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A taxonomic study of *Viola* section *Chamaemelanium* in Korea-based on morphological characters

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A taxonomic study of *Viola* section *Chamaemelanium* in Korea, based on morphological characters, was conducted with light microscopy and scanning electron microscopy. Two species, *V. orientalis* W. Becker and *V. brevistipulata* (Fr. et Sav.) W. Becker, are recognized by rhizome and cauline habits, trichomes on the ovary and the shape and beards of stigmas. The latter can be split further into three varieties, var. *brevistipulata*, var. *minor* Nakai and var. *laciniata* (Boiss.) W. Becker, according to the leaf morphology in particular. *Viola brevistipulata* var. *laciniata* has the most tooth number, and its teeth are irregular erose but the other two varieties are regular sinuate or serrate. As for the size of leaves, *V. brevistipular* var. *brevistipulata* is the largest but *V. brevistipulata* var. *minor* is the smallest among the varities. Of them, *V. brevistipulata* var. *laciniata* is newly recorded in Korea. It was also revealed that both development and arrangement of the beards developed on the ovary and stigma were particularly diagnostic in the identification of the *Viola* section *Chamaemelanium* species.

Key words : morphology, taxonomy, *Viola* section *Chamaemelanium*

The genus *Viola* L. has four sections, *Dischidium, Chamaemelanium, Melanium* and *Nomimum*, based on the shape of the stigma (Gingins, 1823; Becker, 1925; Melchior, 1925). Among these sections, *Chamaemelanium*, which occurs at high

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altitudes, has a facial shaped stigma which is unbeaked, and also has beards on both sides of its lateral parts. The section has been regarded as the most primitive taxon within the genus because of its chromosome number, floral shape, stigmatal shape and distribution (Melchior, 1925; Clausen, 1927; Russell, 1960).

Viola uniflora L., which is distributed in Siberia, was the first species recorded in the section (Linnaeus, 1753). All species within the section that are distributed in East Asia were then treated as *V. uniflora* or its varieties (Maximowicz, 1877, 1889; Palibin, 1899; Nakai, 1909, 1911, 1914a, 1914b, 1916, 1919; Palibin, 1899). After re-examination of the morphological features of rhizomes, ovary and leaves, Becker (1916) found that there were differences between *V. uniflora* and species in East Asia within the section, and he designated them as two new species, *V. orientalis* (Maxim.) W. Becker and *V. brevistipulata* (Franch. et Savat.) W. Becker. Nakai (1922) emphasized the location and shape of the caulescent leaves, and he then documented six species within the section from East Asia, *V. xanthopetala* Nakai, *V. hidakana* Nakai, *V. conferta* (W. Becker) Nakai, *V. yubariana* Nakai, *V. alliariaefolia* Nakai, *V. lasiostipes* Nakai. He also added three more taxa to the section, *V. pubescens* Nakai, *V. brevistipulata* (W. Becker) var. *pubescens* Nakai, and *V. brevistipulata* (W. Becker) var. *acuminata* Nakai (Nakai, 1928). Since then researchers have argued for both interpretations. Ishidoya (1929) preferred to use Nakai's (1922, 1928) scientific name but Maekawa (1954) followed the one given by Becker (1916).

In addition, there are several studies on the species of *Viola* section *Chamaemelanium* in Korea. Nakai (1922) described *V. xanthopetala* Nakai. Several Korean scientists have produced taxonmic keys and illustrative floras on the section. Chung (1957, 1959) described *V. glagella* Muttull and *V. xanthopetala* Nakai (= *V. uniflora* L.), Lee (1969, 1980) described *V. brevistipulata* var. *minor* Nakai and *V. orientalis* W. Becker, and Park (1974) described *V. brevistipulata* W. Becker, *V. glabella* Muttull and *V. orientalis* W. Becker. There are, however, some taxonomic difficulties, which should be solved, such as the circumscription of species and the choice of scientific names, which differ among researchers because of the lack of taxonomic study (Kim, 1987).

The study aims to establish specific limitations through the use of both field and laboratory studies on morphological characters in detail, and to establish the correct scientific names through a review of former reports.

Materials and Methods

The *Viola* section *Chamaemelanium* taxa used for this study were collected during 1988 and 1989 from several areas throughout Korea by the author (Table 1). Once they were brought into the laboratory, some were used as voucher specimens and are housed in the Chonbuk National University Herbarium (JNU). The others were planted in pots to be used as living material. Some collections from the Makino Herbarium (MAK) and Herbarium of Tohoku University (TUS) were also investigated to examine the degree of variation within and among taxa (Table 1).

Identification and description of the species were conducted through observation in the field, and assessment of both qualitative and quantitative morphological characters, both new and existing characters based on literature reviews. The quantitative characters describing the outer morphology were measured with vernier calipers. To examine pollen grains, an acetolysis was performed by general procedures (Erdtman, 1960), and they were then observed and photographed with a light microscope (Carl Zeiss Axiophoto II) and a scanning electron microscope (Akashi SR-50) respectively. In particular, the stigmas and ovaries of flowers were observed with the Wet Mode of the SEM (i. e. The primary electrons were accelerated over 30kV; after scanning the specimen, the back-scattered electrons were then detected by Robinson's detector) to maintain their cellular and tissue shapes while they were examined in the specimen chamber.

Terminology for description followed Erdtman (1952), Hashimoto (1967), Hickey (1973) and Kim (1987).

Results

Ovary: *V. orientalis* has clavate protuberances on the whole part of ovary (Plate I-1). But three taxa, *V. brevistipulata* var. *brevistipulata, V. brevistipulata* var. *minor, V. brevistipulata* var. *laciniata* has tapering rodlet protuberances on the upper part of ovary (Plate I-3, 5, 7). The length of the protuberances is greatest in *V. brevistipulata* var. *brevistipulata* (Plate I-5) and shortest in *V. brevistipulata* var. *laciniata* (Plate I-7).

