ユリ科コバイモ7種の花の比較解剖

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Naohiro Naruhashi*, Takashi Sato*,** and Shozo Noda*** :

Comparative Anatomy of Flowers in the *Fritillaria japonica* Complex (Liliaceae)

鳴橋直弘*・佐藤尚史*,**・野田昭三*** : ユリ科コバイモ７種の花の比較解剖

Abstract

Flowers of the *Fritillaria japonica* complex consisting of seven closely related species were anatomically compared. Cross or longitudinal sections of eighteen parts of five kinds of organs, such as outer and inner tepal, stamen, pistil and peduncle were made, and eighteen characters were selected as criteria to elucidate the specific differences. It is evident that two groups (M-type and E-type) exist within *F. japonica*. From correlation of character of stamen, similarity was found between *F. koidzumiana* and *F. japonica* M-type, and among *F. shikokiana, F. amabilis* and *F. ayakoana*. On character of pistil, there was a similarity among *F. kaiensis, F. koidzumiana* and *F. japonica* M-type, between *F. japonica* E-type and *F. muraiana*, and among *F. shikokiana, F. amabilis* and *F. ayakoana*. These similarities among species do not always support perfectly outer morphological and cytological data, but anatomical data support the outer morphological ones.

Key words : anatomy, flower, *Fritillaria*, Liliaceae, morphology.

The *Fritillaria japonica* complex (Liliaceae - *Fritillaria* - Sect. *Fritillaria*) which is endemic to the Japanese Islands, consists of the following seven species. *Fritillaria koidzumiana* Ohwi with the widest range of distribution, distributed in the Japan Sea side from Yamagata Prefecture to Ishikawa Prefecture, and also occurring partly in Gifu and Shizuoka Prefecture in the Pacific Sea side; *F. kaiensis* Naruhashi in Yamanashi Prefecture and the immediate neighboring area; *F. japonica* Miquel distributed in Fukui Prefecture, Tokai District and further to Okayama Prefecture; *F. muraiana* Ohwi being endemic to Shikoku; *F. shikokiana* Naruhashi distributed in Shikoku and middle of Kyushu; *F. amabilis* Koidzumi occurring from Chugoku District to northern Kyushu; and *F. ayakoana* Maruyama et Naruhashi with limited distribution in Shimane Prefecture (Naruhashi 1973, 1979).

Furthermore, the *F. japonica* complex is believed to be a monophyletic group, because of extensive similarity in habitat and life cycle as well as in outer morphological characters. This belief is also cytologically supported strongly by the observation of achiasmate meiosis in PMC (Noda 1975 and unpublished data). This group shows specific differentiations only in flowers as remarkable morphological features. Therefore, taxonomy of the group has been based on the outer morphological characters of the flower. The *F. japonica* complex is also cytologically divided into two groups with the basic chromosome numbers x=11 and x=12 (Noda 1964, 1968, 1975). Moreover, there is some inconsistency in relationships determined by using morphological data and cytological ones (Naruhashi and Noda 1971; Noda and Naruhashi 1971, 1988).

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Table 1. Locality of materials

Fritillaria amabilis
Hyogo-ken : Shiso-gun (Yasutomi-cho). Okayama-ken : Niimi-shi (Himehara). Hiroshima-ken : Fuchu-shi (Ishigaki ; Kanan-cho). Yamaguchi-ken : Kuga-gun, (Ookomaru). Fukuoka-ken : Itoshima-gun (Mizunashi) , Tagawa-gun (Hikosan) , Yame-gun (Kumawatariyama). Saga-ken : Fujitsu-gun (Taradake). Oita-ken : Oita-gun (Kuramoto)

F. ayakoana
Shimane-ken : Hikawa-gun (Tanbe) , Oota-shi (Ooetakayama) , Oochi-gun (Kawamoto-cho)

*F. camtschatcensis**

*F. imperialis**

F. kaiensis
Yamanashi-ken : Minami-koma-gun (Sano-toge ; Nishiyama). Shizuoka-ken : Fujimiya-shi (Numakubo)

F. koidzumiana
Yamagata-ken : Nishi-tagawa-gun (Nezugaseki ; Tozawa) , Tsuruoka-shi (Nakabato). Fukushima-ken : Oonuma-gun (Nihongi) , Minami-aizu-gun (Gamou). Niigata-ken : Iwafune-gun (Yuzawa) , Kita-kanbara-gun (Shimoakatani) , Gosen-shi (Sakihana-onsen) , Kamo-shi (Kuromizu) , Naka-kanbara-gun (Muramatsu-cho ; Yahiko) , Kariba-gun (Oguni-cho) , Ojiya-shi (Yamadera) , Kashiwazaki-shi (Kujiranami) , Naka-kubiki-gun (Kawabukuro ; Houhime-jinja) , Nishi-kubiki-gun (Hakusan-jinja ; Kurohimeyama). Toyama-ken : Shimo-niikawa-gun (Ogawa-onsen ; Hanyu ; Aimoto ; Unazuki ; Otozawa ; Unazuki-suki-jo ; Yamahikobashi) , Kurobe-shi (Fukudaira) , Uozu-shi (Katakai) , Naka-niikawa-gun (Iori ; Banbajima ; Ishibuchi) , Kami-niikawa-gun (Hongu) , Nei-gun (Shitanomyo ; Naka ; Shimosasahara ; Nishikumisaka ; Ryoshigahara ; Akamedani ; Tani) , Higashi-tonami-gun (Minotani ; Kawakaminakashin) , Nishi-tonami-gun (Tori) . Ishikawa-ken : Kanazawa-shi (Iozen ; Kurokabe) , Ishikawa-gun (Utsuo) . Gifu-ken : Gujo-gun, Hachiman-cho (Kokunii ; Tajiri). Shizuoka-ken : Yaizu-shi (Takakusayama). Yamanashi-ken : Higashi-yashiro-gun (Nakamichi-cho)

