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Multivariate analyses of the *Scutellaria pekinensis* complex (Labiatae) in Korea

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The taxonomy of the *Scutellaria pekinensis* complex has been ambiguous and problematic, because morphological characters are variable. To elucidate the taxonomic structure of the Korean taxa belonging to the complex, 29 characters were measured from 99 individuals collected from 96 localities and analyzed by factor analysis, cluster analysis, and discriminant analysis. The results supported the recognition of four infraspecific taxa of *S. pekinensis* Maxim. in Korea: var. *ussuriensis* (Regel) Handel-Mazzetti, var. *alpina* (Nakai) Hara, var. *transitra* (Makino) Hara, and var. *maxima* S. Kim et S. Lee. Key characters distinguishing the four varieties were inferred on the basis of multivariante analyses.

Keywords: *Scutellaria pekinensis* complex, multivariate analyses

Since *Scutellaria pekinensis* Maximowicz (1859) was described from China, several closely related taxa including *S. japonica* var. *ussuriensis* Regel (1861), *S. transitra* Makino (1904), *S. glechomaefolia* Léveillé & Vaniot (1910), *S. multibrachiata* Léveillé & Vaniot (1910), *S. fauriei* Léveillé & Vaniot (1910), and *S. japonica* var. *alpina* Nakai (1911) were reported. These taxa, so-called the *S. pekinensis* complex, are distributed in deep or semiopened forests in China, Korea, and Japan (Makino, 1963; Wu & Li, 1977). They share common features and are well distinguished from *S. indica* by the angle of the flower axis to the peduncle, the shapes of leaf margin and apex, the length and density of trichomes on leaves and stems, and the maturity of epicalyx protrusion (scutellum) at the time of full blooming (Iwatsuki *et al.*, 1993; Kim & Lee, 1995a).

Most taxa in the *S. pekinensis* complex, however, exhibit extreme variations in external features, and their taxonomic delimitations have been ambiguous and problematic. Kudo (1929) treated *S. japonica* var. *ussuriensis* as an independent species *S. ussuriensis*, *S. japonica* var. *alpina* as *S. ussuriensis* var. *ussuriensis* f. *alpina*, *S. transitra* as *S. ussuriensis* var. *transitra*, and treated both *S. glechomaefolia* and *S. multibrachiata* as synonyms of *S. fauriei*. Hara (1948) treated all above mentioned taxa as three varieties of *S. pekinensis*: var. *transitra*, var. *ussuriensis*, and var. *alpina*. Nakai (1952), on the other hand, recognized *S. dentata*, *S. fauriei*, and *S. transitra* as independent species, whereas merged *S. ussuriensis* var. *ussuriensis* f. *alpina* Kudo (1929) and *S. pekinensis* var. *alpina* Hara (1948) into *S. dentata* var. *alpina*.

The number of *Scutellaria* taxa distributed in the Korean peninsula, was uncertain because no taxonomic study was focussed on it. Chung (1965) and Lee (1980) included several taxa of the *S. pekinensis* complex in their works, however, the number of taxa and their names were not concordant between them. Chung (1965) included five taxa belonging to the *S. pekinensis* complex following Nakai (1952): *S. dentata*, *S. dentata* var. *alpina*, *S. fauriei*, *S. japonica*, and *S. transitra*. Lee (1980), however, included only three taxa: *S. pekinensis* var. *transitra* and *S. pekinensis* var. *ussuriensis* following Hara (1936), and *S. fauriei* following Nakai (1952). Recent study of Kim & Lee (1995a) showed that four taxa belonging to the complex are distributed in the Korean peninsula: *S. pekinensis* var. *ussuriensis* (Regel) Handel-Mazzetti, var. *alpina* (Nakai) Hara, var. *transitra* (Makino) Hara, and var. *maxima* S. Kim et S. Lee.

The present study aims to search for the taxonomic structure (*sensu* Sneath & Sokal, 1973) of the *S. pekinensis* complex in Korea by reinvestigating previously utilized morphological characters (Kim

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and Lee, 1995a) and by analyzing the data with multivariate techniques such as factor analysis, cluster analysis, and discriminant analysis. In this study, we expect to elucidate grouping patterns of individuals and find out the characters distinguishing groups within the complex.

MATERIALS AND METHODS

Materials used in this study included individuals collected by the authors from 1989 to 1993, and herbarium specimens deposited in the herbaria including Sung Kyun Kwan University (SKK), Seoul National University (SNU), Korea University (KSU), Kang Won National University (KWNU), and Ehwa Women's University (EWU).

Measurements were taken from 99 individuals collected from 96 localities (Appendix). From there specimens, 29 morphological characters (Table 1, Fig. 1) were measured. The characters, which were regarded taxonomically important but not quantitatively measurable (e.g. curvedness of floral tube, swelling status of rhizome internode, pollen and fruit morphology observed by SEM), were not included in the analyses.