Stigma: all species of section *Chamaemelanium* have a facial shaped stigma (Plate I-2, 4, 6, 8). Three taxa, *V. orientalis, V. brevistipulata* var. *brevistipulata*

Table 1. Materials used for the study of *Viola* section *Chamaemelanium* (MAK: Makino Herbarium; TUS: Herbarium Tohoku Universitatis Sendaiensis; **(): accession number of herbarium)

Species	Korean name	Source	Collecting data
V. orientalis	노랑제비꽃 (No-ang-jae-bee-koht)	Mt. Chiri	April 16, 1988; May 20, 1988
		Mt. Taedun	April 15, 1989
		Mt. Moak	April 22, 1988; March 25, 1989; April 29, 1989.
		MAK	April 26, 1907 (40798)**; August 19, 1925 (82493); April 28, 1925 (40789); May 5, 1929 (85429); April 19, 1930 (85458); April 27, 1934 (85461); May 10, 1936 (85440); May 15, 1955 (85432); April 19, 1964 (85439)
		TUS	April 20, 1958 (184301); April 29, 1960; March 23, 1969 (50698)
V. brevistipulata var. *brevistipulata*	털노랑제비꽃 (Turl-no-ang-jae-bee-koht)	Mt. Sulak	May 13, 1988; May 26, 1989
		Mt. Odae	May 12, 1988; May 26, 1989
		MAK	August 22, 1908 (233930); July 3 1910 (28751); June 8, 1919 (83689); May 16, 1953 (61277); April 29, 1960 (196191); May 15, 1960 (82704); May 16, 1960 (82700); July 26, (82712); May 9, 1962 (21797); June 15, 1966 (82693); May 26, 1967 (82714)
		TUS	May 23, 1928 (268557); July 4, 1995 (264451); April 27, 1998 (259265); April 28, 1998 (259490); May 4, 1998 (259269)
V. brevistipulata var. *minor*	한라털노랑제비꽃 (Hal-la-turl-no-ang-jae-bee-koht)	Mt. Halla	April 1, 1988; April 5, 1988; April 4, 1988; April 6, 1988; April 16, 1988; May 18, 1989
		TUS	September 10, 1925 (230530)
V. brevistipulata var. *laciniata*	오대털노랑제비꽃 (O-dae-turl-no-ang-jae-bee-koht)	Mt. Odae	May 12, 1988; May 26, 1989
		MAK	June 16, 1908 (233932); July 30, 1915 (28782); May 15, 1938 (82726)
		TUS	May 21, 1985 (114874); June 1, 1997 (245431); July 17, 1997 (199230)

Table 2. Some morphological characters of *Viola* section *Chamaemelanium* in Korea

Unit : cm

Species	Sepal length	Petal length	Stipule Length	Stipule Width	Cauline length	Rhizome length
V. orientalis	0.51±0.07	0.89±0.07	0.36±0.07	0.23±0.04	13.80±1.00	1-3
V. brevistipulata var. *brevistipulata*	0.44±0.05	1.16±0.14	0.74±0.10	0.39±0.09	13.84±0.56	1-10
V. brevistipulata var. *minor*	0.52±0.05	1.18±0.10	0.30±0.08	0.18±0.05	6.82±0.65	1-10
V. brevistipulata var. *laciniata*	0.64±0.08	1.14±0.08	0.32±0.07	0.18±0.05	13.40±2.60	1-10

and *V. brevistipulata* var. *minor*, have stigmatal protuberances on the lower part of the lateral sides. However, *V. brevistipulata* var. *laciniata* has stigmatal protuberances on the lower part of the back side as well as the lower part of the lateral sides (Plate I-8). The lengths of the protuberances are almost the same but *V. brevistipulata* var. *laciniata* is more or less longer (Plate I-8).

Leaf : in *Viola orientalis*, the leaves are cordiform to broad-cordiform, are chartaceous. The teeth are dentate but the furrow of the teeth is shallow, and the leaf apex is obtuse (Plate II-1, 5, 9, 13). In *V. brevistipulata* var. *minor*, the leaf is cordiform to ovate, and is chartaceous. The teeth are sinuate, and the leaf apex is acute (Plate II-3, 7, 11, 15). In *V. brevistipulata* var. *brevistipulata*, the leaves are cordiform to reniform, are coriaceous. The teeth are serrate with the blunt end, and the leaf apex is obtuse (Plate II-2, 6, 10, 14). In *V. brevistipulata* var. *laciniata*, the leaf is cordiform to reniform, and is chartaceous. The teeth are irregular erose, the ends of them are sharp, and the leaf apex is acute (Plate II-4, 8, 12, 16). As for the size of radical leaves, for the first, second, and third caulescents, *V. brevistipulata* var. *brevistipulata* is the largest but *V. brevistipulata* var. *minor* is the smallest among the species of *Chamaemelanium* examined (Tables 2, 3). As for the number of teeth, *V. brevistipulata* var. *laciniata* has the most and *V. orientalis* has the least (Table 3).

Pollen grains and miscellaneous of stipule and rhizome : the pollen grains of species examined are monad and subprolate. They have tricolporate

Table 3. Leaf measurements at anthesis of *Viola* section *Chamaemelanium* in Korea (1 : radical leaf; 2 : first cauline leaf; 3 : second cauline leaf; 4 : third cauline leaf)

Unit : cm

Characters		*V. orientalis*	*V. brevistipulata* var. *brevistipulata*	*V. brevistipulata* var. *minor*	*V. brevistipulata* var. *laciniata*
Blade length	1	2.60±0.25	3.55±0.27	1.21±0.32	2.04±0.23
	2	2.98±0.37	3.91±0.13	1.53±0.37	3.55±0.27
	3	2.64±0.35	3.18±0.13	1.43±0.22	2.90±0.25
	4	1.55±0.28	2.50±0.30	0.96±0.34	2.33±0.18
Blade width	1	3.02±0.21	3.67±0.36	1.44±0.06	2.05±0.50
	2	2.60±0.47	3.15±0.29	1.54±0.09	3.14±0.24
	3	1.70±0.26	2.14±0.13	1.13±0.11	1.80±0.25
	4	1.23±0.36	1.60±0.13	0.62±0.15	1.41±0.19
Lobe length	1	3.26±0.29	4.24±0.32	1.51±0.17	2.40±0.20
	2	3.06±0.29	4.10±0.36	1.47±0.24	4.71±0.53
	3	2.33±0.26	3.10±0.21	1.29±0.25	3.04±0.30
	4	1.58±0.28	2.45±0.28	0.85±0.09	1.80±0.30
Teeth number	1	12.50±0.67	14.56±1.06	11.70±1.18	16.50±0.50
	2	9.44±0.50	13.70±1.28	11.30±0.65	17.00±1.40
	3	6.73±0.70	9.09±1.78	8.70±0.96	10.90±0.80
	4	5.00±0.70	7.00±1.05	6.25±1.03	7.50±1.02