F. japonica E-type
Fukui-ken : Fukui-shi (Otoshi-cho ; Fukatani) , Takefu-shi (Yasudo-cho) , Asuwa-gun (Shimoyoshiyama) , Nanjo-gun (Kawano-mura ; Sugiyama) , Niyu-gun (Rokuroshi) . Okayama-ken : Aida-gun (Fukumoto)

F. japonica M-type
Gifu-ken : Gujo-gun (Kokumi) , Ibi-gun (Nakanasatsu). Mie-ken : Inbe-gun (Fujiwara-dake). Okayama-ken : Ontsu-gun (Kanbara ; Komori)

*F. meleagris**

F. muraiana
Kagawa-ken : Kida-gun (Hinokio). Tokushima-ken : Miyoshi-gun (Ochiai-toge) , Oe-gun (Takakoshi-yama) , Mima-gun (Otakiyama). Ehime-ken : Onsen-gun (Saragamine)

F. shikokiana
Tokushima-ken: Miyoshi-gun (Unpenji). Kochi-ken: Takaoka-gun (Nanokawa) , Nagaoka-gun (Kajigamori) . Kumamoto-ken : Aso-gun (Kuishi) , Kami-mashiki-gun (Sunoko) , Yatsushiro-gun (Matashidani)

*F. verticillata**

*from cultivation in the nursery of Toyama University.

In order to conceive the natural relationship in the group, we studied the flower anatomy of the seven species and discuss in the following our results with other data.

Materials and Methods

Flowers of the seven species of the *Fritillaria japonica* complex were fixed in FAA solution in the field and at the nursery of Toyama University and then used for study. Localities and data of these samples are shown in Table 1.

In order to compare the four species belonging to different sections, i.e., *F. camtschatcensis* (L.) Ker-Gawl. (Sect. *Liliorhiza* in Turrill and Sealy 1980) ; *F. imperialis* L. (Sect. *Petilium*) ; *F. meleagris* L. (Sect. *Fritillaria*) ; and *F. verticillata* Will. (Sect. *Fritillaria*) are also used.

By the middle of the present investigation, using the many anatomical differences noticed, the species in *F. japonica* complex could be divided into two groups, named M-type and E-type.

After thorough studies of the flowers by using binoculars, cross sections of eighteen floral parts : peduncle, ovary, middle of style, dividing portion of style, stigma, filament, anther, apex of anther, basal part of outer tepal, basal part of nectary of outer tepal, upper part of nectary of outer tepal, upper part of outer tepal, apex of outer tepal, and five portions of inner tepal as well as outer tepal, were made and their anatomy was studied by using a microscope (Fig. 1). The sections were stained by Heidenhain's haematoxylin.

Results

In the anatomical characters studied, all seven species of the *Fritillaria japonica* complex appear to be histologically uniform. However, quantitative difference of tissue and qualitative difference of cell are found by detailed observations. And no qualitative differences are found between flowers from original habitats and cultivations in the nursery.

No infraspecific variation is observed in the four species, *F. kaiensis, F. muraiana, F. amabilis* and *F. ayakoana.* Contrary to this, remarkable differences were found between M and E groups of *F. japonica.* On the surface of upper part of nectary of tepal in *F. koidzumiana* plants

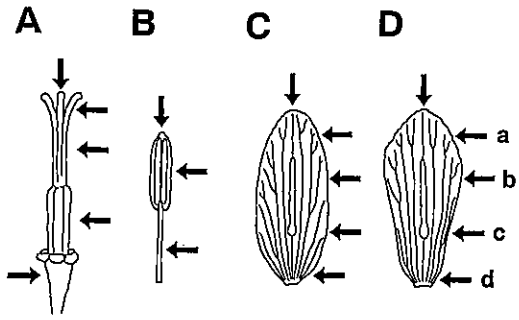

Fig. 1. The eighteen flower parts used for observation.
A, pistil and peduncle ; B, stamen ; C, outer tepal ; D, inner tepal (a, upper part ; b, upper part of nectary ; c, basal part of nectary ; d, basal part).

