed of 1 to 4 layers of circular to elliptical cells measuring from 40 to 90 μm in length and 40 to 70 μm in width. Some cells in this region contain calcium oxalate in raphides about 50 to 90 μm in length, embedded in mucilage, and in solitary crystals about 10 to 15 μm in diameter.

Through the center of the mesophyll course the collateral vascular bundles, with xylem above and phloem beneath. The xylem portion consists of spiral tracheids about 10 to 15 μm in diameter and wood parenchyma cells up to 20 μm in diameter. The sieve tubes of phloem are distinct. The surface view of the upper epidermis reveals pentagonal to hexagonal cells; that of the lower epidermis shows quadrate to polygonal cells as well as numerous elliptical stomata which are surrounded by 2 to 4 neighboring cells and vary from 40 to 50 μm in length and 30 to 35 μm in width (Fig. 4-A).

(Petiole) Fig. 5-A

The outline of the transverse sections varies from crescent shape to narrow crescent shape. Both the upper and lower epidermises are composed of circular cells, from 30 to 90 μm in diameter, and elliptical cells, from 40 to 90 μm in length and 30 to 60 μm in width, which have anticlinal walls covered with a smooth to wavy cuticle. The parenchyma is composed of circular cells about 50 to 100 μm in diameter and elliptical cells varying from 70 to 180 μm in length and 70 to 130 μm in width, some of which contain calcium oxalate in raphide bundles about 50 to 90 μm in length and in solitary crystals up to 20 μm in diameter. The vascular bundles number from 5 to 7. The diameter of tracheids varies from 10 to 20 μm.

(Stem) Fig. 1-C

The transverse sections of the stem are circular in outline. They show an outer cortical tissue and a central stele surrounded by an endodermis. The outermost tissue is composed of one layer of elliptical, slightly thick-walled epidermis, about 30 to 70 μm long and 20 to 30 μm wide, whose walls are covered with a smooth to wavy cuticle. Inner to the epidermis are 1 or 2 layers of circular or elliptical to irregular cells; these cells vary from 30 to 70 μm in length and 30 to 50 μm in width and form a hypodermis. The cortex consists of several layers of thin-walled circular or elliptical parenchyma cells having a diameter of about 60 to 180 μm. Scattered within the cortex are a number of cells which contain calcium oxalate in raphide bundles about 50 to 80 μm in length and in solitary crystals about 10 to 25 μm in diameter. Many parenchyma cells are packed with starch grains. The starch grains are simple or compound, spherical or ovoid and possess a slight projection at one end, with or without a distinct hilum, from 20 to 30 μm in diameter, some up to 40 μm and some down to 2.5 μm. A distinct endodermis consisting of oblong to polygonal cells, from 30 to 80 μm in length and 25 to 60 μm in width, is present, with an observable casparian strip. The ground tissue of the stele is composed of parenchyma cells which measure from 30 to 60 μm in diameter and are similar in shape to those of the cortex. Within the stele can be found many collateral vascular bundles. The peripheral bundles are arranged to form a ring just within the endodermis, whereas the inner ones appear scattered in the ground tissue. The bundles number from 16 to 27. The xylem elements present within these bundles occur on the underside of the phloem. The spiral tracheids have a diameter varying from 10 to 20 μm. The sieve tubes of the phloem are distinct.

(Root) Fig. 1-D

The transverse sections are more or less circular in outline and reveal an outer ocrtical portion and a central stelar region wherein all of the vascular bundles are located. The outermost tissue is the epidermis which is composed of 1 layer of oblong to elliptical cells varying from 40 to 80 μm in length and 25 to 60 μm in width, some of which are modified into root hairs. The cortex, which comprises the next layer within, is composed of several layers of thin-walled elliptical cells, from 70 to 180 μm long and 40 to 100 μm wide, and circular cells about 90 to 200 μm in diameter. These cells are packed with single or compound starch grains. Almost all of the grains are spherical and vary from 10 to 20 μm in diameter, some up to 30 μm and some as small as 2.5 μm. The hilum of the grains is distinct or indistinct. Scattered within the cortex are several slightly thick-walled cells which contain calcium oxalate in raphides about 30 to 60 μm in length and in solitary crystals up to 20 μm in diameter. Inner to the cortex appears a distinct endodermis which has an observable casparian strip and consists of a single layer of almost elliptical cells varying from 25 to 40 μm in length and 15 to 30 μm in width. The ground tissue of the stele is composed of circular or elliptical parenchyma cells. Scattered within the stele are the radial vascular bundles, numbering from 5 to 9, of alternating xylem and phloem patches which are arranged to form a ring just within the endodermis. The xylem is composed of spiral tracheids measuring from 10 to 20 μm in diameter. The sieve tubes of phloem are distinct. The pith cells are about 25 to 60 μm in diameter.

The structures of "Kim-sòan-liân" D and F-1 described previously are completely the same as those of *G. matsumurana*.