Factor analysis was performed by Varimax rotation (Gorsuch, 1974), and projections of OTUs onto the factor axes were obtained from the first six eigenvactors associated with eigenvalues greater than 1.0, as recommended by Bird and Goodman (1977). Three factors with highest eigenvalues were used to draw a three-dimensional scatter diagram. In cluster analysis, factor loading values were used to calculate similarities among OTUs by Euclidean distance and to construct a dendrogram by an unweighted pair group meth-

Table 1. Morphological characters of Korean *Scutellaria pekinensis* complex for multivariate analyses

Character No.	Description [unit]
1.	Plant height [mm]
2.	Length of the leaf blade axis of the largest leaf [mm]
3.	Length of the leaf blade between the tip and the base [mm]
4.	Length from the leaf tip to the most broad part [mm]
5.	Length of petiole [mm]
6.	Width of the largest leaf [mm]
7.	Width of the largest tooth base between the two sinuses [mm]
8.	Width of the largest tooth base between the sinus and the tip [mm]
9.	Height of the largest tooth [mm]
10.	Number of teeth in the largest leaf [number]
11.	Length of flower tube [mm]
12.	Length of pedicel [mm]
13.	Length of lower sepal at the flowering time [mm]
14.	Length of lower sepal at the fruiting time [mm]
15.	Angle between the first tooth tips of both sides and the leaf tip ["]
16.	Angle between the first tooth sinuses of both sides and the leaf tip ["]
17.	Angle of the basal part of flower tube to the calyx axis ["]
18.	Number of hairs on the upper surface of the largest leaf per 9 mm^2
19.	Number of hairs on lower surface of the largest leaf per 9 mm^2
20.	Number of hairs on the half side of stem per 1 mm
21.	Length of hairs on the upper surface of leaf [mm]
22.	Ratio of leaf axis length / leaf width (2/6)
23.	Ratio of leaf axis length / petiole length (2/5)
24.	Ratio of leaf axis length / length from the broadest part to the tip (2/4)
25.	Leaf base condition (2/3)
26.	Ratio of width of the tooth base / tooth height (7/9)
27.	Ratio of width of the tooth base between the sinus and the tip / that between two sinuses (8/7)
28.	Ratio of leaf length / number of teeth (2/10)
29.	Angle of leaf tip ((15+16)/2)

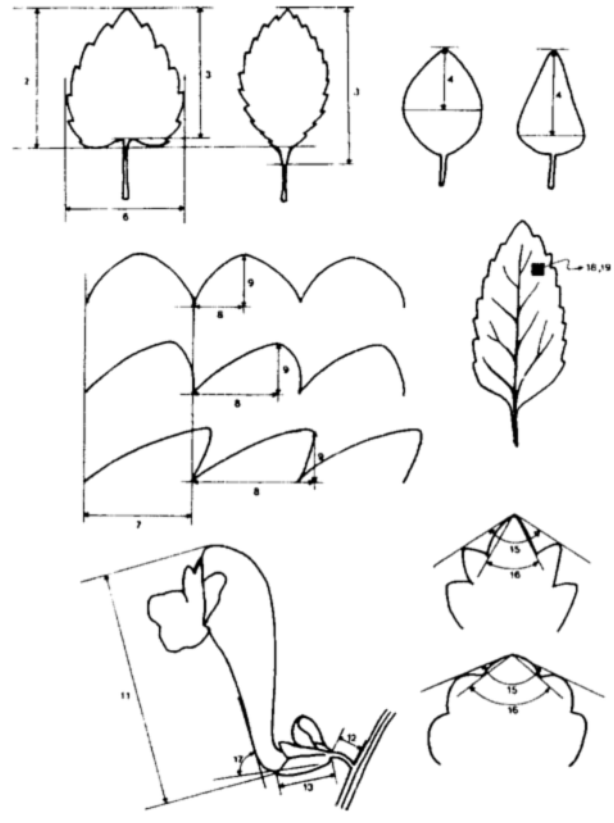

Fig. 1. Representative characters measured for the numerical analyses of the *Scutellaria pekinensis* complex in Korea. Names of each numbered character are shown in Table 1.

ods using arithmetic average (UPGMA). This method was employed by Blackith and Reyment (1971) and Goodman (1972) for eliminating character correlations and reducing the dimensionality of the data. A discriminant analysis was conducted to find good characters discriminating the clusters, to get discriminant functions, and to identify unclustered OTUs by the simultaneous method (Reynolds and Crawford, 1980). Some characters important in discriminating the clusters were exhibited with size range diagrams of individual characters. All those calculations were performed on an IBM PC with the programs of SPSSPC+ (ver. 4.01) and SASGRAPH (ver. 6.01).

RESULTS

The factor loading values from factor analysis of 29 morphological characters using 99 OTUs were listed in Table 2. The first six factors accounted for 74.2% of the total variance. In the first factor, important characters, of which factor loading values were over 0.5, were plant height (C1), length of flower (C11), length of lower sepal (C13, 14), density of hairs on the surface of leaves and stem (C18-20), ratio of leaf length/petiole length (C23), and leaf base condition (C25). In the second factor, important characters were leaf size, shape and margin (C2-9, 24, 28). In the third factor, important characters were angle between the first tooth tips at both side of margin and the leaf tip (C15), angle between the first sinuses (C16), ratio of leaf length/width, and angle of leaf tip (C29).