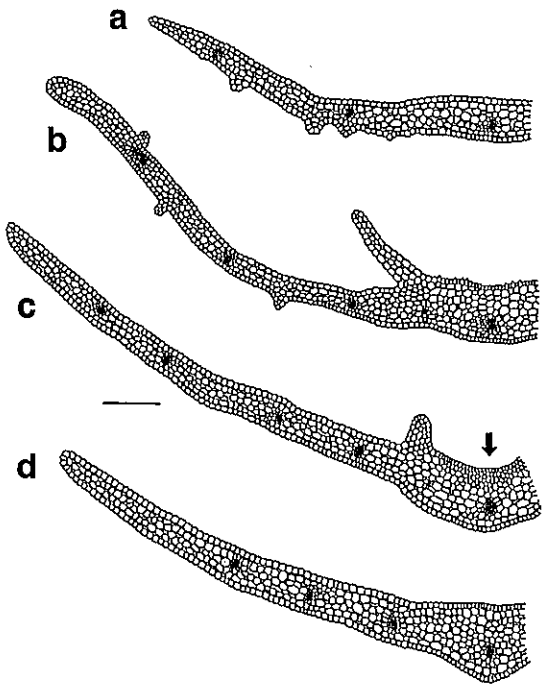

Fig. 2. Cross sections at different points of inner tepal in *F. koidzumiana.*
a, upper part ; b, upper part of nectary ; c, basal part of nectary ; d, basal part (arrow, nectary ; bar, 0.4 mm).

from Tohoku District, long nipple-shaped cells are observed, while short nipple-shaped cells are seen in the plants from Ishikawa Prefecture, and especially almost no nipple-shaped cells could be found in the plants from Takakusayama, Shizuoka Prefecture. In *F. shikokiana*, the degree of connation of upper part of

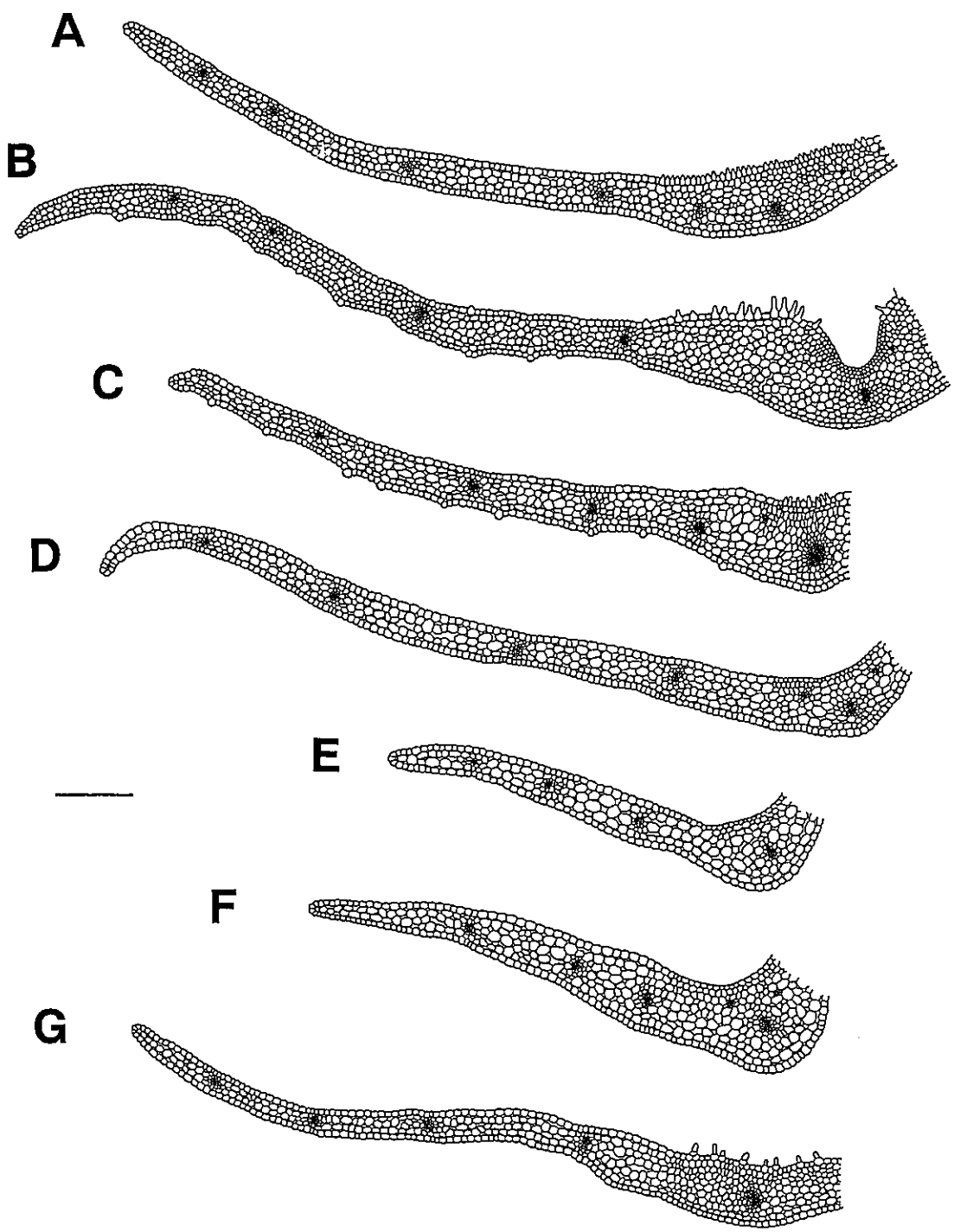

Fig. 3. Cross section at upper part of nectary of inner tepal.
A, *F. kaiensis*; B, *F. japonica* M-type; C, *F. japonica* E-type; D, *F. muraiana*; E, *F. shikokiana*; F, *F. amabilis*; G, *F. ayakoana* (bar, 0.4 mm).

style varies in the materials from Shikoku and Kyushu.