2. "Kim-sòan-liân" E and F-2

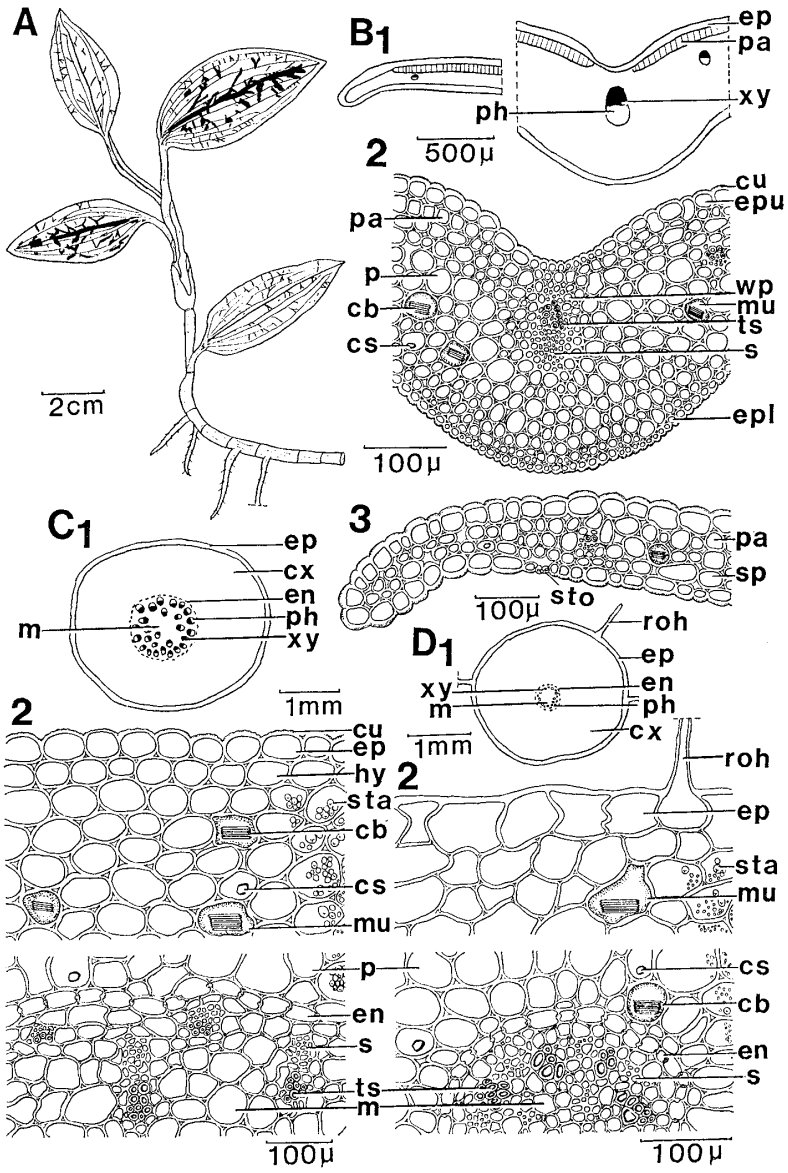

Fig. 2. *G. daibuzanensis*

A, sketch of the entire plant; B, transverse section of leaf. 1, diagram; 2–3, detailed drawing. C,D, transverse section of stem and root. 1, diagram; 2, detailed drawing.

The general structures are the same as those of "Kim-sòan-liân" D.

(Leaf) Fig. 2-B

The transverse sections through the midrib and the lamina show that the mirdib projects strongly on the lower surface, varying from 550 to 820 μm in thickness, and that the upper surface of the midrib is concave. The upper epidermis of the midrib is made up of elliptical to circular cells which are about 30 to 80 μm long and 20 to 50 μm wide and have anticlinal walls; while that of the lamina consists of elliptical or oblong to pentagonal cells varying from 70 to 120 μm in length and 30 to 80 μm in width. Both epidermal walls are covered with a smooth thick cuticle. The lower epidermis of the midrib is composed of circular or slightly elliptical cells having a diameter of about 25 to 50 μm; that of the lamina consists of stomata and elliptical cells measuring from 25 to 70 μm in length and 20 to 30 μm in width. The lower epidermis has thick anticlinal walls covered with a smooth to wavy cuticle. The palisade tissue is composed of one layer of elliptical cells about 30 to 80 μm long and 20 to 70 μm wide. The spongy tissue consists of circular cells, from 40 to 70 μm in diameter, and elliptical cells having a length of about 50 to 130 μm and a width of about 30 to 90 μm. Calcium oxalate in raphide bundles about 70 μm in length and in solitary crystals varying from 10 to 30 μm in diameter can be found in the mesophyll. The xylem of

TABLE I. The Morphological Characteristics of the "Kim-sòan-liân" and *Goodyera* Plants from Taiwan

		Elements	Species						
			G. matsumurana, sample D & F-1	*G. daibuzanensis*, sample E & F-2	*G. procera*	*G. bilamellata*	*G. foliosa*	*G. nankoensis*	*G. velutina*
External	Leaf	form	ovate or ovate-oblong	oblong～elliptic	lanceolate～oblong	broadly lanceolate or elliptic	obliquely elliptic	ovate	ovate～oblong
		vein-network	+	+	−	−	−	−	−
		size (cm)	3. 5-6. 5×2-2. 5	4-7×2-3	7-15×2-4	3. 5-8×1-2	4-7×2-2. 5	1. 5-3×1-2	3-5×1-2
		hair	−	−	−	−	−	−	−
		base form	rounded	cuneate	cuneate	cuneate	attenuate-rounded	cuneate	rounded
		margin	entire	entire	entire	sub-entire	entire or slightly crisped	denticulate or entire	denticulate or entire
		number of veins	5-7	9	5-7	9	7-8	5-7	5-7
		length of petiole(cm)	1. 5-2. 5	2-5	2-6	2-3	1-2	1-1. 5	1-2
Internal	Leaf	upper surface of midrib	slightly concave	concave	concave	concave	deeply concave	slightly concave	deeply concave
		shape of upper epidermal cells	elliptic	elliptic or oblong～pentagonal	elliptic	elliptic-oblong	elliptic	elliptic-circular	elliptic
		thickness of midrib (μm)	450-600	550-820	500-720	400-510	400-500	350-500	380-420
		surface view: shape of lower epidermal cells	quadrate～polygonal	quadrate～polygonal	quadrate～polygonal	rectangular～irregular	rectangular～irregular	pentagonal～hexagonal	rectangular～polygonal
		surface view: size of stomata (μm)	40-50×30-35	30-35×25-30	40-50×20-25	30-40×35-40	40-50×30-35	40-50×30-40	40-50×30-40
	Petiole	outline	crescent-shaped～narrow crescent-shaped	broad～narrow crescent-shaped	broad crescent～shaped	narrow～broad V-shaped	narrow～broad V-shaped	Y-shaped～crescent-shaped	V-shaped
		No. of vb.*	5-7	8-9	6-9	9-12	5-9	3-5	5-6
		diameter of t.*(μm)	10-20	10-20	10-20	10-12. 5	10-15	10	10-15
	Stem	type of cuticle	smooth～wavy	wavy～smooth	wavy	wavy	wavy	smooth～wavy	wavy～dendate
		shape & size of starch grains (μm)	spherical～ellipsoidal 2. 5-20-30-40	spherical～ellipsoidal 5-10-20	spherical 4-10	spherica～lelliptic 2. 5-5-10-15	spherical～elliptic 5-10-20	spherical 2. 5-5	spherical～elliptic 2. 5-5-7. 5-10
		No. of vb.*	16-27	25-48	18-40	35-51	12-21	12-15	20-26
		diameter of t.*(μm)	10-20	10-25-30	10-25	10-15	10-20	10-12. 5	12. 5-20
		shape of en.*	oblong～polygonal	oblong～elliptic	circular～elliptic	oblong～elliptic	elliptic	elliptic	elliptic
	Root	No. of xylem poles	5-9	8-15	5-7	7-9	10-12	3-5	5-18
		diameter of p.* of medulla (μm)	25-60	20-60	10-20	10-20	30-50	10-20	20-60