The OTUs were plotted in the three-dimensional diagram using the first three factors (Fig. 2). The diagram showed that 99 OTUs were grouped into four groups. Four symbols represented four groups derived from the cluster analysis (Fig. 3) by factor loading values to factor axes. However, circles enclosing

Table 2. Loadings of 29 morphological characters for the first six factors from the analysis of 99 individuals of the *Scutellaria pekinensis* complex in Korea

Character No.	FACTOR1	FACTOR2	FACTOR3	FACTOR4	FACTOR5	FACTOR6
C1	.76338*	.29629	.09162	.29592	.06846	-.08522
C2	.39518	.73324*	.04791	.51028	.05774	.09268
C3	.46455	.68046*	.08871	.50467	.08336	.08853
C4	.38202	.71774*	.04424	.54178	.02569	-.08349
C5	-.24821	.73116*	.10259	.20451	.18611	-.15739
C6	.33151	.71197*	.26647	.49753	-.00228	-.06660
C7	.01684	.91271*	.05438	.14248	.10358	-.11165
C8	-.08671	.86070*	.08302	.15279	.04854	.12692
C9	-.11922	.64779*	.10016	.05256	-.63784	-.08300
C10	.43888	.21065	.14776	.77364	.19856	.02579
C11	.77385*	.24365	.16461	.22113	-.07320	.02903
C12	-.05301	.08987	-.23827	-.17094	-.55535	-.04416
C13	.63032*	.30516	.31248	.08166	.03542	.07768
C14	.69594*	.11346	.09344	.03340	-.06630	-.06446
C15	.17673	.04714	.88589*	.15094	-.08409	.03422
C16	.25834	.19538	.75172*	.02883	.27489	.05965
C17	.41019	.19411	-.00097	.14042	.31728	.11274
C18	.72343*	-.32627	.02132	-.08388	.21262	-.02383
C19	.87472*	-.15190	.12386	.10412	.10861	-.13147
C20	.78404*	-.04944	.14490	-.00584	.17987	.00423
C21	.07715	.24281	.08552	.61450	.02430	-.10897
C22	.36965	.28519	-.53420*	.12275	.19616	.48402
C23	.72405*	.04493	-.14178	.31276	-.11627	.27235
C24	.07627	.05369*	.00333	-.16913	.12818	.77424
C25	-.67284*	.10526	-.15802	-.15772	-.31543	.07517
C26	.16330	.26895	-.04834	-.03571	.83952	-.06015
C27	-.26398	-.17256	.14607	.06801	-.15796	.64505
C28	.09123	.75732*	-.09800	-.32792	-.25505	.12619
C29	.24351	.13377	.92504*	.10361	.10060	.05239
Eigenvalue	9.71850	4.78298	2.56214	1.77146	1.51001	1.17644
% of variance	33.5%	16.5%	8.8%	6.1%	5.2%	4.1%

*Characters significantly loaded to factor 1, 2, 3.

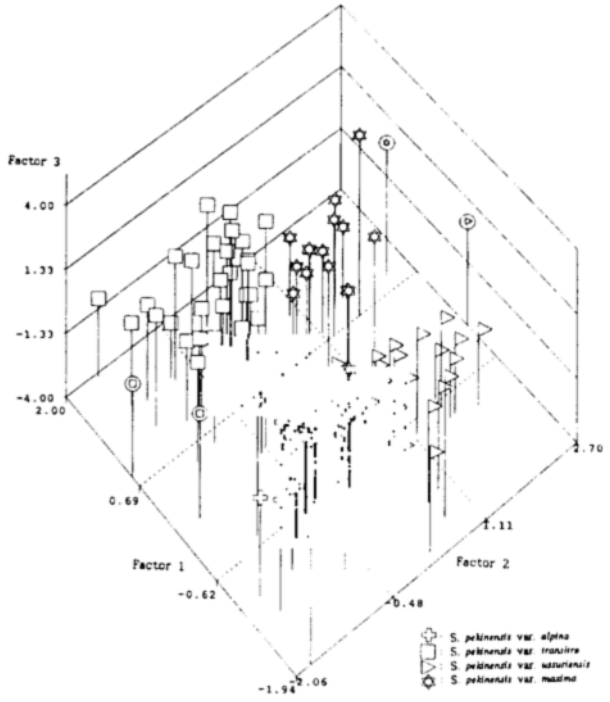

Fig. 2. Three-dimensional scatter plot of the *Scutellaria pekinensis* complex in Korea by factors 1 to 3. Each symbol depicts each OTU. Circles indicate the OTUs which are loosely clustered in the cluster analysis (Fig. 3). The symbols inside circles follow the groups obtained by a discriminant analysis.

the symbols depicted the asterisked OTUs (43, 62, 81, 87) which appeared clustered loosely or distantly to their neighbors in the cluster analysis (Fig. 3). The four groups in the plot correspond to *S. pekinensis* var. *alpina* (A), var. *transitra* (T), var. *ussuriensis* (U), and var. *maxima.* (M). In gross morphology, *S. pekinensis* var. *maxima* is very similar to *S. pekinensis* var. *transitra,* but factor analysis showed that the two taxa are well-distinguished by factor 2 which is primarily related to size of leaves, petioles, and teeth.

