J. Plant Biol. 41 (4) : 283~292 (1998)

Morphological Variation of the *Callicarpa japonica* Complex in Eastern Asia

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The *Callicarpa japonica* complex in Eastern Asia is considered a polymorphic species by its leaf characters which usually show a wide range of variation. Therefore, much taxonomic confusion has reigned within this group, especially in taxonomic circumscriptions and nomenclatures of taxa. To identify variation patterns of the *C. japonica* complex, 23 diagnostic characters were examined using 599 specimens. These were subjected to principal component analysis (PCA). From the results based on the analysis of the leaf characteristics, inflorescence, and geographical distribution patterns, the *C. japonica* complex can be divided into six infraspecific taxa which include var. *japonica*, var. *luxurians*, var. *taquetii*, var. *angustata*, var. *japonica* f. *leucocarpa*, and var. *luxurians* f. *leucocarpa*. The *C. japonica* complex distributed in Eastern Asia is extensively differentiated in leaf characters and inflorescence.

Keywords: *Callicarpa japonica* complex, variation pattern, principal component analysis

INTRODUCTION

The *Callicarpa japonica* complex in Eastern Asia is highly variable in terms of leaf characters which are usually regarded the diagnostic characters to distinguish taxa among the complex. Therefore, much taxonomic confusion has reigned within this group, especially in taxonomic circumscriptions and nomenclatures of taxa.

The interest of taxonomists in the *C. japonica* complex began from a description by Thunberg in 1784. Sprengel (1825) treated *C. japonica* as a taxon conspecific with *Callicarpa longifolia* distributed in Malaysia and Japan, and placed it under *C. longifolia* as a synonym. Schauer (1847) established two varieties under *C. longifolia*, var. *subglabrata*, and var. *floccosa*, and considered that *C. japonica* was synonymous to var. *subglabrata*. On the other hand, Miquel (1870) accepted the identity of *C. japonica* as a polymorphic species and described three new forms of *C. japonica*. Savatier (1873) described var. *angustifolia* under *C. japonica*.

As to the *C. japonica* complex distributed in Korea, Nakai (1914, 1922, 1926, 1927) recorded seven infraspecific taxa of *C. japonica* in Eastern Asia, which included var. *taquetii*, having small leaves and few flowers distributed in Bogildo and Chejudo; var. *luxurians*, having large leaves and inflorescences distributed in Chejudo, Ullungdo, and the southern coastal region of the Korean peninsula; var. *leucocarpa*, having white flowers and fruits; var. *luxurians* f. *leucocarpa*, having white flowers and fruits among var. *luxurians*; var. *angustata*, having long leaves; var. *microcarpa*; and var. *candida*. Also, Nakai (1938) established f. *major*, f. *rhombifolia*, f. *grossidentata*, and var. *glabra* in the Korean *C. japonica* complex using leaf shape, leaf serration, leaf trichome, and inflorescence. Chung (1957) reported three varieties of *C. japonica* as Korean taxa : var. *japonica*, var. *luxurians*, and var. *taquetii*. Later, Lee (1966) reported var. *glabra*, var. *leucocarpa*, var. *luxurians*, and var. *taquetii* as the Korean taxa. Recently Chung and Kim (1987) considered the Korean *C. japonica* complex to be composed of var. *taquetii*, var. *luxurians*, and var. *leucocarpa*. The *C. japonica* varieties distributed in Japan has been reported as var. *luxurians* and f. *albifructus* (Ohwi, 1965; Makino, 1988). Var. *luxurians*, var. *angustata*, and f. *kiruninsularis* of *C. japonica* are also known to be distributed in China (Péi and Chen, 1982). Therefore, the taxonomic circumscriptions and nomenclatures of Eastern Asian *C. japonica* reported in literature are very complicated.

To understand the patterns of variation in the *C. japonica* complex and to reexamine the circumscriptions of taxa, principal component analysis on morphological characters was employed. The dif-

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ferentiating process of the *C. japonica* complex was also inferred based on the variation of major characters.