The 18 points used as differential characters on four organs are as follows (Fig. 1).

Perianth

Flowers of the group are solitary and nodding. The perianth consists of three outer tepals and three inner tepals. Tepals are nectariferous. Anatomical differences except for partial quantitative differences between outer and inner tepals were not detected among eleven species. Therefore, inner tepals are used for present explanation and illustration as comparison. Tepals consist of epidermis, parenchyma and vascular tissue. Nectary is found on surface of adaxial side in the center of tepal.

Half cross sections of four portions of inner tepals in *F. koidzumiana* are illustrated in Fig. 2. In this species, there are slender emergencies surrounding the nectary on the adaxial side, and small emergencies on the abaxial side too. On the surface of upper part of nectary, nipple-shaped cells are scattered and small veins with a main vein under nectary is present. Upper part of nectary in cross section is more complicated than other part of tepal. Therefore this portion was compared among six species in Fig. 3.

Surface of both sides of tepal in *F. kaiensis, F. amabilis* and *F. ayakoana* is smooth except for nectary. In both M-and E-types of *F. japonica, F. muraiana* and *F. shikokiana,* on surface of abaxial side protrusions containing semi-globular cells are present. The surface of nectary consists of nipple-shaped papillae in *F. kaiensis* and *F. japonica* E-type. These nipple-shaped papillae particularly surround the nectary in *F. japonica* M-type. In *F. ayakoana,* there are long processes consisting of two cells in the nectary. Under the nectary no veins are present except for a main vein in only *F. shikokiana.* Nectary of *F. japonica* M-type shows conspicuous hollow and nectary gland of *F. muraiana, F. shikokiana* and *F. amabilis* is like palisade tissue on the surface. The nipple-shaped cells and long processes of two cells on or surrounding the nectary are not observed in the four species taken for comparison except for the *F. japonica* complex.

According to the cell-type they show, the surface of apex of tepal are divided into four types; campanulate shaped cell, nipple-shaped cell, round head of two cells and process of two cells. Though apex of inner and outer tepals look almost the same, outer tepals show more remarkable features (Fig. 4).

Stamen

Six stamens are inserted on the base and in front of the tepals. Filaments are slender and basifixed anthers are oblong. Cross section of filaments shows usually elliptical shape. Filament of *F. koidzumiana* consisting of large parenchymatous cells and many intercellular spaces is larger than that of *F. amabilis* and *F. ayakoana.* Filaments usually consist of epidermis, parenchyma and single vascular bundle. In epidermis of filament, three types of cell together with common epidermal cells are distinguishable, namely short nipple-shaped cell, long nipple-shaped cell, and process of two cells (Fig. 5). Among them, long nipple-shaped cells are found in *F. japonica* E-type, *F. shikokiana* and

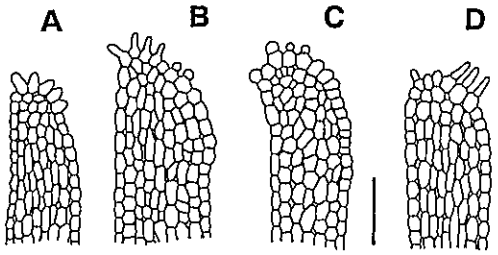

Fig. 4. Longitudinal section of apex of outer tepal (radial plane).
A, *F. kaiensis*; B, *F. koidzumiana*; C, *F. muraiana*; D, *F. ayakoana* (bar, 0.25 mm).

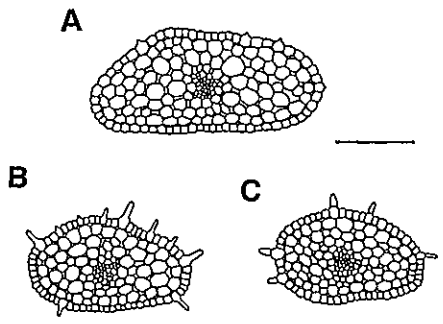

Fig. 5. Cross section of filament.
A, *F. muraiana*; B, *F. amabilis*; C, *F. ayakoana* (bar, 0.3 mm).

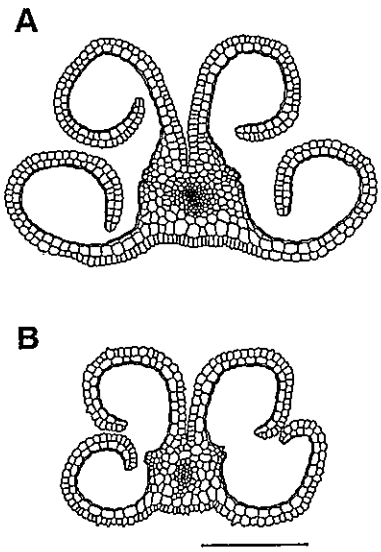

Fig. 6. Cross section of dehiscent anther.
A, *F. koidzumiana*; B, *F. amabilis* (bar, 0.5 mm).