Table 4. Pollen measurements of *Viola* section *Chamaemelanium* in Korea

Unit : m

Species	Equatorial view		P/E
	Equatorial diameter	Polar length	
V. orientalis	66.20±6.46	40.49±3.68	1.63
V. brevistipulata var. *brevistipulata*	57.62±6.38	36.86±3.49	1.58
V. brevistipulata var. *minor*	56.26±5.87	36.58±4.57	1.54
V. brevistipulata var. *laciniata*	52.70±5.18	36.54±5.06	1.44

apertures, and their surface sculpturing is foveolate (Plate III). *Viola orientalis* has larger pollen grains than other species studied (Table 4). In the case of the length and width of the stipule, *V. brevistipulata* var. *brevistipulata* is

distinguished as large and the others are similar to each other (Table 2). In the case of the length of the rhizome, *V. orientalis* is notably short as 1~3cm. In case of the length of the cauline, *V. brevistipulata* var. *laciniata* are significantly shorter than the other three species (Table 2).

Taxonomic Treatments

Section *Chamaemelanium* Gingins, Mim. surla fam. Viol. 1 (1823); W. Becker, Engl., Pfl. -fam. ed. 2, XXI, 363 (1925); Takenouchi, Sci. Contr. Tung-pei Teach Univ. 1, 2 (1955)

Korean name: No-ang-jae-bee-koht-jeol (노랑제비꽃절)

Caulous perennial herbs. Rootstock short or relatively long. Leaves: radical leaf-blade cordate to reniform, auriculate to reniform bases, acute to obtuse apices; cauline leaf-blade cordate to deltoid, cordate to aequilateral bases, acute to acuminate apices. Stipules small and free, entire margin. Flowers yellow to deep yellow, lip petal obovate and curved toward lower side, upper petal excurved, lateral petals pubescent. Spur short. Stigma facial shaped, lateral (and/or marginal beards), no rostrum but stigmatal cavity. Ovary ovoid, pubescent. Pollen grain prolate, foveolate.

Distribution: Distributed above 600 m altitude.

Key to the taxa of *Viola* section *Chamaemelanium* in Korea:

1. Rhizome curved, long and sometimes branched; tapering rodlet only at the upper part of ovary
   2. Leaves chartaceous, margin biserrate or serrate
      3. Biserrate with 16~20 teeth on radical and first cauline leaves ..... *V. brevistipulata* var. *laciniata*
      3. Serrate with less than 10~15 teeth on radical and first cauline leaves ..... *V. brevistipulata* var. *brevistipulata*
   2. Leaves coriaceous, margin sinuate ..... *V. brevistipulata* var. *minor*
1. Rhizome erect and short; clavate protuberances throughout ovary ..... *V. orientalis*

***Viola orientalis* (Maxim.) W. Becker,** Beih. Bot. Centralbl. Abt. II, 34:256 (1916), 36:50 (1918)

V. uniflora (L.) var. *orientalis* Maxim., Enum. Pl. Mongol. 81 (1889)

V. uniflora (L.) var. *glabricapsula* Makino Bot. Mag. (Tokyo) 26 : 172 (1912).

V. xanthopetala Nakai, Bot. Mag. (Tokyo) 36 : 29 (1922).

V. conferta (Becker) Nakai, Bot. Mag. (Tokyo) 36 : 31 (1922).

Korean name : No-ang-jae-bee-koht (노랑제비꽃)

Caulous perennial herb. Pubescent normally on roots, leaves, stems, sometimes glabrous except on leaves. Cauline short, noded closely, straight. Rootstock thick, 1 to 5 cm. Secondary roots white, long, slightly swollen at base, stretches radially. Cauline erect, straight, around 5 to 15 cm long, dark brown. Leaves chartaceous, green, dentate with shallow furrow, acrodromous, teeth number; radical 12 to 13, first caulescent 9 to 10, second 7 to 8, third 5 to 6. Radical leaves 3 to 5, cordiform to broad-cordiform, around 2.5cm long, around 3cm wide, base lobate, blade 3cm wide, apex acute. Caulescent leaves 3 to 4, cordiform to ovate, almost opposite each other, first caulescent leaf petiole long, base undeveloped, apex acute; first leaf 2.8cm long, 3cm wide, second 2. 5cm long, 3cm wide. Flowering time between April and May. Flowers 1 to 3 per individual, spur short as no projection behind peduncle. Sepals 0.4 to 0.6cm long, appendages ovate. Petals yellow, oblong, entire, 0.7 to 1.0cm long, hairs inside the lateral petals. Ovary bell-shaped, clavate protuberances on the whole surface with the tallest 1500㎛. Stigma facial shaped with beards on lateral sides.

Distribution : Distributed almost to the top of the mountains in the middle part of the Korean peninsula.

Diagnosis : Nakai (1922) has regarded the species whose caulescent leaves come out apart from each other as *V. uniflora* L. and *V. orientalis* W. Becker, and then reported new species whose caulescent leaves come out almost at the same place as *V. xanthopetala* Nakai. Fu and Teng (1977) supported Nakai (1922). But, based on the observation in the natural habitat and glasshouse from March to July, this study confirmed that the first, second and third caulescent leaves come out closely together at the beginning of growth, then they gradually come out apart as time goes by according to differential patterns and degrees of growth of the caulescent leaves. Therefore, it is suggested that *V. xanthropetala* which Nakai described from herbarium specimens without observing them in their natural habitat, is *V. orientalis* at a different growth stage.