MATERIALS AND METHODS

A total of 1,372 sheets of herbarium specimens was loaned from 27 major herbariums : BISH, BM, CAS, CHR, E, F, GH, HIRO, JJU, KEW, L, LIV, MICH, MO, NY, OSLO, PC, PE, PH, SING, SNU, SNUA, TAI, TEX, TUS, U, and WAG. From them, 599 sheets were selected for principal component analysis (Appendix). Each specimen was identified based on its original description, type specimens, and the related literature. As shown in Table 1, leaf shape, inflorescence, and flower characters were measured and assessed, some by calculated ratio. Quantitative characters of leaves and inflorescences were measured using light scale lupes (×7, ×10), a slide caliper, and a semicircular protractor (Table 1, Fig. 1). Principal component analysis of the data matrix was made by the SAS program (SAS Institute, 1990: Version 6.12).

Table 1. Twenty-three morphological characters used in the numerical analysis of the *C. japonica* complex. See Fig. 1 for further clarification.

Character No.	Description (unit)
1.	LL : Leaf blade length (cm)
2.	LW : Leaf width at the midpoint (cm)
3.	LL/LW : Leaf blade length/leaf width at the midpoint (character 1/ character 2)
4.	LA : Leaf apex angle (degree)
5.	LSA : Leaf subapex angle (degree)
6.	LBA : Leaf base angle (degree)
7.	LS : Leaf serrate number (no.)
8.	LM : Leaf margin thickness (mm)
9.	PL : Petiole length (cm)
10.	PL/LL : Petiole length/leaf blade length (character 9/ character 1)
11.	FN : Flower number (no.)
12.	BL : Bract length (cm)
13.	BW : Bract width (cm)
14.	BRL : Bracteole length (cm)
15.	PN : Branching difference of peduncle (no.)
16.	APD : Primary branch length of inflorescence (cm)
17.	BPD : Secondary branch length of inflorescence (cm)
18.	CPD : Tertiary branch length of inflorescence (cm)
19.	AA : Secondary branch angle of inflorescence (degree)
20.	BA : Tertiary branch angle of inflorescence (degree)
21.	SA : Calyx angle (degree)
22.	SL : Calyx length (cm)
23.	SC : Flower color (0, violet; 1, white)

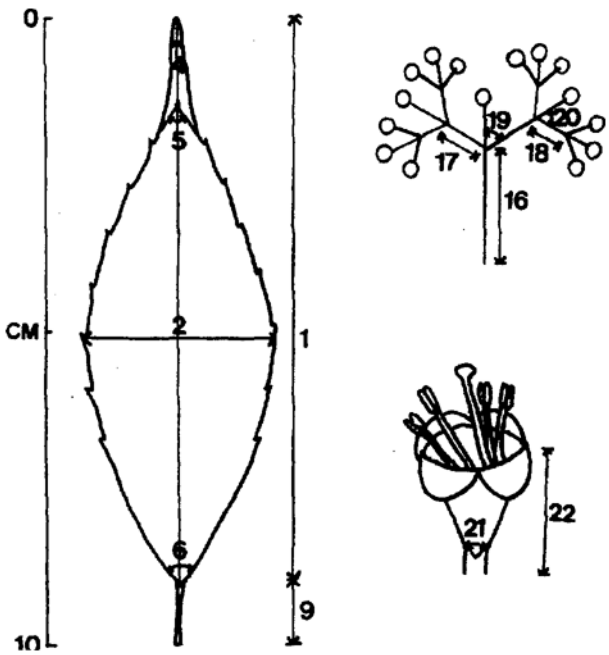

Fig. 1. Diagram of some morphological characters for numerical analysis. Numbers correspond to character numbers in Table 1.