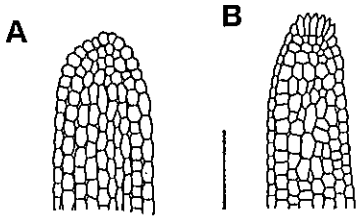

Fig. 7. Longitudinal section of apex of anther (radial plane).
A, *F. koidzumiana*; B, *F. ayakoana* (bar, 0.25 mm).

F. amabilis. Process of two cells is found in *F. ayakoana*.

Anther size of *F. koidzumiana* is the largest in the *F. japonica* complex. Anther locule is enclosed by two layers with and without nipple-shaped cells (Fig. 6). The inner layer shows a well developed cuticle layer. On the other hand, three layers are found in *F. camtschatcensis* and *F. imperialis*, and partially in *F. verticillata*. Nipple-shaped cells are lacking in the four species taken for comparison.

Apex of anther consists of epidermis and parenchyma. Two types of epidermis were recorded, one in *F. koidzumiana* with somewhat rounded polyhedral cells, and the other in *F. ayakoana* with nipple-shaped cells (Fig. 7).

Pistil

The pistil in the *F. japonica* complex consists of three carpels. Ovary is slender triangular ellipsoidal with parietal placentation. In *F. shikokiana*, *F. amabilis* and *F. ayakoana*, the ovary is barrel shaped with narrower neck and base and with irregular surface and the ditch of ridgeline is deeper. By degree of connation in the middle of the ovary, carpels are divided into three types. The first is perfectly coherent type as found in *F. kaiensis*, the second shows connation with papillate tissue as seen in *F. koidzumiana* and *F. japonica* M-type, and the third displays no connation as illustrated in *F. ayakoana* and in the remaining species (Fig. 8). *F. imperialis* with coherent carpels belongs to the same type as *F. kaiensis*, while *F. camtschatcensis*, *F. meleagris* and *F. verticillata* show the second type of connation like *F. koidzumiana*.

The middle part of the style is orbicular-triangle to hastate-orbicular in cross section, consisting of epidermis, parenchyma, vascular bundle and one lumen. The lumen is surrounded by a remarkable single layer like palisade tissue and has an irregular trefoil shape owing to bulges or processes of the wall (Fig. 9 b). Distally at the free part where a lumen is not found, the style is divided into three short branches. Cross section of one branch is horseshoe-shaped or circular (Fig. 9 a). Polyhedral cells or nipple-shaped cells are observed in epidermis of style (Fig. 9). These nipple-shaped cells are also found in *F. imperialis* and *F. meleagris*.

The stigma of seven species is mostly the same in morphological features. Namely horizontal-polyhedral palisade-like tissue of the single layer inside and vertical-polyhedral cells of the outside layer, with or without nipple cells. There are some elongated cells on the apex of the stigma, these were divided into three types: narrow campanulate cell, long nipple-shaped cell and long process of two cells (Fig. 10). These elongated cells have also been found in the four species for comparison.

Peduncle

Except for slight differences in quantity, number and distribution of vascular bundles and relative size of epidermal cell and parenchymatous cell, no significant differences were found in