* t, tracheids; vb, vascular bundles; p, parenchyma cells; en, endodermal cells.

the vascular bundles consists of spiral tracheids about 10 to 15 μm in diameter and wood parenchyma cells up to 20 μm in diameter; beneath the xylem is a phloem with distinct sieve tubes. The surface view of the upper epidermis reveals pentagonal to hexagonal cells; that of the lower epidermis reveals quadrate to polygonal cells and numerous elliptical stomata which are surrounded by 2 to 4 neighboring cells, rarely up to 5, and are from 30 to 35 μm long and 25 to 30 μm wide (Fig. 4-B).

(Petiole) Fig. 5-B

The transverse sections present a broad to narrow crescent-shaped outline. The vascular bundles number from 8 to 9. The upper epidermis is covered with a layer of wavy cuticle, and the lower epidermis is covered with a layer of wavy to dentate cuticle. The tracheids attain a diameter from 10 to 20 μm.

(Stem) Fig. 2-C

The transverse sections are almost circular in outline and reveal an outer cortical portion and an atactostele. The epidermis is composed of elliptical or more or less circular cells which are from 50 to 70 μm in length and 25 to 50 μm in width and covered with a wavy to smooth cuticle. Beneath the epidermis appears 1 to 3 layers of hypodermis composed of elliptical cells. The cortex consists of tangentially elongated cells, some of them containing calcium oxalate in solitary crystals and in raphide bundles. Many of the parenchyma cells forming the ground tissue are packed with starch grains. The starch grains are spherical to elliptical, simple or compound, with or without a hilum, from 10 to 20 μm in diameter, and with a few down to 5 μm. The endodermis consists of oblong to elliptical cells varying from 35 to 80 μm in length and 25 to 55 μm in width. The vascular bundles, numbering from 25 to 48, occur within the endodermis. A relatively large number of these bundles are arranged to form a ring just inner to the endodermis. The vascular bundles are collateral; the spiral tracheids in each bundle having a diameter varying from 10 to 25 μm, with a few up to 30 μm, and the phloem is present.

(Root) Fig. 2-D

The transverse sections are almost circular in outline. They reveal an outer cortex forming the major part of the root and a central stelar region. The epidermis consists of oblong to irregular cells about 40 to 100 μm long and 30 to 35 μm wide, some of which are modified into root hairs. The ground tissue is differentiated into two regions, the outer cortex and the inner stele, by a distinct endodermis. The cortex is made up of circular cells having a diameter of 60 to 150 μm and elliptical or irregular cells varying from 50 to 180 μm in length and 50 to 110 μm in width. Calcium oxalate in solitary crystals and in raphide bundles, and starch can be found in this region. The starch grains are single or compound, spherical, with or without a hilum, from 2.5 to 10 μm, some up to 20 μm. The endodermis is composed of elliptical cells measuring from 15 to 30 μm in length and 15 to 25 μm in width. The radial vascular bundles within the endodermis consist of 8 to 15 arches. The tracheids measure from 15 to 20 μm in diameter. The parenchyma of the medulla is made up of circular or polygonal cells having a diameter varying from 20 to 60 μm.

The structures of "Kim-sòan-liân" E and F-2 are completely the same as those of *G. daibuzanensis*.

3. *G. procera*

The general structures are similar to those of *G. matsumurana*.

(Leaf) Fig. 3-A

The midrib is prominent below, from 550 to 720 μm in thickness. The upper surface of the transverse sections is concave. The upper epidermis of the midrib and the lamina is composed of a layer of elliptical cells which are about 35 to 120 μm long and 30 to 70 μm wide and have slightly thick anticlinal walls. The lower epidermis of the midrib consists of circular cells about 30 to 40 μm in diameter and elliptical to pentagonal cells about 30 to 50 μm long and 25 to 40 μm wide which have thick anticlinal walls; that of the lamina is composed of stomata and elliptical to oblong cells which have anticlinal walls and measure from 40 to 60 μm in length and 30 to 40 μm in width. Both the upper and lower epidermises are covered with a layer of dentate cuticle. The palisade region is composed of elliptical cells varying from 60 to 80 μm in length and 40 to 70 μm in width. The spongy region consists of more or less elliptical cells about 50 to 120 μm long and 50 to 70 μm wide. Some of the mesophyll contain solitary crystals and raphide bundles of calcium oxalate. The collateral vascular bundles are found scattered within the mesophyll. Each vascular bundle contains tracheids about 10 to 15 μm in diameter, some up to 20 μm, and polygonal wood parenchyma cells. There is a patch of phloem composed of sieve tubes inside the xylem. The surface view of the upper epidermis reveals pentagonal to hexagonal cells; that of the lower epidermis