RESULTS

Character Variation

Table 2 shows the average values of the 23 characters measured from the 599 specimens. The *C. japonica* complex can be divided into four infraspecific taxa using leaf blade length (character no. 1) as a diagnostic character : var. *taquetii* with about 4 cm, var. *japonica* with 8 cm, var. *angustata* with 10 cm, and var. *luxurians* with 13 cm. This grouping pattern is similar to that of leaf width (character no. 2): var. *taquetii* with 1.4 cm, var. *angustata* with 2.5 cm, var. *japonica* with 3 cm, and var. *luxurians* with 5.4 cm. In addition, var. *angustata* is well distinguished from the other taxa within this complex by its the leaf blade length/width ratio (character no. 3) and leaf base angle (character no. 4). With regard to the length/width ratio of the leaf blade, var. *angustata* shows ratio of 4.1, where as other varieties show a range from 2.5 to 3.1. However, the leaf serrate number (character no. 7) shows a different grouping pattern. The leaf serrate numbers of var. *luxurians* and var. *angustata* are above 50, but others within this complex are below 50. These results show that var. *angustata* can be easily distinguished from other taxa by its leaf blade length/width ratio, and leaf base angle. Var. *taquetii* can also be easily dis-

Table 2. Means and standard deviation of 23 morphological characters for 6 species related to the *C. japonica* complex. Measurements were taken from herbarium specimens. Character numbers correspond to those in Table 1. C = var. *japonica*, Ⓔ = var. *japonica* f. *leucocarpa*, A = var. *angustata*, T = var. *taquetii*, L = var. *luxurians*, ⓞ = var. *luxurians* f. *leucocarpa*.

Character No.	C	Ⓔ	A	T	L	ⓞ*
1	8.43±1.58	8.34±2.50	10.19±2.42	4.38±1.01	13.26±2.62	16.90
2	3.09±0.70	3.26±0.75	2.53±0.65	1.43±0.37	5.45±1.10	6.40
3	2.79±0.46	2.60±0.74	4.11±0.72	3.11±0.40	2.47±0.39	2.64
4	21.13±5.00	20.00±4.92	19.90±6.27	16.15±3.91	23.21±5.01	22.00
5	66.29±8.12	66.80±4.69	63.03±5.93	47.36±6.12	70.14±7.40	70.00
6	53.74±8.47	48.50±6.82	30.93±7.24	38.94±6.64	57.60±9.92	60.00
7	43.57±8.79	43.90±9.33	52.48±12.14	21.33±5.48	59.29±9.98	65.00
8	0.10±0.01	0.10±0.00	0.10±0.00	0.10±0.01	0.11±0.02	0.10
9	0.45±0.15	0.55±0.2	50.74±0.28	0.21±0.08	1.06±0.43	2.20
10	0.05±0.02	0.07±0.03	0.07±0.02	0.05±0.02	0.08±0.03	0.13
11	24.30±7.90	21.40±8.26	21.80±8.01	11.67±3.97	75.15±32.66	127.00
12	0.11±0.38	0.05±0.16	0.21±0.52	0.06±0.18	0.19±0.52	0.00†
13	0.03±0.08	0.02±0.06	0.04±0.11	0.02±0.06	0.04±0.10	0.00†
14	0.21±0.04	0.21±0.03	0.21±0.02	0.18±0.07	0.22±0.04	0.20
15	4.58±0.49	4.40±0.52	4.43±0.50	3.58±0.50	6.12±0.62	7.00
16	0.72±0.19	0.83±0.41	0.66±0.17	0.56±0.15	1.01±0.35	1.30
17	0.43±0.11	0.47±0.15	0.40±0.09	0.30±0.07	0.64±0.24	0.70
18	0.28±0.08	0.30±0.11	0.25±0.07	0.18±0.06	0.48±0.16	0.50
19	91.28±3.38	91.00±2.36	90.65±3.11	90.64±2.82	91.17±2.89	92.00
20	89.87±2.80	89.70±2.75	89.18±2.60	72.79±21.25	90.31±2.57	93.00
21	50.55±4.01	47.90±3.90	49.35±3.95	49.86±3.52	50.49±5.47	58.00
22	0.10±0.01	0.10±0.00	0.10±0.00	0.10±0.00	0.10±0.01	0.10
23	0	1	0	0	0	1