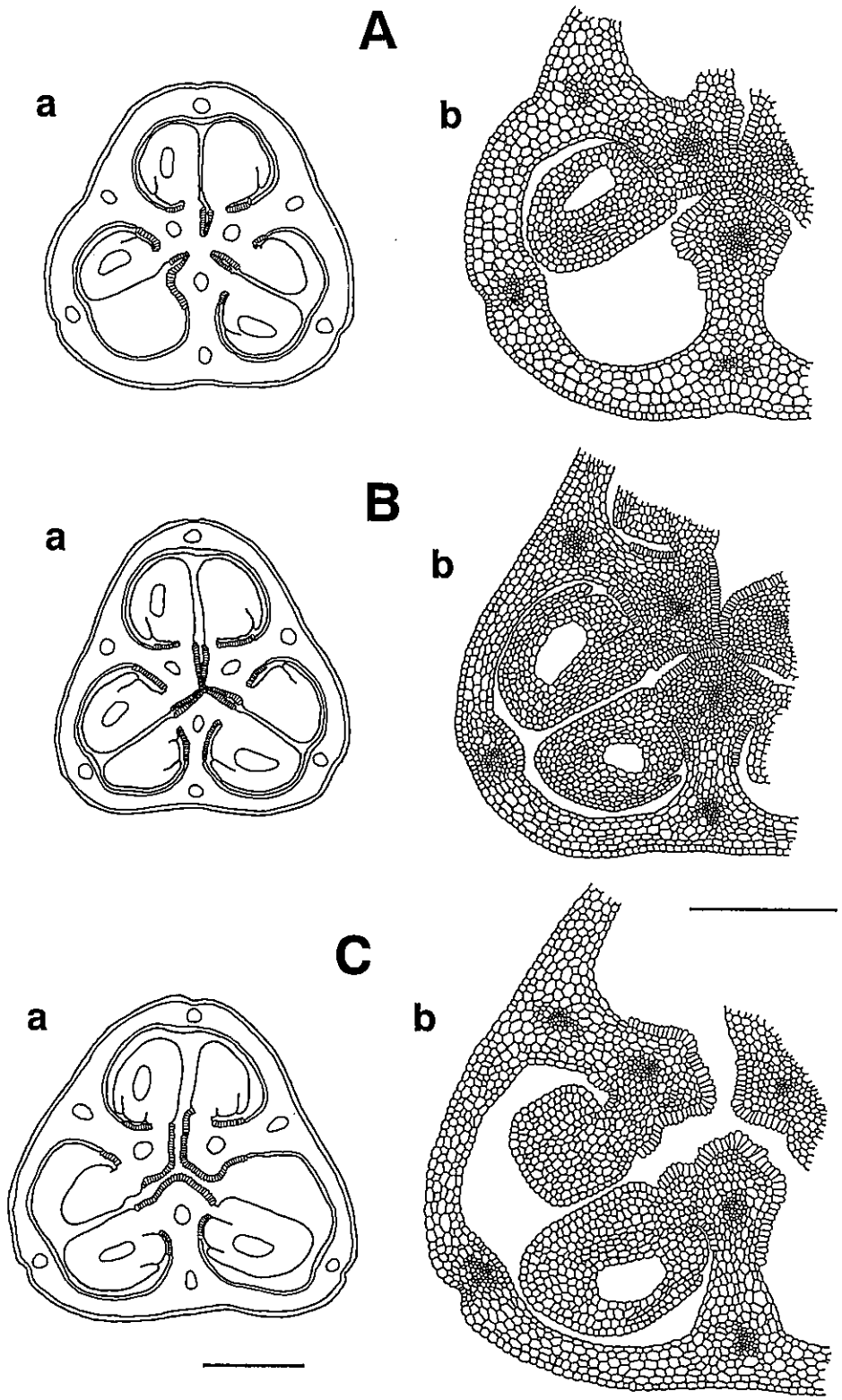

Fig. 8. Cross section of ovary.
A, *F. kaiensis*; B, *F. koidzumiana*; C, *F. ayakoana*; a, schematic representation (bar, 0.6 mm); b, part of ovary (bar, 0.5 mm).

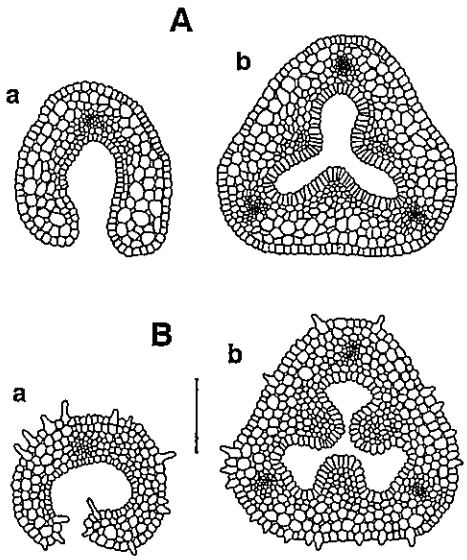

Fig. 9. Cross section at upper and middle part of style.
A, *F. japonica* M-type; B, *F. ayakoana*; a, upper part; b, middle part (bar, 0.3 mm).

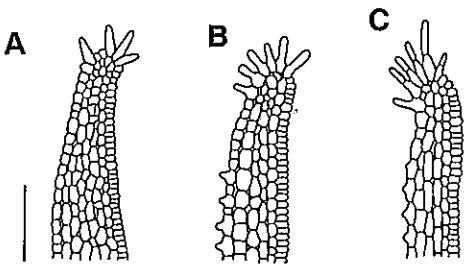

Fig. 10. Longitudinal section of stigma (radial plane). A, *F. japonica* E-type; B, *F. shikokiana*; C, *F. ayakoana* (bar, 0.25 mm).

the anatomy of the peduncle of the seven species. However, shape and size in epidermal cell of *F. ayakoana* are variable such as raising, short nipple-shaped or brick like, in comparison with others with polyhedral cell. In contrast to this, *F. camtschatcensis, F. imperialis, F. meleagris* and *F. verticillata,* differ from the *F. japonica* group on the viewpoint of the presence of pericycle and the circular distribution of vascular bundles. Moreover, due to a thick-walled epidermis like sclerenchyma *F. camtschatcensis* is very distinct from the others. Cross section of peduncle in *F. amabilis* is shown in Fig. 11.