***Viola brevistipulata* (Franch. et Savat.) W. Becker,** Beih. Bot. Centralbl. Apt. II, 46 : 265 (1916), 36, 50 (1918).

V. pubescens var. *brevistipulata* Franch. et Savat., Enum. Jap. II. 288 (1879).

V. brevistipulata (Franch. et Savat.) var. *acuminata* Nakai, Bot. Mag. (Tokyo) 17 : 557 & 591 (1928).

V. lasiostipes Nakai, Bot. Mag. (Tokyo) 34 : 32 (1922).

Caulous perennial herb. Pubescent usually on roots, leaves, and petioles but sometimes absent. Rootstock longer than 2cm, sometimes branched, bends sideways with close-grained knots. Secondary roots brown, stretched horizontally. Cauline straightly erect, 5 to 25cm long, brown. Leaves reniform to cordiform, coriaceous or chartaceous, green. Flower dark yellow to yellow. Petals hairs inside of the lateral one. Spur very short, never reaches peduncle.

var. *brevistipulata*

Korean name : Turl-no-ang-jae-bee-koht (털노랑제비꽃)

Cauline 8 to 25cm long. Leaves chartaceous, green, reniform to cordiform, often fluffy, apex acuminate, length; first caulescent 3 to 4cm long, second 2 to 3cm, third 1 to 2cm. Teeth dentate, number; radical 14 to 15, first caulescent 14 to 15, second 10 to 11, third 7 to 8. Ovary bell-shaped, tapering rodlet protuberance only at upper part, less than about 1500㎛. Stigma facial shaped with beards on lateral sides.

Distribution : Distributed on alpine belts in Kangwon and Kyounggi province, Korea.

Diagnosis : This species was treated as a variety of *V. pubescence* because of the lack of hair on the whole plant compared to the *V. pubescence* var. *brevistipulata* Franch. et Savat. usually found in America (Franchet and Savatier, 1897). It also has a small stipule and is light green, then its status was later to *V. brevistipulata* (Franch. et Savat.) W. Becker (Becker, 1916). This species differs from *V. orientalis* by the feature of habits having both the branched rhizome and the tapering rodlet protuberance (Plate I-5, 6).

var. *minor* Nakai, Bot. Mag. (Tokyo) 97 : 260 (1933) *quoad specim. exloc typic, tantum;*

V. brevistipulata subsp. *minor* (Nakai) F. Maekawa et Hashimoto, J. Jap. Bot. 43 : 161 (1968).

V. kishidai Nakai, Bot. Mag. (Tokyo) 69 (1922).

V. flaviflora Nakai, J. Jap. Bot. 15 : 401 (1939)

Korean name : Hal-la-turl-no-ang-jae-bee-koht (한라털노랑제비꽃)

Cauline erect, 3 to 20cm long, brown. Leaves coriaceous, dark green with some brown. Teeth deep serrate to blunt, number; radical leaves II to 12, first caulescent leaf 10 to II, second 8 to 9, third 6 to 7. Radical leaves reniform and cordiform, number 4 to 6, 1.2 to 1.3cm long, 1.5 to 1.6cm wide, bases cordate to shallow auriculate, apex abtuse. Caulescent leaves cordiform, number 3 to 5, almost opposite, petiole shorter than leaf, apex acute to obtuse, first leaf 1.5cm long and wide, second leaf; 1.6cm long, 1.2cm wide. Petals yellow, oblong, 1.1 to 1.4cm long, hairs inside of the lateral petals. Calyx 0.4 to 0.6cm long, appendages semicircular. Spur very short, never reaches to peduncle. Cleistogamy, almost no petalsis. Ovaries bell-shaped, tapering rodlet protuberance only at upper part of ovary, less than 500㎛. Stigma facial shaped with beards on lateral sides.

Distribution : Distributed in Mt. Halla, Korea.

Diagnosis : This species is similar to *V. orientalis* in its morphology of above ground but is distinct from it because of its long and bent rhizome. In this study, it was found that this species is distributed in Mt. Halla, and has distinctively smaller leaves than other species in the section.

var. *laciniata* (Boiss.) W. Becker, Beih. Bot. Centralbl Abt. II, 34 : 266 (1916);

V. uniflora var. *laciniata* de Boissiew, Bull. Soc. Bot. Fr. 323 (1900); *V. xanthopetala* var. *laciniata* Takenouchi, Bot. Mag. (Tokyo) 46 : 187 (1932);

V. laciniata (Boiss.) Koidzumi, Act. Phyt. Geo. 7 : 113 (1938);

V. brevistipulata var. *brevistipulata* f. *laciniata* (Boiss.) F. Maekawa. Hara, Enum. Sper. Jar. 3 : 198 (1954).

Korean name : O-dae-turl-no-ang-jae-bee-koht (오대털노랑제비꽃)

Leaves chartaceous, green, cordiform to reniform. Teeth biserrate, erose, irregularly spaced, number; radical 16 to 17, first caulescent 17 to 18, second 11 to 12. Ovaries bell-shaped, tapering rodlet protuberance only at the upper part of ovray, less than 500㎛. Stigma facial shaped with beards on lateral sides as well as on the back.

Distribution : Distributed on alpine belts in Kangwon province, Korea.

Diagnosis : This species is described from Korea for the first time. It has irregular biserrate teeth, and has also more teeth than other species within the section *Chamaemelanium* (Plate 2, Table 3). A diagnostic character that has not been reported until now is the stigma with many beards on the back as well as on lateral sides (Plate I-8).

Discussion

Viola section *Chamaemelanium* has been regarded as a difficult group for taxonomic study because it is hard not only to identify from its relatives because of similarities in appearance, but also to circumscribe the boundary of species, because of the high variation among and within the species (Gingins, 1823; Melchior, 1925; Clausen, 1927). Furthermore, detailed studies on habitat-behavior are lacking, and their are many intermediate forms because of the high frequency of hybrids between relatives (Russell, 1960; Kim, 1987; Kim *et al.*, 1991). There are no congruent classification systems agreed between researchers.