*Measure values; ⓞ = var. *luxurians* f. *leucocarpa* (1 sheet).
†Specimens without bract.

tinguished from the other taxa by its leaf blade length, leaf width, and leaf serrate number (Table 2). The *C. japonica* complex can be divided into three groups by flower numbers per inflorescence (character no. 11) and the branching difference of the peduncle (character no. 15). The average number of flowers in var. *taquetii* is about 11, whereas those of var. *japonica* and var. *angustata* are about 21~24. Var. *luxurians* has an average of more than 75 flowers per inflorescence. Among the specimens having white flowers and fruit, 10 sheets are included in the variation range of var. *japonica* and 1 sheet is included in the variation range of var. *luxurians*. Therefore, these are arranged into var. *japonica* f. *leucocarpa* and var. *luxurians* f. *leucocarpa* (Table 2). In total, the *C. japonica* complex can be divided into four varieties by its characteristics of leaf and infloresecence, and further divided into two forms by the color of flower and fruit. The six infraspecific taxa recognized within this complex include var. *japonica*, var. *taquetii*, var. *luxurians*, var. *angustata*, var. *japonica* f. *leucocarpa*, and var. *luxurians* f. *leucocarpa*.

Principal Component Analysis

In order to clarify the composition of infraspecific populations of the *C. japonica* complex, the results shown in Table 3 were obtained from principal component analysis of 23 characters. Component 1, occupying 34.0% of total divergence, is represented by characters having a high positive vector value such as leaf blade length (character no. 1), leaf width (character no. 2), petiole length (character no. 9), flower number (character no. 11), branching difference of peduncle (character no. 15), and tertiary branch length of inflorescence (character no. 18). On the other hand, a character having a negative vector value was the leaf blade length/width ratio (character no. 3). Component 2 occupies 9.4% of total divergence. Among component 2, the characters representing high positive vector value were leaf apex angle (character no. 4), leaf subapex angle (character no. 5), leaf base angle (character no. 6), bract length (character 12), and bract width (character 13). Characters representing a negative vector value were the leaf blade length/width ratio (character no. 3),

Table 3. Loading of the first three principal components for 23 morphological characters of the *C. japonica* complex. Character numbers correspond to those in Table 1.

Character No.	Components		
	1	2	3
1	0.2972	−0.0293	−0.0237
2	0.3158	0.0938	−0.1263
3	−0.1323	−0.2947	0.2567
4	0.1251	0.3318	−0.1971
5	0.2154	0.3596	−0.2236
6	0.1763	0.4156	−0.2545
7	0.2752	−0.0183	−0.0469
8	0.1338	−0.0610	−0.0117
9	0.2951	−0.2233	0.0646
10	0.2028	−0.2602	0.0966
11	0.2999	−0.1849	0.0085
12	0.0702	0.3657	0.5585
13	0.0612	0.3642	0.5686
14	0.0983	0.0354	−0.0120
15	0.3174	−0.1210	−0.0306
16	0.2539	−0.0484	0.1856
17	0.2918	−0.1180	0.1600
18	0.3029	−0.1438	0.1038
19	0.0202	−0.0339	−0.1076
20	0.1634	0.0816	−0.1041
21	0.0160	−0.0808	−0.0832
22	0.0390	0.0361	0.1070
23	0.0120	−0.0283	−0.0124
Eigenvalue	7.8209	2.1528	1.9386
Cumulative % of eigenvalue	34.0	43.4	51.8

petiole length (character no. 9), and petiole length/leaf blade length ratio (character no. 10). Among component 3, bract length (character no. 12) and bract width (character no. 13) represented high positive values, but leaf subapex angle (character no. 5) and leaf base angle (character no. 6) represented high negative values of vector. Fig. 3-I is plotted in all populations of the *C. japonica* complex using component 1 and component 2. According to Fig. 3-I, the *C. japonica* complex is divided into four groups, namely, var. *japonica,* var. *taquetii*, var. *angustata*, and var. *luxurians*, two including f. *leucocarpa*. In Fig. 3-I, var. *taquetii* and var. *luxurians* were divided from var. *japonica* by component 1, representing mainly leaf blade length, leaf width, and branching difference of the peduncle. Finally, var. *angustata* was divided from *C. japonica* by component 2, representing mainly leaf base angle, leaf apex angle, and leaf subapex angle.