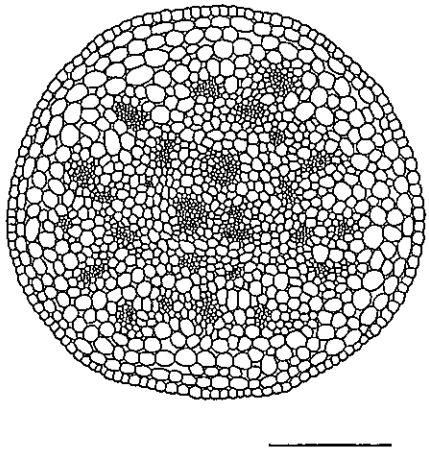

Fig. 11. Cross section of peduncle in *F. amabilis* (bar, 0.4 mm).

Discussion

The eleven species examined in the present study were fundamentally similar in the anatomy of their flowers and in histology of organs. Furthermore, seven species of the *F. japonica* complex showed similarities with one another. Especially the peduncles were almost the same, but they differed from those of the four species used for comparison. The anatomical characters used as differentials are shown in Table 2 and 3.

In outer morphology long nipple-shaped cells have been observed on surface of filament in *F. shikokiana, F. amabilis* and *F. ayakoana* (Naruhashi and Noda unpublished). The remaining four species which have been considered to have no processes on the filament, were observed to have short nipple-shaped cells on their filaments.

As a results of the present anatomical study, two differentiated groups within *F. japonica,* M- and E-types, were recognized. The M-type is distributed in Tokai District to Okayama Prefecture, has long nipple-shaped cells on the adaxial side of tepal and remarkable hollow nectary. In contrast the E-type occurring in Fukui Prefecture and Fukumoto in Okayama Prefecture, has papillate processes on nectary, longer filament processes than M-type and no connation of carpels.

In *F. shikokiana,* difference in degree of connation of the three branches of style is observed between plants from middle Kyushu and Shikoku.

Table 2. Characters and character states

1. epidermal cell of peduncle	0 : polyhedral	1 : irregular
2. epidermal cell of adaxial side of tepal	0 : polyhedral	1 : nipple-shaped
3. surface of adaxial side of tepal	0 : smooth	1 : emergence
4. surface of abaxial side of tepal	0 : smooth	1 : protrusion
	2 : emergence	
5. shape of nectary	0 : smooth	1 : hollow
6. epidermis of nectary	0 : palisade	1 : nipple-shaped
	2 : process of two cells	
7. epidermis of apex of tepal	0 : campanulate	1 : nipple-shaped
	2 : round head of two cells	3 : process of two cells
8. small vein under nectary	0 : absent	1 : present
9. epidermis of filament	0 : short nipple-shaped	1 : long nipple-shaped
	2 : process of two cells	
10. epidermis on anther	0 : polyhedral	1 : nipple-shaped
11. epidermis of apex of anther	0 : polyhedral	1 : nipple-shaped
12. shape and surface of ovary	0 : cylindrical and smooth	1 : barrel shaped and undulate
13. ditch of ridgeline	0 : shallow	1 : deep
14. connation of carpel	0 : coherent	1 : connation with papillate tissue
	2 : no connation	
15. wall of lumen in style	0 : protrusion	1 : process
16. arm of upper part of style	0 : horseshoe-shaped	1 : circular
17. epidermal cell of style	0 : polyhedral	1 : nipple-shaped
18. epidermal cell of stigma	0 : campanulate	1 : long nipple-shaped
	2 : long process of two cells	

Table 3. Character features

Characters / Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
F. kaiensis	0	0	0	0	0	1	0	1	0	1	1	0	1	0	1	0	0	1
F. koidzumiana	0	0	1	2	0	1	1–2	1	0–1	0	0	0	0	1	1	0	0	1
F. japonica M	0	1	0	1	1	0	0–2	1	0	0	0	0	0	1	0	0	0	0
F. japonica E	0	0	0	1	0	1	0–2	1	1	1	0	0	0	2	1	0	0	0
F. muraiana	0	0	0	1	0	0	2	1	0	0	1	0	0	2	0	0	0	0
F. shikokiana	0	0	0	1	0	0	1	0	1	1	1	1	0	1–2	0	1	1	1
F. amabilis	0	0	0	0	0	0	1	1	1	1	1	1	0	2	0–1	1	1	1–2
F. ayakoana	1	0	0	0	0	2	3	1	2	0	1	1	1	2	1	1	1	2

Table 4. Comparison among outer morphological data, cytological data and present data

Character / Species	Outer morphological data*				Correlation of each organ on present study			Cytological data**	
	Shape of flower	Nectary position	Anther's color	Cleft of stigma	Tepal	Stamen	Pistil	Chromosome number	Karyotype
F. kaiensis	1	1	0	0			A'	24	C
F. koidzumiana	0	0	0	0		A	A	24	C
F. japonica M	0	0	0	0		A	A	22	B-Ⅰ
F. japonica E	0	0	0	0			B	22	B-Ⅱ
F. muraiana	0	0	1	1			B	24	D
F. shikokiana	2	2	1	1	A	B	C	24	D
F. amabilis	2	2	0	1	A'	B	C	22	A
F. ayakoana	1	1	0	1		B'	C'	22	A

*, from Naruhashi and Noda 1971 and Naruhashi and Noda unpublished data; **, from Noda and Naruhashi 1971 and Noda and Naruhashi unpublised data. Shape of flower 0, broadly campanulate; 1, cup-shaped campanulate; 2, tubular-campanulate. Nectary position from base 0, 1/3-2/5; 1, 1/4; 2, 1/7-1/9. Anther's color 0, white; 1, purple. Cleft of stigma 0, open; 1, closed.