To clarify the distinction of the four groups derived by factor and cluster analyses, discriminant analysis was conducted. The OTUs loosely connected to the four varieties (OTUs 43, 62, 81, 87) were excluded to obtain discriminant functions. The results from the analysis were summarized as follows: Characters significantly representing the first three discriminant functions (Table 3) were almost same as those in the factor axes; Four OTUs, marked X (Fig. 4a) were classified as three varieties (Fig. 4b) by discriminant function. The discriminant analysis was possible to classify the four groups with

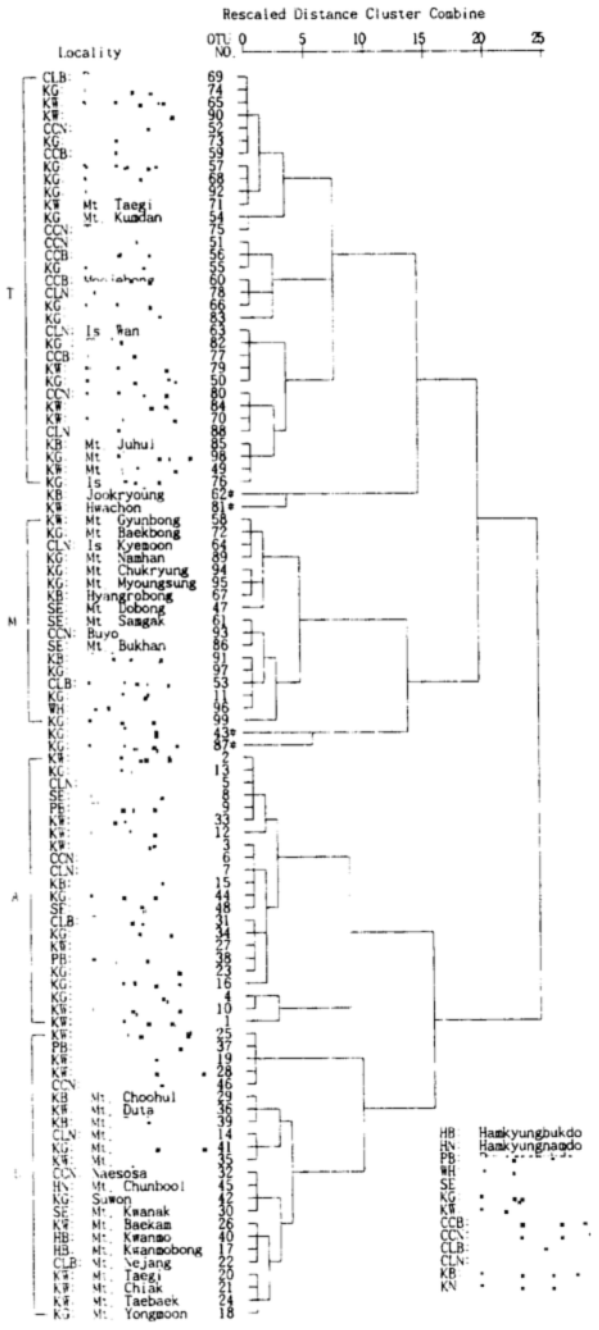

Fig. 3. Phenogram of 99 OTUs of the *Scutellaria pekinensis* complex in Korea derived from the UPGMA cluster analysis. The factor scores from the factor analysis were used to calculate the similarities. (T: *S. pekineisis* var. *transitra*, M: *S. pekineisis* var. *maxima*, A: *S. pekinensis* var. *alpina*, U: *S. pekinensis* var. *ussuriensis*. *: ungrouped OTU).

96.84% correctness (Table 4).

The discriminant analysis exhibited that the individuals were divided into two groups by the func-

Table 3. Pooled-within-groups correlations between discriminating variables and discriminant functions of the *Scutellaria pekinensis* complex in Korea. Variables are ordered by the absolute values of correlation within each function

Character No.	Function 1	Function 2	Function 3
C19	.55774*	-.10830	-.18423
C20	.41670*	-.00586	.00834
C1	.34500*	.23658	.15824
C25	-.34144*	.00391	.01630
C11	.32024*	.11245	-.00661
C18	.29752*	-.13537	-.12556
C23	.27732*	.03211	-.25990
C13	.23244*	.10872	.15392
C14	.20927*	-.00671	.03141
C16	.18672*	.14852	.02815
C12	-.09023*	-.05527	-.05548
C7	-.01848	.65319*	.04338
C6	.14203	.57207*	.20522
C2	.17779	.56779*	.05100
C3	.22110	.54940*	.08825
C4	.19226	.54248*	.02974
C8	-.05557	.54045*	.02444
C5	-.11112	.48873*	.07740
C10	.19960	.32361*	-.00760
C28	-.05184	.26991*	-.01756
C21	.06749	.23963*	-.07731
C26	.05176	.23034*	.03963
C9	-.05691	.21849*	-.02622
C17	.15445	.17307*	-.04425
C27	-.06421	-.11055*	.06676
C24	-.03770	.05151*	-.01447
C22	.08825	.07129	-.31814*
C15	.03741	.04593	.18813*
C29	.12312	.10752	.12682*
Eigenvalue	10.8295	4.4604	1.3199
% of variance	65.20%	26.85%	7.95%

tion 1: (1) *S. pekinensis* var. *alpina* and *S. pekinensis* var. *ussuriensis* having almost glabrous leaves and stems (C19, 20), short to medium plant height (C1), and small flowers (C11); (2) *S. pekinensis* var. *transitra* and *S. pekinensis* var. *maxima* having pubescent leaves and stems (C19, 20), medium to long plant height (C1) and large flowers (C11). It was shown that the two groups were sharply distinguished by C 19 and C20 (Figs. 5a, b) but slightly overlapped by C1 and C11 (Figs. 5c, d).