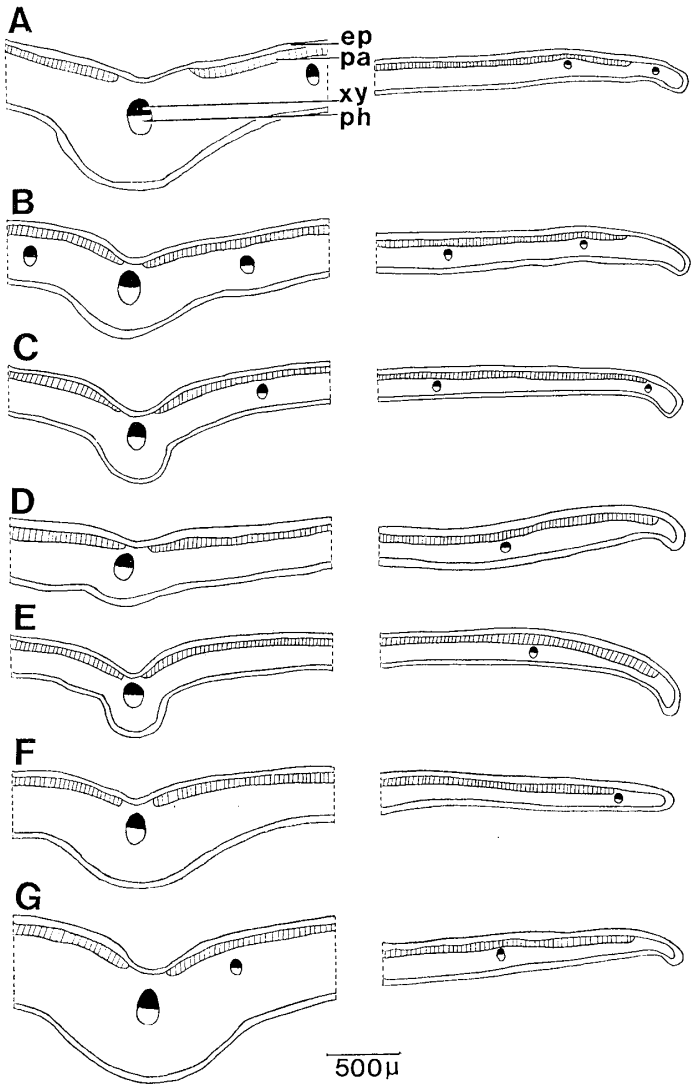

Fig. 3. Diagram of the Transverse Sections of Leaf

A, *G. procera*; B, *G. bilamellata*; C, *G. fcliosa*; D, *G. nankoensis*; E, *G. velutina*; F, *G. matsumurana*; G, *G. daibuzanensis*.

reveals quadrate to polygonal cells and numerous stomata, which are surrounded by 2 to 4 neighboring cells and measure from 40 to 50 μm in length and 20 to 25 μm in width (Fig. 4-C).

(Petiole) Fig. 5-C

The transverse sections show a broad crescent-shaped outline. The upper epidermis is covered with a layer of smooth to wavy cuticle, and the lower epidermis is covered with a layer of wavy to dentate cuticle. The vascular bundles number from 6 to 9. The tracheids attain a diameter varying from 10 to 20 μm.

(Stem) Fig. 6-A-1

The transverse sections are almost circular in outline and show an outer cortical region and a central stelar portion. The epidermis is intact and forms the outermost layer; it is composed of elliptical to irregular cells which are covered with a wavy cuticle and measure from 25 to 70 μm in length and 20 to 30 μm in width. The hypodermis is composed of 1 to 2 layers of tangentially elongated cells. The ground tissue is differentiated into two regions, the outer cortex and the inner stele, by a distinct endodermis. The cortex is made up of circular to elliptical parenchyma cells, several of which contain spherical starch grains about 4 to 10 μm in diameter; whereas others contain calcium oxalate in raphide bundles and in solitary crystals. The endodermis consists of circular to elliptical cells varying from 40 to 60 μm in length and 20 to 40 μm in width. The vascular bundles number from 18 to 40, with spiral tracheids about 10 to 25 μm in diameter.

(Root) Fig. 6-A-2

The transverse sections are elliptical in outline and show an outer cortical tissue and a central stelar region. The epidermis consists of one or two layers of oblong to irregular cells varying from 70 to 120 μm in length and 40 to 100 μm in width, some of which are modified into root hairs. The cortex is composed of circular or elliptical to irregular cells, some of which contain calcium oxalate in raphide bundles and in solitary crystals, and starch grains. The grains are single or compound, spherical, from 2.5 to 10 μm in diameter, some up to 15 μm. The endodermis, consisting of one layer of rectangular to elliptical cells varying from 20 to 25 μm in length and 10 to 15 μm in width, is distinct. The radial vascular bundles consist of 5 to 7 arches with spiral tracheids about 10 to 20 μm in diameter. The ground tissue of medulla is made up of slightly elliptical to polygonal parenchyma cells having a diameter of about 10 to 20 μm.

4. *G. bilamellata*

(Leaf) Fig. 3-B

The midrib is prominent below, from 400 to 510 μm in thickness, and its transverse sections show that the upper surface is concave. The upper epidermis of the midrib consists of mostly elliptical cells, more or less pentagonal cells about 40 to 80 μm long and 20 to 50 μm wide, and a few circular cells about 25 to 50 μm in diameter and having thick anticlinal walls. The upper epidermis of the lamina is composed of elliptical to oblong cells, about 40 to 90 μm in length and 30 to 60 μm in width, with anticlinal walls. The walls are covered with a smooth to wavy cuticle. The lower epidermis of the midrib consists of cir-