The Korean members of the section have not been much studied, therefore the confirmation of the existence of the section including its habitats, remain unreported. There was also some confusion in choosing scientific names among researchers on the Korean flora (Kim, 1987). In this study, we conclude that there are two species and two varieties, *V. orientalis, V. brevistipulata* var. *brevistipula, V. brevistipulata* var. *minor* and *V. brevistipulata* var. *laciniata* in Korea.

Nakai (1922) thought this section had six species based on the features of the caulescent leaves, and he treated all of them as new species. For *V. xanthopetala,* he described the first caulescent leaves as developing out apart, and the second and the third developing out together at the same portion of the cauline in an opposite arrangement. He distinguished this species from *V. uniflora,* whose three caulescent leaves develop out all together on the same portion of the cauline, but treated this species as a synonym of *V. orientalis.* As a result of observation in natural habitats from March to July, this study found that three caulescent leaves developed out together at the beginning of growth but they gradually grew apart as time went on. So it was considered that using Becker's (1916) scientific name is more reasonable than Nakai's (1922), and this is further supported by the protuberances develped on the whole ovary. It is strongly suggested that the species reported as *V. xanthopetala,* therefore, is considered a synonym of *V. orientalis.*

Viola brevistipulata var. *brevistipulata* has been reported as a species which lives in the mountains of Korea (Park, 1974). This species had firstly been reported as *V. pubescens* var. *brevistipulata* because there is less hair on the whole plant than on *V. pubescens* which lives in Middle and South America (Franchet and Savatier, 1879). Its status was later raised to species level, *V. brevistipulata,*

by Becker (1916). Nakai (1922) studied the East Asian species of Violaceae, and named this taxon *V. lasiostopes*, and reported that it is similar to *V. glabella* and different from *V. fischeri* of Siberia and *V. brevistipulata* of East and South Asia because it has differently shaped caulescent leaves, degree of hair development, length of peduncle and shape of the marginal teeth. Additionally, the surface sculpturing of pollen grains provides a good basis for distinguishing it from others within the section, because this is a little swollen on the foveolate pollen (Plate III-6).

Viola brevistipulata var. *minor*, was reported by Nakai (1933), and is similar to *V. orientalis* in its appearance but differs from it because of its long and horizontally bent rhizome. Meanwhile, Maekawa and Hashimoto (1963, 1968) have reported this species as *V. brevistipulata* subsp. *minor* but had not performed a taxonomic study including the description and identification nor had they formal described the taxon, so it is difficult to discuss their results in this study. In this study, the species is considered distinctive because of its long and horizontally bent rhizome, distinctively smaller leaves than other species of this section (Tables 2, 3), and coriaceous and sinuate teeth (Plate II-2, 6, 10, 14).

There has been no report of whether or not *Viola brevistipulata* var. *laciniata* grows in Korea. Boissieu (1900) named it *V. uniflora* var. *laciniata* because the teeth of the leaves are sharper and irregular and the furrow is more deeply separated than *V. uniflora*, and later Becker called the taxon, found especially in East Asia *V. brevistipulata* var. *laciniata*. Takenouchi (1932) has reported it as *V. xanthopetala* var. *laciniata* following Nakai but it is hard to consider it as *V. xanthopetala* based on the results from this study. In particular, *V. orientalis* and *V. brevistipulata* cannot be treated as the same species because their rhizome and ovary morphology is clearly distinguishable from one another. This species has notably more teeth than other species of the same section (Table 3) and is easily distinguished because the protuberances of the stigma are developed on the back of the stigma as well as on the lower part of both sides (Plate I-8).

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Literature Cited

Becker, W. 1916. Violae Asiaticae et Australenses. Beih. Bot. Centralb. Abt II 34 : 264-266.

_____. 1925. *Viola, In* A. Engler, K. Prantl, 2nd eds., 21 Bd. Die Naturlichen Pflanzen familien, Pp. 363-376.

Boissien, D. 1900. Plantes du Japon. Bull. Soc. Bot. France 47 : 316-323 (in French).

Chung, T. H. 1957. Flora of Korea. II. Shinjisa, Seoul (in Korean).

_____. 1959. A key of the species of Violaceae. Kor. J. Bot. 2 : 25-26 (in Korean).

Clausen, J. 1927. Chromosome number and the relationship of species in the genus *Viola*. Ann. Bot. 41 : 677-714.

Erdtman, G. 1952. Pollen morphology and plant taxonomy. *In* Almquist, Wiksell, eds, Angiosperm, Stockholm.

_____. 1960. The acetolysis method. Sven. Bot. Tidskr. 54 : 561-564.

Fu, P. Y. and Y. C. Teng. 1977. Flora Plantarum Herbacearum Chinae Boreali-Orientalis, Tomus 6. Sci Pulbl, Beijing, Pp. 79-129.

Franchet, A. and L. Savatier. 1879. Enumeratio Plantarum Japonicarum II. p. 288.

Gingins, F. 1823. Memoire sur la Famille des Violacees. Memoires de la societe de Physique et D'Histoire Naturelle de Geneve 2 : 1-29.

Hashimoto, T. 1967. Violets of Japan. Shibundo-shinko-sha, Tokyo (in Japanese).

Hickey, L. J. 1973. Classification of the architecture of dicotyledons leaves. Amer. J. Bot. 60 : 17-33.

Ishidoya, T. 1929. Review of *Viola* from Korean and Manshuria. J. Chosen Nat. Hist. Soc. 8 : 15-17.

Kim, K. 1987. Studies of comparative morphology on the Korean *Viola* species. Ph. D. thesis, Sung Kyun Kwan University, Seoul (in Korean).

_____, B. Y. Sun, S. S. Whang and G. H. Chung. 1991. Biosystematic study on the genus *Viola* in Korea-Comparative morphology of the Viola albida complex. Kor. J. Bot. 34 : 229-238 (in Korean).