The two taxa in each group were subdivided by the function 2 in which the size of leaves (C2-4, 6) and margin teeth (C7) were important. As these characters were compared individually, differences between *S. pekinensis* var. *alpina* and var. *ussuriensis* and between var. *transitra* and var. *maxima* were conspicuous but slightly overlapped in C2, 3, 4, 6 (Figs. 6a-d) and 7 (Fig. 6e).

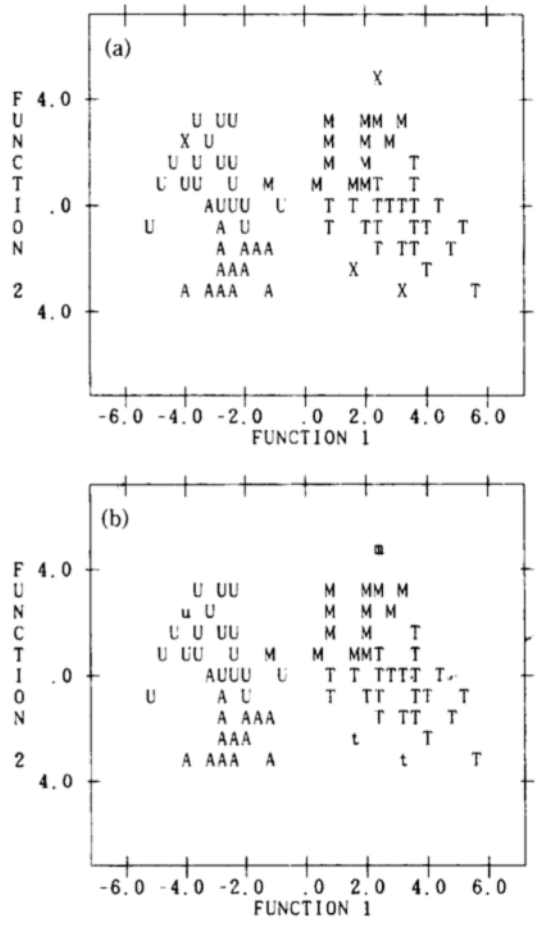

Fig. 4. Plot of the *Scutellaria pekinensis* complex in Korea by discriminant function 1 and 2 from the discriminant analysis. (A: *S. pekinensis* var. *alpina*, T: *S. pekinensis* var. *transitra*, U: *S. pekinensis* var. *ussuriensis*, M: *S. pekinensis* var. *maxima*, X: ungrouped OTU in the cluster analysis, m, u, t: ungrouped OTU which are discriminated by discriminant function).

Table 4. Classification result of discriminant analysis of the Korean *Scutellaria pekinensis* complex by simultaneous method

Actual Group	No. of Cases	Predicted Group Membership			
		A	T	U	M
Group A	22	22	0	0	0
		100.0%	.0%	.0%	.0%
Group T	33	0	33	0	0
		.0%	100.0%	0%	.0%
Group U	24	2	0	22	0
		8.3%	0%	91.7%	.0%
Group M	16	0	0	1	15
		.0%	0%	6.3%	93.8%
Ungrouped Cases	4	0	2	1	1
		.0%	50.0%	25.0	25.0%

Percent of "grouped" cases correctly classified: 96.84%

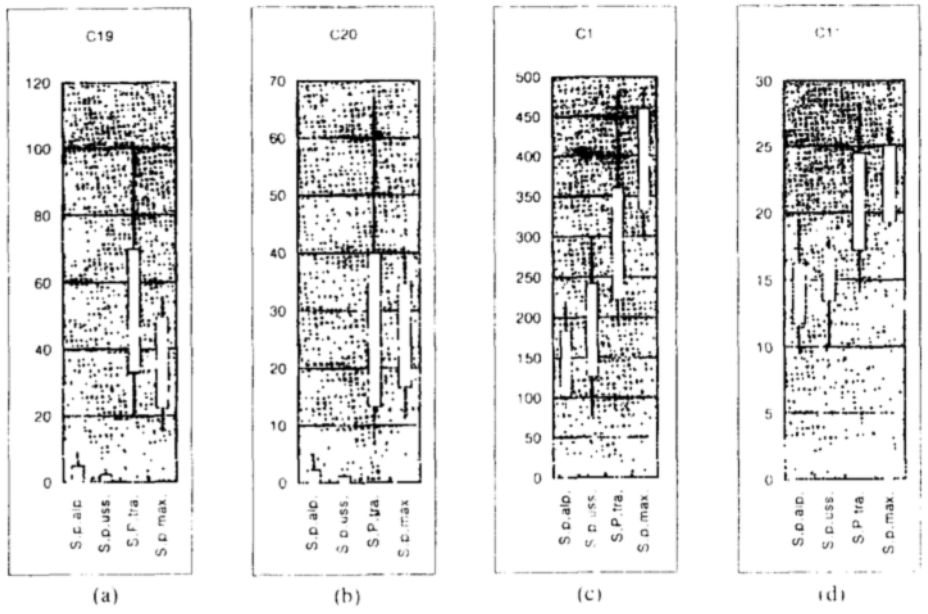

Fig. 5. Size range diagrams of characters well discriminating the groups by function 1 in the discriminant analysis of the Korean *Scutellaria pekinensis* complex. Bars indicate standard deviations. (a) Number of hairs on lower surface of the largest leaf per 9 mm^2 (C19). (b) Number of hairs on the half side of stem per 1 mm (C20). (c) Plant height [mm] (C1). (d) Length of flower tube [mm] (C11).