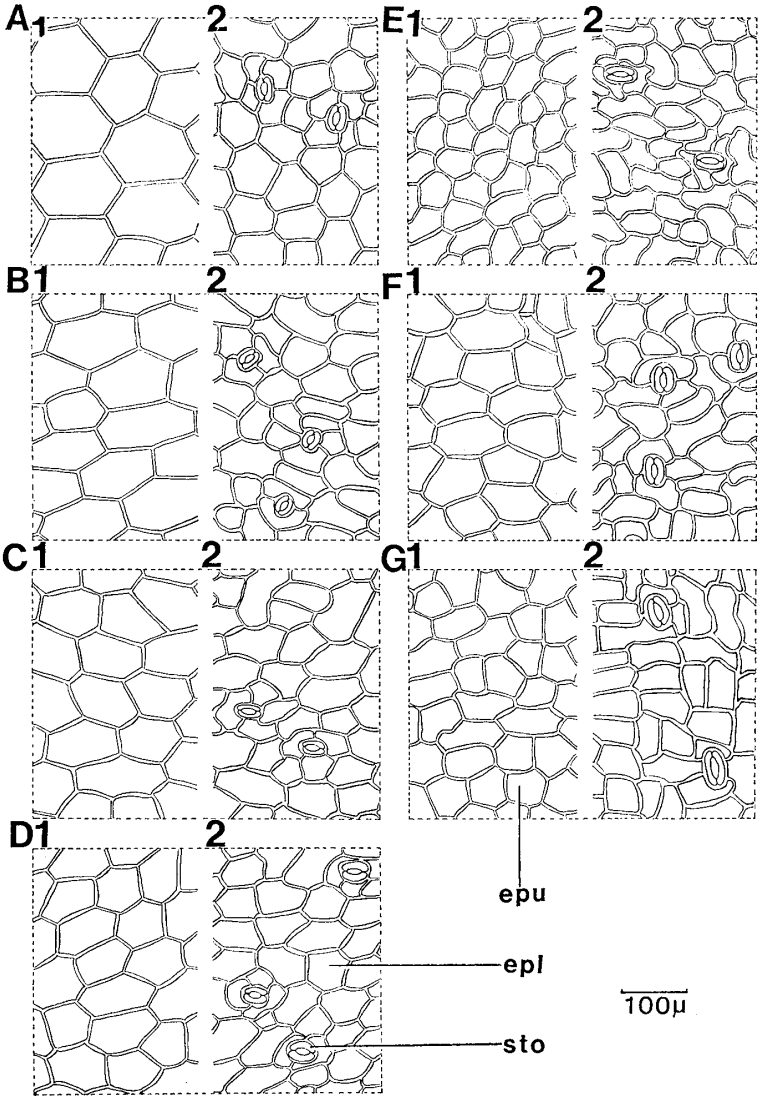

Fig. 4. Surface View of Leaf

A, *G. matsumurana*; B, *G. daibuzanensis*; C, *G. procera*; D, *G. bilamellata*; E, *G. foliosa*; F, *G. nankoensis*; G, *G. velutina*.

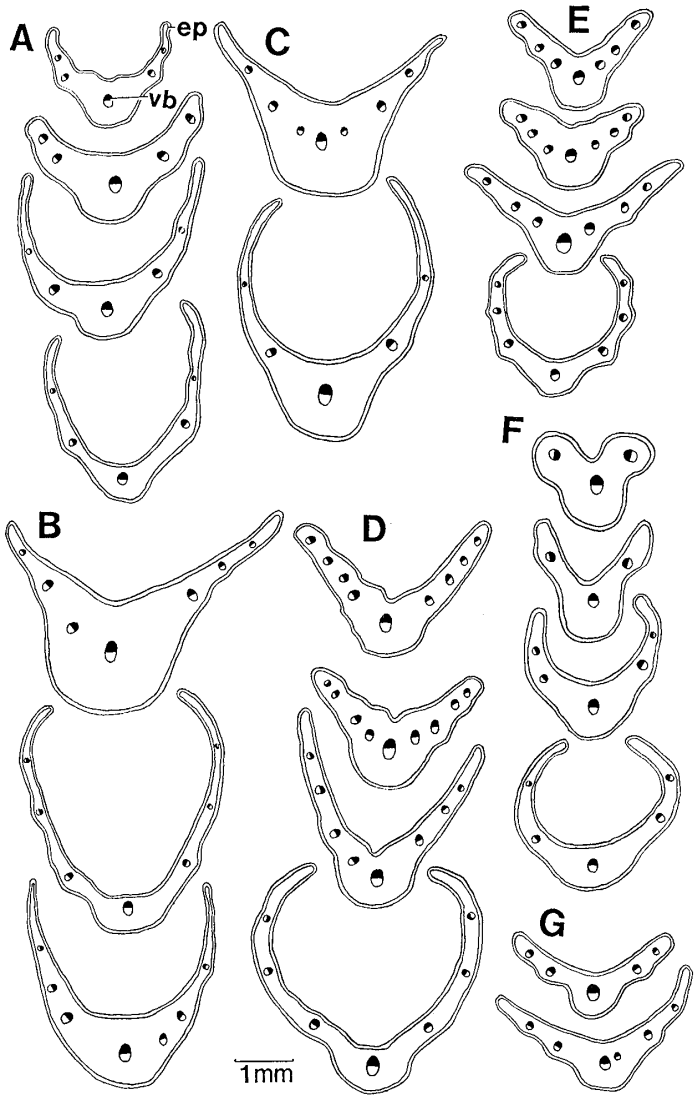

Fig. 5. Diagram of the Transverse Sections of Petiole

A, *G. matsumurana*; B, *G. daibuzanensis*; C, *G. procera*; D, *G. bilamellata*; E, *G. foliosa*; F, *G. nankoensis*; G, *G. velutina*.

cular cells measuring from 20 to 40 μm in diameter; that of the lamina is composed of elliptical cells varying from 40 to 110 μm in length and 30 to 50 μm in width. The lower epidermis has thick anticlinal walls covered with a wavy cuticle. The palisade tissue consists of one layer of elliptical cells having a length of about 40 to 70 μm and a width of about 40 to 60 μm. The spongy tissue consists of circular to elliptical cells varying from 30 to 100 μm in length and 30 to 60 μm in width. Calcium oxalate in raphide bundles and in solitary crystals can be found in the mesophyll. The vascular bundles are collateral, and the tracheids vary in each bundle from 10 to 12.5 μm. The surface view of the upper epidermis reveals quadrate to pentagonal or polygonal cells; that of the lower epidermis reveals rectangular to irregular cells, and stomata which are surrounded by 2 to 4 neighboring cells and measure from 30 to 40 μm in length and 35 to 40 μm in width (Fig. 4-D).

(Petiole) Fig. 5-D

The outline of the transverse sections presents a narrow to broad V shape. The upper epidermis is covered with a layer of smooth to wavy cuticle, and the lower epidermis is covered with a layer of wavy to dentate cuticle. The number of vascular bundles varies from 9 to 12. The tracheids have a diameter varying from 10 to 12.5 μm. In addition to the raphide bundles, the solitary crystals of clacium oxalate and the clustered crystals about 40 μm in diameter can be found in the ground tissue.