Lee, T. B. 1969. Plant resources on Korea. Bull. Seoul. Nat. Univ. (Biol. Agr.) 20 : 158-159 (in Korean).

_____. 1980. Illustrated Flora of Korea. Hyangmunsa, Seoul. Pp. 556-557 (in Korean).

Linnaeus, C. 1753. Species Plantarum. p. 936.

Maekawa, F. 1954. Violaceae. *In* Enumeratio Spermatophytraum Japonicum. III. Hara, H. (ed), Iwanami, Tokyo, Pp. 197-211.

_____ and T. Hashimoto. 1963. Violets of Japan : 2. Shibundo-shinko-sha, Tokyo, Pp. 1-9.

Maekawa, F. and T. Hashimoto. 1968. Nomenclatural treatments for the violets of Japan. J. Jap. Bot. 43 : 161-163 (in Japanese).

Makino, T. 1912. Observations on the Flora of Japan. Bot. Mag. (Tokyo) 26 : 148-158.

Maximowicz, C. J. 1877. Diagnoses plantarum novarum asiaticarum. Bull. Acad. Imp. Sci. St. Pettersb 23 : 336-337.

_____. 1889. Enumeratio Plantarum hueusque in Mongolia nec non adjuscente parte Turkestaniae senenses Lectum (Flora Mongolica) I. p. 81.

Melchior, H. 1925. Die Phylogentische Entwicklung der Violaceen und die Naturlichen vervantschaftverhaltnisse ihrer gattungen. *In* Repertorium specierum novarum regni vegetabilis, Beitrage zur systematik und pflanzengeographie, Vol. 2, Repertoriums, Fedde, F. (ed), Dahlem, Berlin, Pp. 83-125.

Nakai, T. 1909. Flora Koreana I. J. Coll. Sci. Imp. Univ. Tokyo 26 : 62-74.

_____. 1911. Flora Koreana II. J. Coll. Sci. Imp. Univ. Tokyo 31 : 445-447.

_____. 1914a. Plantae novae Japonicae et Koreanae III. Bot. Mag. (Tokyo) 28 : 326-334.

_____. 1914b. Chosen Shokubustsu. Seibi-do, Tokyo, p. 120.

_____. 1916. Viola coreanae. Bot. Mag. (Tokyo) 30 : 276-289.

_____. 1919. Notulae ad Plantas Japoniae et Korea XIX. Bot. Mag. (Tokyo) 33 : 1-11.

_____. 1922. Violae Novae Japonicae. Bot. Mag. (Tokyo) 34 : 29-33.

_____. 1928. Violae ad Floram Japonicam Novae. Bot. Mag. (Tokyo) 42 : 556-566.

_____. 1933. Notulae ad Plantas Japonicae et Korea XLIII. Bot. Mag. (Tokyo) 47 : 235-267.

_____. 1974. Key to the herbaeous plants in Korea (Disotyledoneae). Jeong-um-sa, Seoul, Pp. 272-279.

Palibin, J. 1899. Conspectus Florae Korea I. Acta Horti. Petrop. 17 : 30-36.

Park, M. K. 1949. An enumeration of Korean plants. Ministry of Education,

Seoul, Pp. 160-164 (in Korean).

Russell, N. H. 1960. Studies in the photoperiodic responses of violets (*Viola*). The Southwestern Naturalist 5 : 177-186.

Takenouchi, M. 1932. On the new variety of *Viola xanthopetala*. Bot. Mag. (Tokyo) 46 : 587.

_____. 1955. Brief notes on the taxonomy, ecology and geographic distribution of species of *Viola* indigenous to Manchuria and Inner-Mongolia. Sci. Contr. Tung-pei Teach. Univ. 5 : 65-95.

Explanation of Plates

Plate I. SEM micrographs of the stigma and ovary of *Viola* section *Chamaemelanium* in Korea (×20−50). 1, 2. *Viola orientalis*; 3, 4. *Viola brevistipulata* var. *minor*; 5, 6. *Viola brevistipulata* var. *brevistipulata*; 7, 8. *Viola brevistipulata* var. *laciniata*.

Plate II. Silhouette of the leaves of *Viola* section *Chamaemelanium* in Korea (Scale bar=3cm). 1, 5, 9, 13. *Viola orientalis*; 2, 6, 10, 14. *Viola brevistipulata* var. *minor*; 3, 7, 11, 15. *Viola brevistipulata* var. *brevistipulata*; 4, 8, 12, 16. *Viola brevistipulata* var. *laciniata*.

Plate III. SEM micromorphs of the pollen grain and their surface sculpturing of *Viola* section *Chamaemelanium* in Korea (×2,000−20,000). 1, 2. *Viola orientalis*; 3, 4. *Viola brevistipulata* var. *minor*; 5, 6. *Viola brevistipulata* var. *brevistipulata*; 7, 8. *Viola brevistipulata* var. *laciniata*.

Plate Ⅰ.