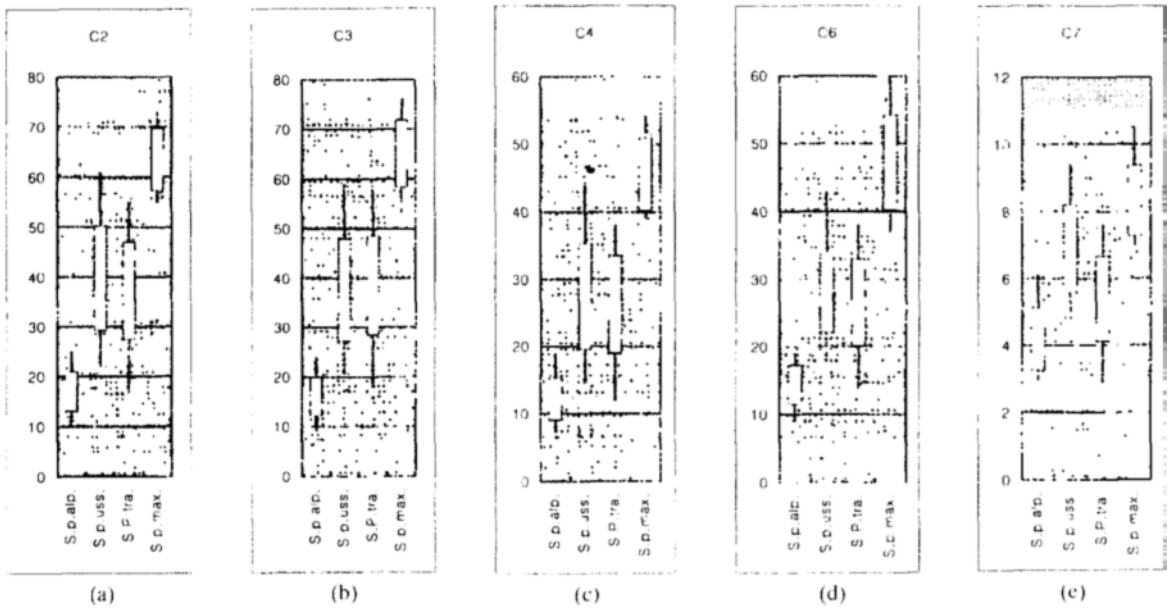

Fig. 6. Size range diagrams of characters well discriminating the groups by function 2 in the discriminant analysis of the Korean *Scutellaria pekinensis* complex. Bars indicate standard deviations. (a) Length of the leaf blade axis of the largest leaf [mm] (C2). (b) Length of the leaf blade between the tip and the base [mm] (C3). (c) Length from the leaf tip to the most broad part [mm] (C4). (d) Width of the largest leaf [mm] (C6). (e) Width of the largest tooth base between the two sinuses [mm] (C7).

On the basis of these characters, the four groups, which are recognized here as varieties, can be distinguished as follows:

1. Stem and leaves utterly or almost glabrous. Plant short (7-30 cm). Floral tube length shorter (0.9-1.8 cm).

2. Length of the largest leaf 2.2-6.1 cm. Width of the largest leaf 18-43 cm-----var. *ussuriensis*
2. Length of the largest leaf 1.0-2.5 cm. Width of the largest leaf 0.9-1.9 cm------var. *alpina*

1. Stem and leaves pubescent. Plant height tall (18-48 cm). Floral tube length longer (1.4-2.8 cm).
3. Length of the largest leaf 5.5-7.3 cm. Width of the largest leaf 3.7-6.0 cm. Length of the tooth base 7-10.5 mm----------var. *maxima*
3. Length of the largest leaf 1.7-5.5 cm. Width of the largest leaf 1.3-3.8 cm. Length of the tooth base 2.9-7.6 mm----------var. *transitra*

DISCUSSION

Hara (1948) treated the Korean taxa of the *S. pekinensis* complex as three varieties of *S. pekinensis*: var. *alpina*, var. *transitra*, and var. *ussuriensis*. The present authors described a new variety, var. *maxima* S. Kim et S. Lee (1995a). Recognition of these four varieties in Korea was supported by the present study as well as the recent morphological studies (Kim, 1993; Kim & Lee, 1995a, b). In discriminant analysis, two groups distinguished by function 1 were well supported by the character of leaf base shape which showed little overlapping: *S. pekinensis* var. *alpina* and var. *ussuriensis* strongly tend to possess cordate to truncate bases, whereas var. *transitra* and var. *maxima* have round to acute bases (Kim & Lee, 1995a). This tendency does not agree with the contention of Iwatsuki *et al.* (1993); he considered the leaf base character was not important in distinguishing the taxa of the *S. pekinensis* complex.