(Stem) Fig. 6-B-1

The transverse sections are more or less circular in outline and show an outer cortical portion and an

atactostele. The epidermis is composed of elliptical cells about 40 to 60 μm in length and 25 to 40 μm in width; the walls of these cells are covered with a wavy cuticle. The hypodermis is composed of 2 layers of elliptical cells with sclerotic walls. The cortex consists of 10 to 15 layers of parenchyma of circular to elliptical or irregular cells. Several cells in this region are packed with starch grains. The grains are single or compound, elliptical to spherical, from 10 to 15 μm or down to 2.5 to 5 μm in diameter. Scattered within the cortex are several circular or elliptical cells containing calcium oxalate in raphide bundles and in solitary crystals. The endodermis is made up of oblong to elliptical cells. The ground tissue of the stele is composed of parenchyma cells similar in shape to those of the cortex; some of the cells contain starch grains. Within the stele can be found collateral vascular bundles numbering from 35 to 51. The xylem elements present within these bundles occur on the inside of the phloem, and the tracheids vary from 10 to 15 μm in diameter.

(Root) Fig. 6-B-2

The transverse sections are almost elliptical in outline and reveal a wide cortical portion and a small central stelar region. The epidermis is made up of oblong cells about 40 to 80 μm long and 20 to 40 μm wide, some of which being modified into root hairs. The cortex is composed of 12 to 18 layers of circular or elliptical to irregular cells, some of which contain starch grains about 2 to 5 μm in diameter and calcium oxalate in raphide bundles and in solitary crystals. The endodermis consists of oblong cells varying from 20 to 30 μm in length and 10 to 20 μm in width. The parenchyma of the medulla is composed of circular cells having a diameter of 10 to 20 μm. Scattered within the stele are the vascular bundles of 7 to 9 arches. The spiral tracheids measure from 10 to 15 μm in diameter.

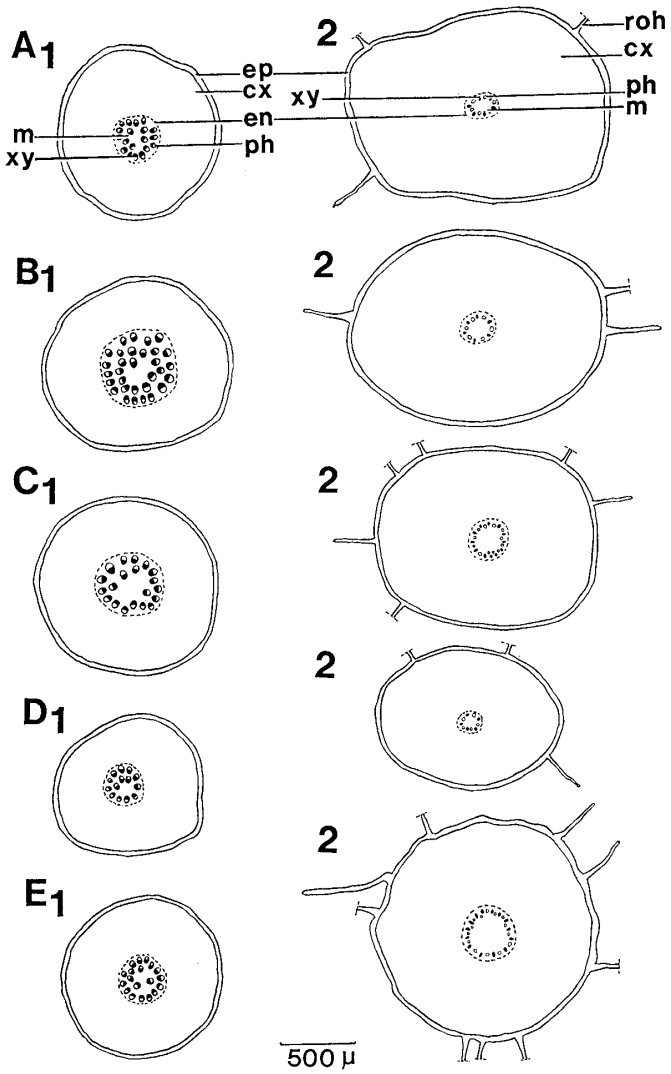

Fig. 6. Diagram of the Transverse Sections of Stem and Root

A, *G. procera*; B, *G. bilamellata*; C, *G. foliosa*; D, *G. nankoensis*; E, *G. velutina*.

5. *G. foliosa*

(Leaf) Fig. 3-C

The transverse sections through the midrib show that the upper surface is deeply concave, and that the midrib projects strongly on the lower surface and varies from 400 to 500 μm in thickness. The upper epidermis of the midrib consists of circular to slightly polygonal cells about 20 to 25 μm in diameter; that of the lamina consists of elliptical cells measuring from 40 to 80 μm in length and 25 to 45 μm in width. Their anticlinal walls are straight and are covered with a smooth to wavy cuticle. The lower epidermis of the midrib is composed of more or less circular cells varying from 25 to 40 μm in diameter; that of the lamina is composed of stomata and elliptical cells about 40 to 110 μm long and 30 to 50 μm wide. Their anticlinal walls are thick and straight, covered with a wavy cuticle. The palisade tissue consists of one layer of elliptical cells varying from 50 to 80 μm in length and 40 to 70 μm in width. The spongy tissue consists of loosely arranged circular cells about 30 to 60 μm in diameter and elliptical cells about 55 to 125 μm long and 35 to 75 μm wide, with large intercellular spaces, and contain raphide bundles and solitary crystals of calcium oxalate. The vascular bundles, containing tracheids about 10 to 15 μm in diameter, are scattered in the mesophyll. The surface view of the upper epidermis reveals pentagonal to polygonal cells; that of the lower epidermis reveals rectangular to irregular cells, along with stomata which are surrounded by 2 to 4 neighboring cells and vary from 40 to 50 μm in length and 30 to 35 μm in width (Fig. 4-E).

(Petiole) Fig. 5-E

The outline of the transverse sections shows a narrow to broad V shape. The epidermal cells of both surfaces have straight anticlinal walls covered with a smooth cuticle on the upper surface and with a wavy to dentate cuticle on the lower surface. The vascular bundles number from 5 to 9, and the spiral tracheids have a diameter of about 10 to 15 μm.