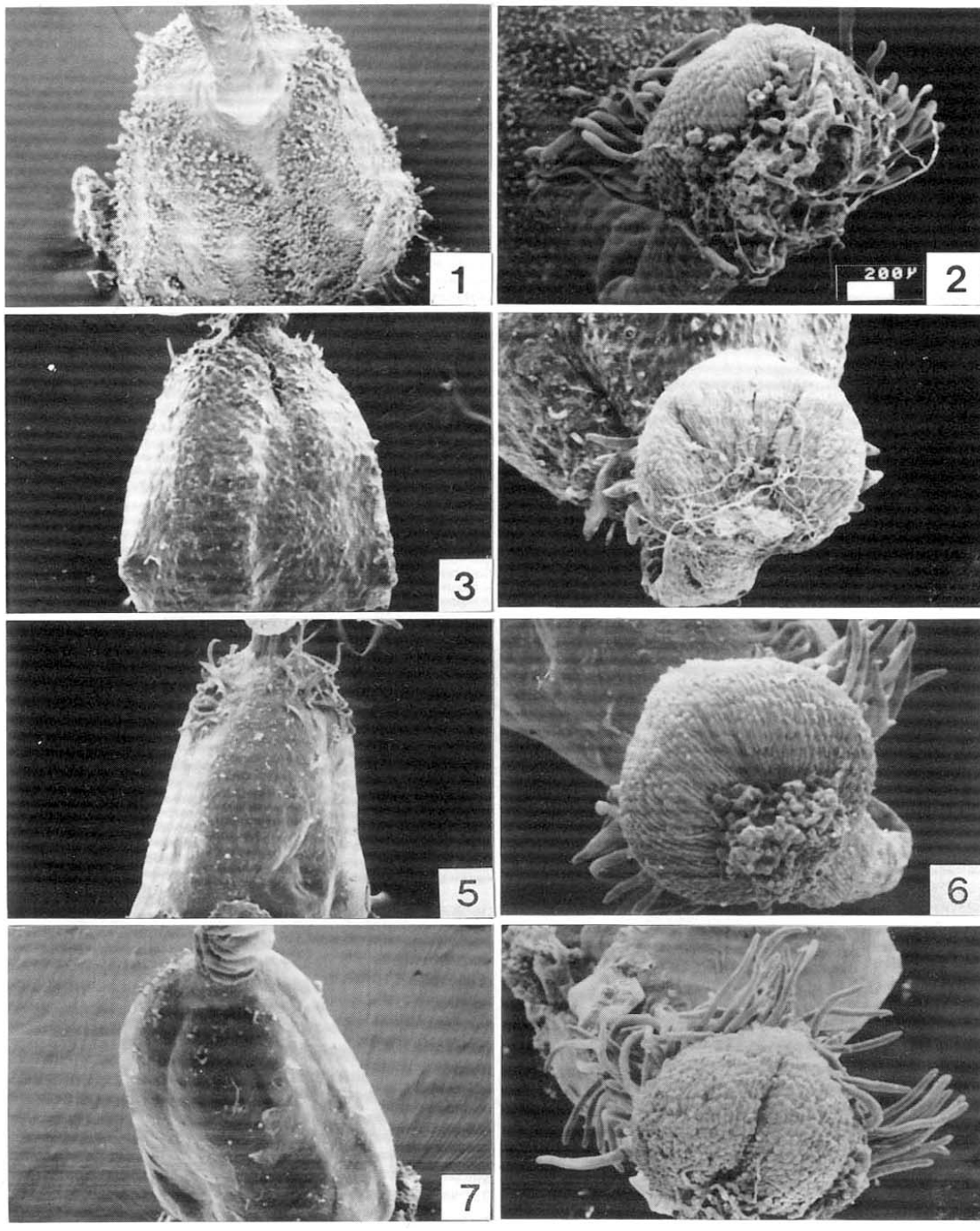


Plate II.