Giving different taxonomic categories to four subgroups according to the order of the functions is not supported by the qualitative characters such as the swollen internode rhizome, the curvedness of floral tubes, and the morphology of pollen and seeds (Kim & Lee, 1995a, b). Variety *alpina* is distinct from the remaining varieties by its swellen rhizome internodes, and var. *maxima*, by its straight floral tubes (Kim & Lee, 1995a), larger size and rougher ornamentation of seed (Kim & Lee, 1995b) and pollen (Kim, 1993).

Hara (1936) pointed out that *S. fauriei* and *S. japonica* were small forms of *S. pekinensis* var. *transitra* and treated the former as synonyms of the latter. The small individuals of *S. pekinensis* var. *transitra*, were not well distinguished in the factor analysis, but attention might be paid to the two individuals (OTU 62 and 81; circled in Fig. 2) clustered separately from the rest (Fig. 3). However, it is not certain if the individuals are same as *S. fauriei* or *S. japonica*.

In taxonomy of *Scutellaria*, characters of inflorescences were regarded as important. *S. pekinensis* var. *ussuriensis* was characterized by its wide angle of two flower axes at each node, and recognized as a distinct species (Kudo, 1929). However, the present study as well as pollen (Kim, 1993) and seed (Kim & Lee, 1995b) do not support the species position but rather support the infraspecific position of *S. pekinensis*. Taxa belonging to the *S. pekinensis* complex from China and Japan would need to be studied further to fully understand the taxonomic structure of the complex as a whole.

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APPENDIX. List of specimens examined

var. *alpina*.

Choongchungnamdo: Chonan, 24 Aug. 1963, *Han T.K.*, (EWU). **Chullabukdo:** Gosangun, 12 Aug. 1962, *Lee, W.C.* (KWNU); Mt. Chiri, 30 June 1912, *Chung, T.H.* and *Nakai, T.*, (SNU); Mt. Chiri, Piagol, 31 July 1971, *Lee, Y.N.* and *Oh, Y.J.*, (EWU). **Kyoungsangbukdo:** Mt. Sobaek, 23 June 1989, *Lee, S.H.*, (KUS). **Kyonggido:** Is. Kwanwha, 9 May 1976, *Song, H.M.*, (KUS); Kwangnung, 20 July 1990, *Kim, S.*, (SKK); Mt. Bekbong, 12 June 1982, *Heo, B.*, (SKK); Mt. Dobong, 12 Sep. 1934, Do, B. S. and *Sim H.J.*, (SNU); Mt. Kwangduk, 19 Aug. 1990, *Kim, H.*, (KWNU); Mt. Samyoung, 30 June 1991, *Suh, O.*, (KUS). **Kangwondo:** Mt. Kumgang, 15 July 1918, *Chung, T.H.*, (KUS); Mt. Kumkang, 2 Aug. 1916, *Chung, T.H.* and *Nakai, T.*, (SKK); Mt. Obong, 4 June 1977, *Shin, S.S.*, (KWNU); Mt. Odae, 6 July 1989, *Chung, Y.J. et al.*, (SKK); Mt. Solak, 31 Aug 1989, *Lee, J.Y.*, (KWNU); Mt Sogyebang, 22 July 1987, *Kim, H.D.*, (SKK); Yongwhasa Temple, 13 Aug 1990, *Kim, J.*, (SNU). **Pyunganbukdo:** Changseng, 13 Sep. 1911, *Chung, T.H.* and *Isidoya*, (SKK); Whochang, 23 July 1916, *Chung, T.H.* and *Kudo, Y.*, (SKK). **Seoul:** Mt. Dobong, 1 July 1969, ?, (SNU); Mt. Samak, 12 Aug. 1985, *Lee, W.C.*, (KWNU).

var. *ussuriensis*.

Choongchungnamdo: Mt. Daedoon, 24 July 1958, *Park, S.H.*, (SKK); Naesosa Temple, 8 May 1989, ?, (SKK). **Chullabukdo:** Mt. Nejang, 6 Oct. 1971, *Kim, S.*, (SNU). Chullanamdo: Mt. Chiri, 30 July 1987, *Lee, S.*, (SKK). **Hamkyungbukdo:** Mt. Kwanmo, 16 July 1936, *Do, B.S.*, (SNU); Mt. Kwanmobong, 16 July 1936, *Do, B.*, (SNU). **Hamkyungnamdo:** Mt. Chunbool, 19 Aug. 1943, *Do, B.S. et al.*, (SNU). **Kangwondo:** Mt. Baekam, 11 June 1968, ?, (SNU); Mt. Chiak, 4 June 1989, *Choi, I.S.*, (SKK); Mt. Duta, 28 June 1991, *Lee, W.C.*, (KWNU); Mt. Hyangrobong, 18 June 1967, ?, (SNU); Mt. Myon, 15 July 1990, *Oh, S.H.*, (SNU); Mt. Sogyebang, 22 July 1981, *Lee, W.C.*, (KWNU); Mt. Taebaek, 2 Aug. 1976, *Lee, W.C.*, (KWNU); Mt. Taegi, 23 June 1986, *Han, E.S.*, (KUS). **Kyonggido:** Mt. Eyengmubong, 6 June 1986, ?, (KUS); Mt. Yongmoon, 3 June 1989. *Park, D.H.*, (SKK); Suwon, 17 Aug. 1936, *Do, B.S.*, (SNU). **Kyoungsangbukdo:** Mt. Baekam, 15 July 1934, *Do, B.S. et al.*, (SNU); Mt. Choohul, 12 June 1992, *Lee, S.J.*, (KUS). **Pyunganbukdo:** Mt. Myohyang, 20 July 1938, *Do, B.S. et al.*, (SNU). **Seoul:** Mt. Kwanak, 20 May 1989, *Kim, J.H.*, (SKK).

var. *transitra*.