(Stem) Fig. 6-C-1

The transverse sections are almost circular in outline and show an outer cortical region and a central stelar portion. The epidermis is composed of a layer of elliptical to circular cells, from 30 to 70 μm in length and 30 to 50 μm in width, covered with a wavy cuticle. The hypodermis is composed of 2 or 3 layers of elliptical to oblong cells with thick walls. The ground tissue of the cortex is composed of 10 to 14 layers of circular or elliptical cells, some of which contain starch grains and calcium oxalate in raphide bundles and in solitary crystals. The starch grains are spherical or elliptical, single or compound, about 10 to 20 μm in diameter, some down to 5 μm. The vascular bundles number from 12 to 21. Each bundle contains a xylem and a phloem; the former consisting of spiral tracheids about 10 to 20 μm in diameter and wood parenchyma cells, and the latter being composed of distinct sieve tubes. The ground tissue of the stele is similar in cell shape and cell contents to those of the cortex.

(Root) Fig. 6-C-2

The transverse sections are circular to elliptical in outline. They show an outer cortical portion, which forms the major part of the root, and an inner central stelar region. The epidermis consists of a single row of rectangular to elliptical cells varying from 60 to 100 μm in length and 20 to 40 μm in width, some of which are modified into root hairs. Next within is the cortex composed of several layers of thin-walled circular parenchyma cells. Some of the cortical cells are filled with starch grains. These grains are spherical and measure from 5 to 10 μm in diameter. Scattered within the cortex are numerous cells which contain gum and calcium oxalate of solitary crystals, raphide bundles, and clustered crystals about 20 to 30 μm in diameter. The innermost layer of the cortex is marked distinctly by a single layer of endodermis composed of oblong to elliptical cells about 20 to 50 μm long and 20 to 40 μm wide. The vascular bundles consist of 10 to 12 xylem patches alternating with as many phloem patches. The tracheids vary from 20 to 30 μm in diameter. The parenchyma cells of the medulla measure from 30 to 50 μm in diameter and have sclerotic walls.

6. *G. nankoensis*

(Leaf) Fig. 3-D

The transverse sections through the midrib show that the upper surface is slightly concave, and that the midrib projects slightly on the underside and is from 350 to 500 μm in thickness. The upper epidermis of the midrib consists of circular to elliptical cells varying from 40 to 80 μm in length and 30 to 50 μm in width; that of the lamina consists of circular or polygonal cells about 60 to 90 μm in diameter and elliptical

cells about 80 to 120 μm long and 50 to 80 μm wide. Their anticlinal walls are thick and straight and are covered with a wavy cuticle. The lower epidermis of the midrib is composed of circular cells about 30 to 40 μm in diameter and oblong or polygonal cells varying from 30 to 50 μm in length and 20 to 50 μm in width; that of the lamina consists of elliptical to rectangular cells having a length of about 40 to 80 μm and a width of about 20 to 50 μm. Their anticlinal walls are straight and covered with a wavy to dentate cuticle. The palisade tissue is composed of one layer of cells and is sometimes indistinct. The spongy tissue consists of circular or elliptical to irregular cells. Calcium oxalate can be found in the mesophyll. The tracheids measure from 7.5 to 10 μm in diameter. The surface view of both epidermises reveals pentagonal to hexagonal cells, and only on the lower epidermis are there stomata, which are surrounded by 2 to 4 neighboring cells and are from 40 to 50 μm in length and 30 to 40 μm in width (Fig. 4-F).

(Petiole) Fig. 5-F

The outline of the transverse sections is in a Y shape to crescent shape. The upper epidermis is covered with a layer of smooth to wavy cuticle, and the lower epidermis is covered with a layer of wavy to dentate cuticle. The vascular bundles number from 3 to 5. The tracheids have a diameter of about 10 μm.

(Stem) Fig. 6-D-1

The transverse sections are circular to more or less circular in outline and show an outer cortical portion and a central stelar region. A distinct continuous layer of epidermis which consists of a single layer of rectangular cells having thick walls covered with a smooth to wavy cuticle is present. The hypodermis consists of 1 to 3 layers of tangentially irregular or elongated cells with slightly thick walls. Inner to the hypodermis is the cortex composed of irregularly arranged tangentially polygonal or circular cells. These cortical cells are packed with starch grains, and some of them contain raphide bundles and solitary crystals of calcium oxalate. The starch grains are spherical and have a diameter of about 2 to 5 μm. The endodermis is composed of one single layer of elliptical cells about 25 to 45 μm long and 15 to 30 μm wide. The ground tissue of the stele is composed of polygonal or irregular parenchyma cells, some of which contain mucilage, starch grains, and calcium oxalate of solitary crystals. Many collateral vascular bundles, numbering from 12 to 15, are scattered within the stele. Each bundle contains tracheids which measure from 10 to 12.5 μm in diameter and have spiral thickenings on their walls. Outside of the xylem is a distinct patch of phloem which is composed of sieve tubes and a few small thin-walled polygonal parenchyma cells.

(Root) Fig. 6-D-2

The transverse sections are elliptical in outline and show an outer cortical layer and a small inner stelar region. The epidermis is composed of tangentially elongated polygonal or elliptical to oblong cells varying from 30 to 70 μm in length and 20 to 50 μm in width, some of which are modified into root hairs. Inner to the epidermis is the parenchymatous cortex composed of several layer of large circular cells. Most of the cells are packed with spherical starch grains about 2.5 to 5 μm in diameter, while some other cells ar filled with calcium oxalate in raphide bundles about 35 to 40 μm in length and in solitary crystals about 10 to 20 μm in diameter. The endodermis is composed of oblong to elliptical cells measuring from 20 to 50 μm in length and 15 to 20 μm in width. The radial vascular bundles are made up of 3 to 5 arches. The spiral tracheids have a diameter varying from 10 to 15 μm. The parenchyma of the medulla is made up of very small parenchyma cells about 10 to 20 μm in diameter.