Ten characters related to the leaf are the most important diagnostic characters classifying the *C. japonica* complex. The results of Table 4 were obtained from principal component analysis of the 10 characters related to the leaf. In Table 4, components 1, 2, and 3 occupy 46.0%, 18.1%, and 9.8% of total divergence respectively. The patterns on the vector values of each component were similar to the results of the 23 characters shown in Table 3. Characters having high positive values in component 1 are leaf blade length, leaf width, and leaf serrate number, but the character having a value of negative vector was the leaf blade length/width ratio. The petiole length, petiole length/leaf blade length ratio, and leaf blade length/width ratio in component 2 represented high positive values. The leaf apex angle, leaf subapex angle and leaf base angle represented high negative values. Leaf blade length and leaf margin thickness in component 3 represented values of positive vector. On the other hand, petiole length, and petiole length/leaf blade length ratio represented values of negative vector. Fig. 3-II shows the plotting pattern of the *C. japonica* complex drawn by component 1 and component 2 from Table 4. The distribution pattern of taxa in Fig. 3-II was similar to that of Fig. 3-I which is divided into four groups. Moreover, specimens having white flowers or white fruit are plotted in the ranges of var. *japonica* and var. *luxurians*. Therefore, the *C. japonica* complex in eastern Asia can be known to comprise of six infraspecific taxa as results in character variations.

Table 4. Loading of the first three principal components for leaf characters of the *C. japonica* complex. Character numbers correspond to those in Table 1.

Character No.	Components		
	1	2	3
1	0.3941	0.2049	0.2741
2	0.4323	−0.0074	0.1259
3	−0.2129	0.4275	0.1804
4	0.2326	−0.3205	−0.1292
5	0.3430	−0.3102	−0.0607
6	0.2849	−0.4690	−0.0623
7	0.3732	0.1941	0.1581
8	0.1771	0.1120	0.6476
9	0.3653	0.3972	−0.2475
10	0.2355	0.3851	−0.5887
Eigenvalue	4.5998	1.8098	0.9821
Cumulative % of eigenvalue	46.0	64.1	73.9

Differentiation Trend of major characters of the *C. japonica* Complex

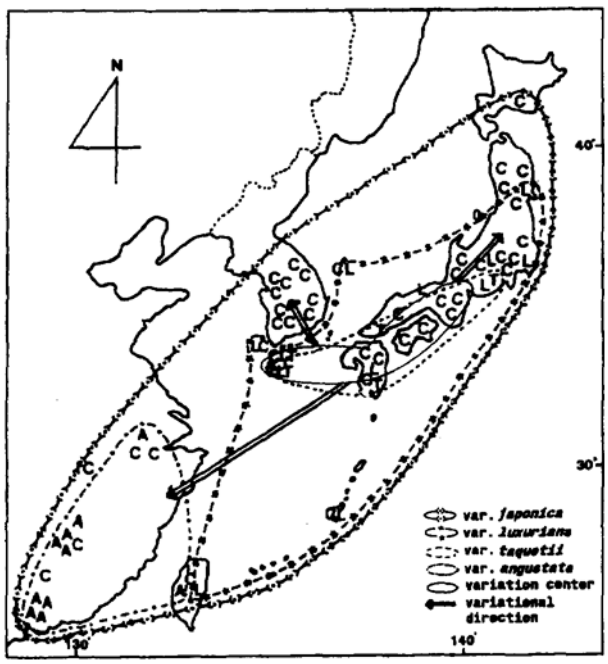

Fig. 2. Map showing distribution pattern of major infraspecific taxa of the *C. japonica* complex based on collection sites of specimens. C = var. *japonica*, L = var. *luxurians*, T = var. *taquetii*, A = var. *angustata*.