No infraspecific taxa in the *F. japonica* group has been discussed from outer morphological study until now (Naruhashi 1971; Noda and Naruhashi 1988). However, based on cytological study, Noda and Naruhashi (1988) reported two types in *F. japonica* and *F. shikokiana* by karyotype analysis respectively. Two types (M and E) in *F. japonica* are not coincident with the two types of karyotype (Ⅰ and Ⅱ) of the species. However, the connation of three branches of style in *F. shikokiana* was different between plants from Kyushu and Shikoku, showing correlation with the karyological data (Ⅰ and Ⅱ).

In this paper diagnostic characters are not treated independently. The groups of character states which show correlation are adopted to analyze the relationship among species.

Judging from each anatomical character, outer shape of ovary, process on filament and stigma, connation of carpels, and feature of style show correlation as the group of character state and also correlate to division of style. From the point of this view, similarity of characters among *F. kaiensis, F. koidzumiana* and *F. japonica* M-type, between *F. japonica* E-type and F. *muraiana,* and between *F. shikokiana* and *F. amabilis,* were recognized. Character state of surface in filament and anther wall shows correlation, and especially similarities of characters between *F. koidzumiana* and *F. japonica* M-type, between *F. muraiana* and *F. kaiensis,* and between *F. shikokiana* and *F. amabilis* were recognized. *F. ayakoana* having more specialized characters shows high similarity to *F. amabilis.*

Although correlation in character state of tepal is weak and it is in no relation to pistil and stamen, those of *F. shikokiana* and *F. amabilis* show slight resemblance and agree with outer appearance of flower.

From the outer morphological and cytological data, it is inferred that the *F. japonica* complex has cytologically been differentiated into two groups by reduction in basic chromosome number from x=12 to x=11 and then parallel evolution in morphology might have occurred in each group (Noda and Naruhashi 1988). However, anatomical characters in the present study show correlation to outer morphological characters, but less correlation to cytological characters (See, Table 4). Therefore, judging from the morphological data, the group with 2n=22 might be explained as polyphyletic by no common apomorphic characters. On the other hand, characters of chromosome are considered to be more conser-

vative than other morphological characters. If this is true, then morphological characters might have been evolved in parallel.

Because of the high similarity in the morphology of stamens and pistils in *F. koidzumiana* and the M-type group of *F. japonica*, the E-type group of *F. japonica* may be regarded as derived from the M-type.

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摘　要

ユリ科バイモ属コバイモ*Fritillaria japonica* complexは，カイコバイモ*F. kaiensis* Naruhashi，コシノコバイモ*F. koidzumiana* Ohwi，ミノコバイモ*F. japonica* Miquel，アワコバイモ*F. muraiana* Ohwi，トサコバイモ*F. shikokiana* Naruhashi，ホソバナコバイモ*F. amabilis* Koidzumi，イズモコバイモ*F. ayakoana* Maruyama et Naruhashiの7種からなり，日本に固有の植物である。各種の外部形態は酷似し，顕著な種差は花のみに見られる。その花の外部形態での類似と染色体の基本数と核型から見た類似は一致しない。本研究は花の解剖を行い，7種の組織や細胞について比較検討した。取り上げた花の器官は，花被，雄ずい，雌ずい，および花柄で，Fig. 1で図示した18ヵ所について，切片標本を作り観察した。

結果からミノコバイモに2つの種内群が認められた。東海地方および岡山県（福本以外の産地）に分布する型（M型）は，花被向軸面の表皮細胞が長ニップル型で，突起があり，蜜腺部が極端に凹む。これに対して，福井県と岡山県の福本に分布する型（E型）は，蜜腺部に乳頭状突起をもつ。さらにM型と比べて花糸の突起が長く，子房の心皮中軸が合着しない点で識別される。また，トサコバイモは九州と四国の個体間で，柱頭裂片の合着の強弱などに差が認められた。これは，一部細胞学的データと一致した。

個々の形態形質を見ると，子房の外観，花柱・柱頭上の突起，心皮中軸の合着，花柱の形状の形質に関して，形質状態のまとまりの間に相関関係があり，外部形態的な柱頭の裂片の形状とも相関が見い出される。これに基づくと，カイコバイモ・コシノコバイモ・ミノコバイモM型，ミノコバイモE型・アワコバイモ，トサコバイモ・ホソバナコバイモの間で形質の類似性が認められる。花糸，葯壁表皮の形

質状態にも相関は見られ，特に，コシノコバイモ・ミノコバイモM型，アワコバイモ・カイコバイモ，トサコバイモ・ホソバナコバイモで類似性が示される。イズモコバイモは各形態形質が特殊化しているものの，ホソバナコバイモとの類似性が高い。また，トサコバイモとホソバナコバイモの類似は，外部形態から見た花被の形や各器官表皮の形状とも相関している。

結論として，解剖学的データは細胞学からの類似度よりもより外部形態の類似度を支持している。

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