Choogchungbukdo: Jinchon Moojebong, 26 May 1988, *Lee, W.C.*, (KWNU); Mt. Minjooji, 26 June 1992, *Lee, W.C.*, (KWNU); Mt. Sokri, 23 May 1959, *Lee, W.C.*, (SKK); Mt. Wolak, 31 July 1990, *Kim, S.*, (SKK). **Choongchungnamdo:** Mt. Chilkap, 26 July 1979, *Lee, W.C.*, (KWNU); Mt. Keryong, 22 June 1988, *Lee, K.*, (KUS); Mt. Taejo, 11 June 1988, *Kim, M.Y.*, (SNU); Tacan, 31 July 1977, *Lee, W.C.*, (KWNU). **Chullabukdo:** Byonsan, 13 June 1981, *Hong, M.K. et al.*, (SKK). **Chullanamdo:** Is. Dolsan, 21 May 1967, *Kee, W.*, (SKK); Is. Kyemoon, 4 May 1928, ?, (SKK); Is. Wan, 18 Aug. 1975, *Lee, W.C.*, (KWNU). **Kyoungsangbukdo:** Jookryoung, 1 Oct. 1961, *Chung, T.H.*, (SKK); Mt. Juhul, 6 June 1987, *Kim, J.*, (KUS). **Kyonggido:** Chulwon, 10 June 1987, ?, (SNU); Is. Dukjuk, 23 May 1992, *Kang, S.O.*, (SKK); Kapyung Hamyun, 29 June 1992, *Moon, J.H.*, (SNU); Mt. Baikun, 21 June 1992, *Woo, J.Y.*, (SKK); Mt. Boolam, 20 June 1992, *Hyon, S.J.*, (SKK); Mt. Chonma, 7 June 1986, *Kim, Y.J.*, (SKK); Mt. Jugum, 2 June 1985, *Kim, J.H.*, (SNU); Mt. Kumdan, 12 June 1977, *Chung, K.*,

(KUS); Mt. Kunja, 19 June 1987, *Lee, S.*, (SKK); Mt. Kwangkyo, 22 June 1992, *Park, D.S.*, (SKK); Mt. Myoungsung, 3 June 1989, *Kim, J.S.*, (SNU); Mt. Myungji, 30 May 1992, *Ahn, Y.L.*, (SKK); Mt. Taewha, 23 June 1983, *Shin, H.C.*, (SNU). **Kangwondo:** Hwachon Kumanri, 12 June 1968, ?, (SNU); Mt. Chungok, 25 May 1989, *Lee, W.C.*, (KWNU); Mt. Daeryong, 29 May 1982, *Lee, W.C.*, (KWNU); Mt. Konbong, 11 June 1987, *Lee, W.C.*, (KWNU); Mt. Kongjak, 11 Aug. 1977, *Yoon, K.M.*, (KWNU); Mt. Samyoung, 27 May 1982, *Lee, W.C.*, (KWNU); Mt. Soribong, 22 July 1981, *Lee, W.C.*, (KWNU); Mt. Taegi, 23 June 1986, *Cho, S.H.*, (KUS).

var. *maxima*.

Choongchungnamdo: Buyo, 5 June 1977, *Peik, S.*, (KWNU). **Chullabukdo:** Mt. Bekyang, 10 June 1969, *Lee, Y.*, (EWU). **Chullanamdo:** Is. Kyemoon, 4 May 1928, ?, (SKK). **Kyoungsangbukdo:** Hyangrobong, 18 June 1967, ?, (SNU); Jookryoung, 11 Oct. 1961, *Chung, T.H.*, (SKK). ***Kyonggido:*** Kwangnung, 14 June 1990, *Kim, S.*, (SKK); Mt. Baekbong, 22 June 1992, *Kang, S.W.*, (SKK); Mt. Bulam, 6 June 1989, *Kang, B.*, (SKK); Mt. Chukryung, 31 May 1992, *Lee, J.*, (SKK); Mt. Myoungsung, 3 June 1989, *Kim, J.*, (SNU); Mt. Namhan, 4 July 1986, *Kim, Y.D.*, (SNU); Mt. Soyo, 27 June 1959, *Lee, W. C.*, (SKK); Mt. Whanghak, 3 June 1978, *Kim, E.*, (KUS); Mt. Yongmoon, 18 July 1975, *Lim, K.M.*, (KUS). **Kangwondo:** Mt. Chiak, 3 June 1989, *So, E. Y.*, (SKK); Mt. Gyunbong, 11 June 1987, *Lee, W.C.*, (KWNU). **Seoul:** Mt. Bukhan, 24 June 1990, *Kim, S.*, (SKK); Mt. Dobong, 2 Oct. 1962, *Chung, T.H.*, (SKK); Mt. Samgak, 5 June 1990, *Han, M.K.*, EWU). **Whanghedo:** Dowon, 8 Aug. 1961, *Chung, T.H.*, (SKK).