Morphological characters of the *C. japonica* complex distributed throughout Eastern Asia shows various differentiation patterns of diagnostic characters. As shown in Fig. 2, the variational center of the *C. japonica* complex distributed in eastern Asia is located in the triangular region comprising of the southern islands of the Korean peninsula and the southern regions of the Japanese islands.

Leaf sizes in the variational center display various taxa : small (var. *taquetii*), medium (*C. japonica*) and large (var. *luxurians*). However, as the distance from the variational center increases, variations for leaf size becomes weaker. On the other hand, the variation pattern of the leaf base angle shows a different pattern. Namely, the leaf base angle of the China-Taiwan population (var. *angustata*) distributed in the southwestern region of the variational center are larger than those distributed in any of the other regions. The population (var. *luxurians*) showing many variations in inflorescence is mainly distributed near the northern region of the variational center. These results show that character variations of the *C. japonica* complex are differentiating from leaves and later from inflorescences. Regions distributed in populations showing these variation patterns are gradually broadening. Fig. 2 is the geographical distribution map of the *C. japonica* complex which was drawn from collection localities of the specimens. Populations of var. *japonica* are distributed in the central and southern regions of Korea; in Japan; in Taiwan; and in the Anhui, Chekiang, Kwangsi, Kiangsi, Kweichow, Szechuan, and Shantung provinces of China. Also, var. *japonica* is cultivated in Hong Kong, the Netherlands, Britain, U.S., and Norway. Populations of var. *taquetii* are distributed in the southern island region of Korea, the Honshu region of Japan, and the Chekiang region of China. However, populations of var. *luxurians* are distributed only in the southern island regions of Korea, Japan, and Taiwan. Var. *angustata* appears only in China and Taiwan.

DISCUSSION

Variations of the *C. japonica* complex were investigated in literature, records of specimen labels, character variations patterns, and results of a principal component analysis. Twenty two names related to *C. japonica* were cited in literature. Additionally, the number of names related to the *C. japonica* complex that were recorded on the 599 specimen labels was 13. The major reason for this difference can be attributed to morphological variations of *C. japonica* complex.

As shown in table 2 and fig. 3-I, II, the *C. japonica* complex can be recognized as four major infraspecific taxa from the results of analyses of character variation and PCA: var. *japonica* (Thunberg, 1784), var. *angustata* (Rehder, 1916), var. *taquetii* (Nakai, 1922), and var. *luxurians* (Rehder, 1916). This result supports the conclusion of Chung and Kim (1987) who recognized three taxa within this complex except for var. *angustata*, distributed in China and Taiwan. However, that result does not support the conclusion of Nakai (1922, 1927, 1938) who recognized eight taxa within the complex.

Eleven specimens identified as var. *leucocarpa*, f. *albiflora*, var. *rhombifolia* f. *leucocarpa*, and var. *luxurians* f. *leucocarpa* were investigated in this study. However, f. *albiflora* and var. *rhombifolia* f. *leucocarpa* could not be found in any related literature. Also, character variations of var. *leucocarpa*, f. *albiflora* and var. *rhombifolia* f. *leucocarpa* are included in the variation range of var. *japonica*, and hence should be included in var. *japonica*. In the case of the specimens identified as var. *leucocarpa*, major characteristics of this variety except for white flowers are identical to those of var. *japonica*, and