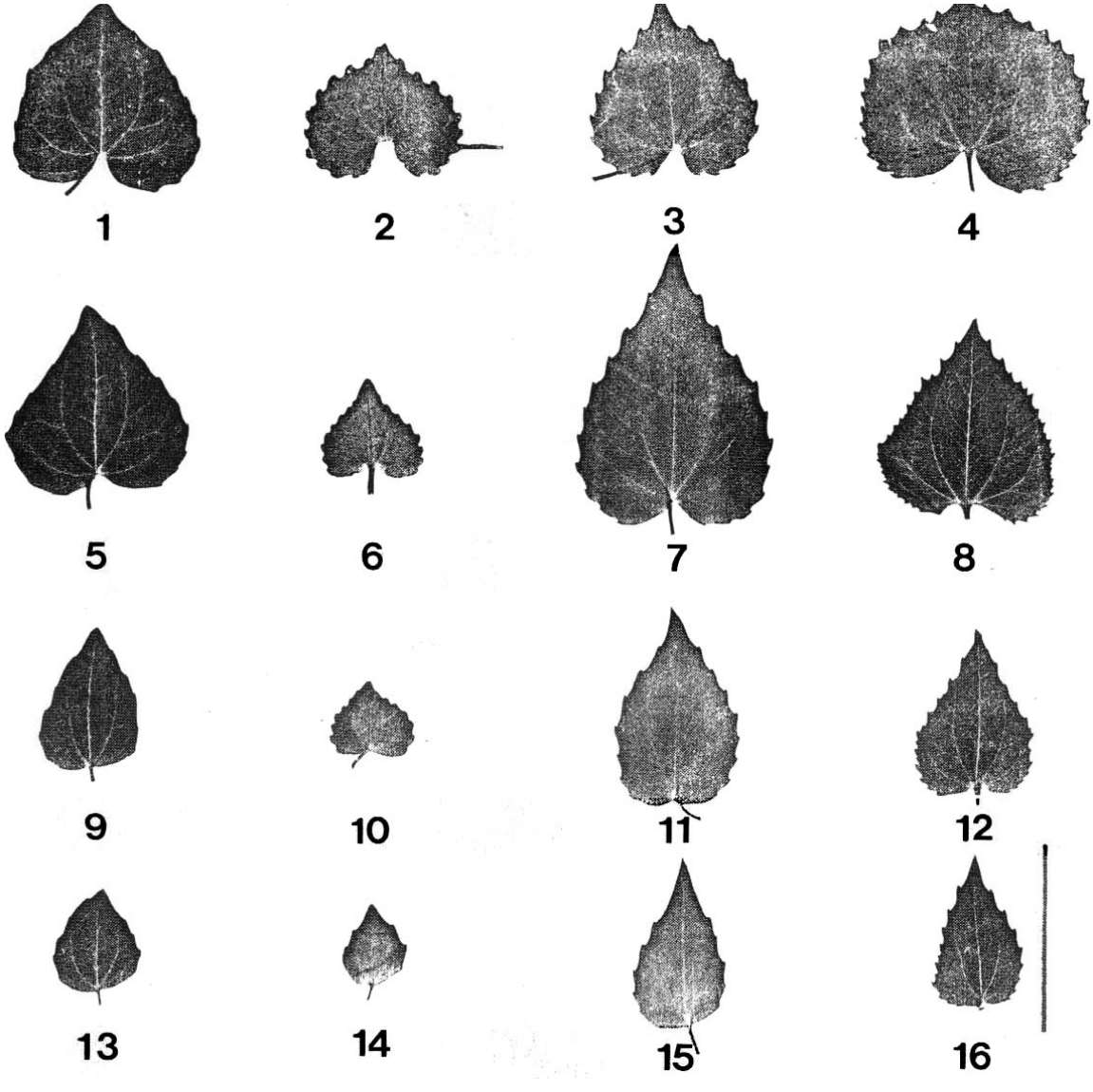
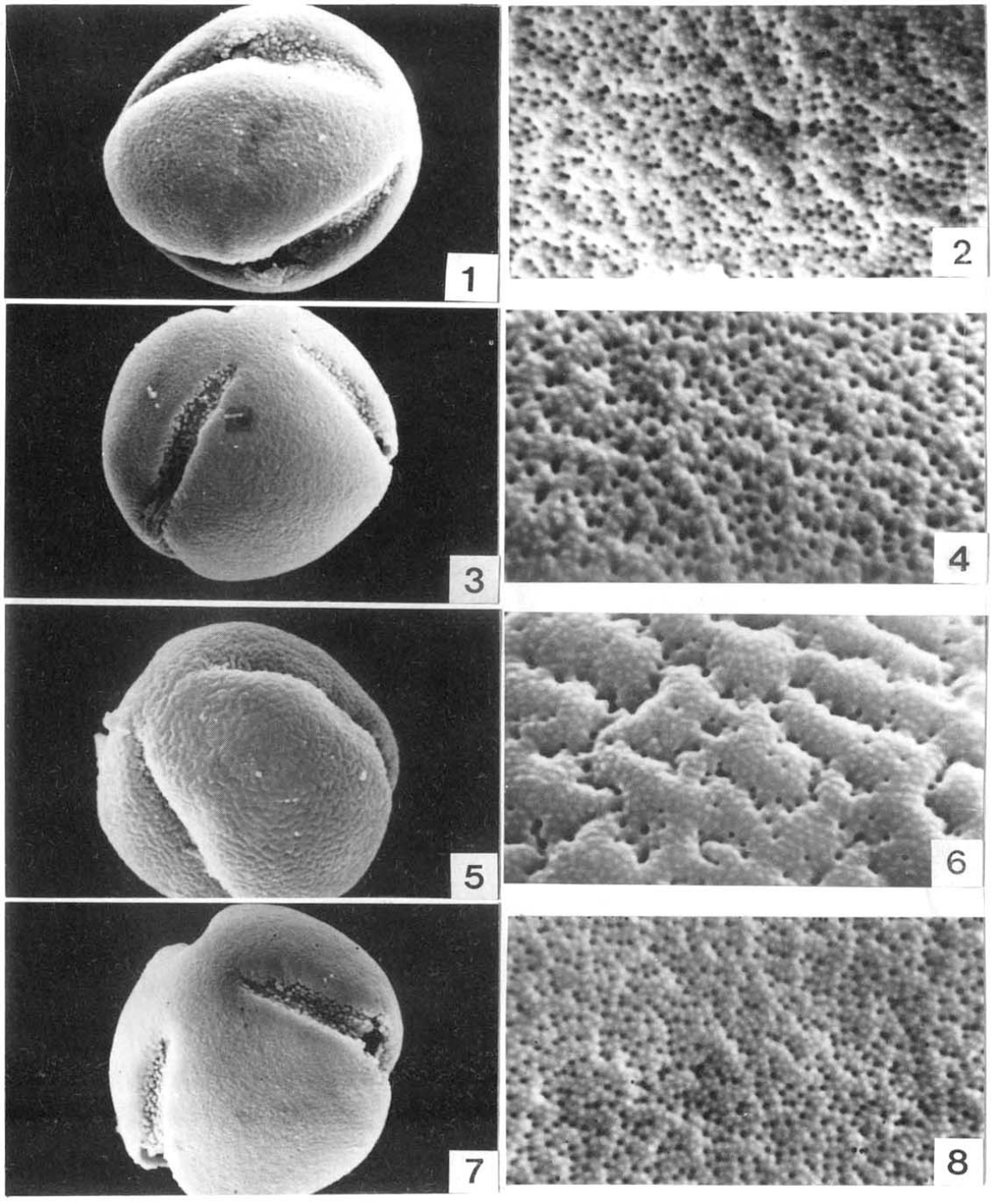


Plate III.



한국산 제비꽃속 노랑제비꽃절의 분류학적 연구 —형태학적 형질을 중심으로

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한국산 제비꽃속 노랑제비꽃절 (*Viola* section *Chamaemelanium*) 식물에 대해 광학현미경 및 전자현미경을 사용하여 형태 분류학적 연구를 수행하였다. 지하경과 지상경의 특징, 자방 돌기 그리고 주두의 모양과 돌기 등의 특징에 의해 *V. orientalis*와 *V. brevistipulata*가 구별되었다. 나아가 후자는 잎의 특징에 따라 3 변종 즉 var. *brevistipulata*, var. *minor* 그리고 var. *laciniata* 등으로 세분되었다. *Viola brevistipulata* var. *laciniata*는 거치 수가 가장 많고, 불규칙한 치상의 복거치를 갖는다. 그러나 다른 두 변종은 규칙적인 파상 또는 치상의 거치를 갖는다. 세 변종간 잎의 크기는 *V. brevistipulata* var. *brevistipulata*가 가장 크고 *V. brevistipulata* var. *minor*가 가장 작다. 이들 중 *V. brevistipulata* var. *laciniata*는 한국 미기록 종이다. 또한 자방과 주두에 발달된 돌기물의 모양 및 배열양상은 본 절내 종을 동정할 때 중요한 표징형질로 확인되었다.

주요어 : 형태, 분류, 제비꽃속, 노랑제비꽃절

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