7. *G. velutina*

(Leaf) Fig. 3-E

The transverse sections through the midrib reveal that the upper surface is deeply concave, while the midrib projects strongly on the lower surface and has a thickness of 380 to 420 μm. The upper epidermis of the midrib consists of more or less circular to elongated circular cells having a diameter of about 15 to 35 μm; that of the lamina is composed of elliptical cells about 40 to 80 μm long and 25 to 50 μm wide. The lower epidermis of the midrib is composed of circular cells about 25 to 35 μm in diameter and elliptical cells varying from 25 to 60 μm in length and 30 to 40 μm in width; that of the lamina is made up of elliptical cells measuring from 30 to 125 μm in length and 25 to 50 μm in width. Both the upper and lower epidermises have straight, thick anticlinal walls covered with a smooth to wavy cuticle on the upper surface and a wavy cuticle on the lower surface. The palisade tissue, sometimes indistinct, is composed of one layer of elliptical or circular cells about 35 to 70 μm long and 30 to 60 μm wide. The spongy tissue

consists of circular cells about 35 to 60 μm in diameter and elliptical cells varying from 40 to 120 μm in length and 40 to 60 μm in width, with or without large intercellular spaces. Calcium oxalate in solitary crystals and in raphide bundles may be found in this region. The vascular bundles contain a xylem and a phloem. The xylem is composed of wood parenchyma and tracheids about 10 μm in diameter. The phloem consists of distinct sieve tubes and companion cells. The surface view of the upper epidermis reveals quadrate to elongated hexagonal cells, while that of the lower epidermis reveals rectangular to polygonal cells, and stomata which are surrounded by 2 to 4 neighboring cells and measure from 40 to 50 μm in length and 30 to 40 μm in width (Fig. 4-E).

(Petiole) Fig. 5-G

The transverse sections reveal a V-shaped outline. The upper epidermis is covered with a layer of smooth to wavy cuticle, while the lower epidermis is covered with a layer of dentate cuticle. The vascular bundles vary from 5 to 6 in number; their tracheids measure from 10 to 15 μm in diameter.

(Stem) Fig. 6-E-1

The transverse sections are circular in outline and show an outer cortical portion and a central stelar region. The epidermis is composed of tangentially elliptical cells with thick walls covered with a wavy to dentate cuticle. The hypodermis consists of one to two layers of elongated cells having slightly thick walls. Inner to the hypodermis is the cortex consisting of tangentially elliptical to circular parenchyma cells. Many of these cells are packed with starch grains which are spherical to elliptical, from 5 to 7.5 μm in diameter, some up to 10 μm and some down to 2.5 μm, while other cells contain calcium oxalate in raphide bundles and in solitary crystals. The endodermis is made up of elliptical cells having a length of about 25 to 60 μm and a width of about 10 to 40 μm. The vascular bundles number from 20 to 26. The tracheids measure from 12.5 to 20 μm in diameter. The ground tissue of the stele has the same shape as that of the cortex.

(Root) Fig. 6-E-2

The transverse sections are circular in outline and present an outer broad cortical portion and a small central stelar region. The epidermis is composed of elliptical to irregular cells varying from 40 to 80 μm in length and 40 to 60 μm in width, some of which are modified into root hairs. The cortex is composed of several layers of thin-walled circular to elliptical cells, some of which contain calcium oxalate in raphide bundles and in solitary crystals, and starch grains. The grains are single or compound, spherical to elliptical, from 1.5 to 5 μm in diameter, some up to 10 μm. Inner to the cortex is the endodermis, whose casparian strip is discernable, consisting of a single layer of elliptical to oblong cells about 25 to 40 μm in length and 20 to 30 μm in width. Scattered within the stele are the vascular bundles of 5 to 18 arches. The tracheids measure from 10 to 15 μm in diameter. The ground tissue of the stele has the same shape and contents as those of the cortex. The pith cells have a diameter of about 20 to 60 μm.

Results and Discussion

1. The characteristics of the external morphology and internal structures of "Kim-sòan-liân" D, E, F and *Goodyera* species are shown in TABLE I.

From observations of the leaf (form, size, existence of vein-network, base form, state of margin, number of veins, upper surface and thickness of midrib, shape of upper epidermal cells, size of stoma), petiole (length, outline of transverse section, number of vascular bundles, diameter of tracheids), stem (type of cuticle, shape and size of starch grains, number of vascular bundles, diameter of tracheids, shape of endodermal cells) and root (number of xylem patches, diameter of pith cells), it is possible to identify the species of these seven plants.

The results show that the botanical origins of "Kim-sòan-liân" D, E, F are the entire or the aerial part of the following plants: (A) *G. matsumurana*, (B) *G. daibuzanensis*, (C) the mixture of *G. matsumurana* and *G. daibuzanensis*.

2. *G. procera* named "Shí-féng-dān" (石風丹) in China has been used as the folk remedy for rheumatism, arthritis, and hemiplegia.[4] Other *Goodyera* plants, *G. schlechtendaliana* REICHB. f. or *G. repens* (L.) R. BR., have been used for bronchitis, cough of lung disease, osteocope, keratitis, scrofulosis and external application for snake-bite.[4] However, the application of these plants for the diseases mentioned above

4) Chiang Su New Medicinal College, "Dictionary of Chinese Crude Drug" (中葯大辞典), Shanghai Scientific Technological Publisher, China, 1977, pp. 598, 2282, 2283 (in Chinese).

has not been found in Taiwan.

Because of its beautiful vein-network in its leaves and its having some medicinal effects similar to "Kim-sòan-liân", *G. matsumurana* and *G. daibuzanensis* have been used as the substitutants for "Kim-sòan-liân" on the Taiwan market.

In order to avoid mistakes and confusion, we consider it a better practice to use the original plant, and not substitutants, in the preparation of this drug.

Abbreviations: **ep**, epidermis; **epu**, upper epidermis; **epl**, lower epidermis; **cu**, cuticle; **pa**, palisade; **p**, parenchyma; **wp**, wood parenchyma; **ts**, spiral tracheid; **ph**, phloem; **mu**, mucilage; **cb**, raphide in bundle; **cs**, solitary crystal; **sp**, spongy cell; **xy**, xylem; **cx**, cortex; **m**, medulla; **hy**, hypodermis; **sta**, starch grain; **en**, endodermis; **roh**, root hair; **sto**, stoma; **s**, sieve tube.

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