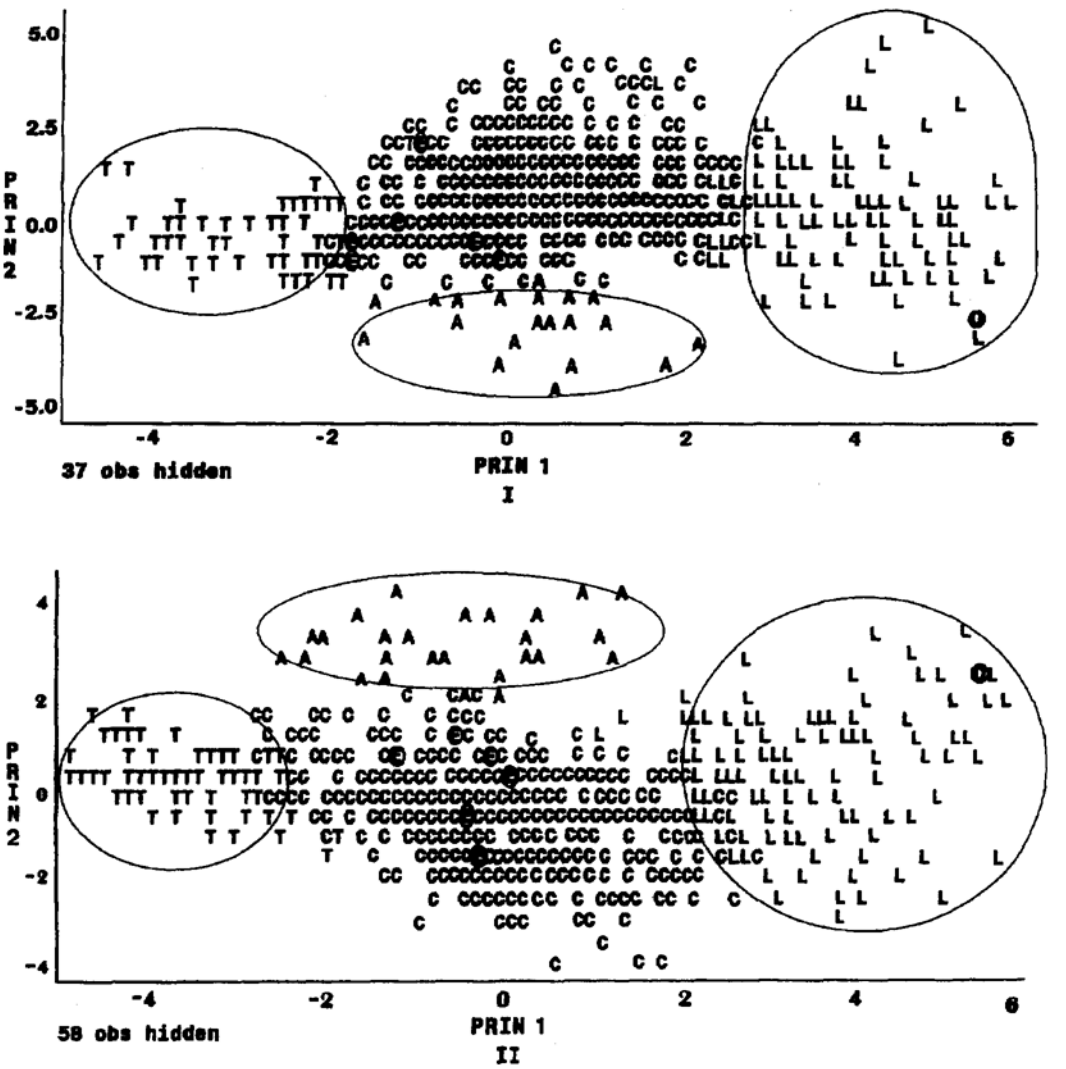

Fig. 3. Results obtained from a principal component analysis of 6 species related to the *C. japonica* complex. I : using 23 diagnostic characters, II : using 10 leaf characters. C = var. *japonica*, Ⓔ = var. *japonica* f. *leucocarpa*, A = var. *angustata*, T = var. *taquetii*, L = var. *luxurians*, ⓞ = var. *luxurians* f. *leucocarpa*.

this result is also in accord with original description of Nakai (1922). Therefore, it is more reasonable to treat this variety as a form of var. *japonica* : *C. japonica* var. *japonica* f. *leucocarpa*, stat. nov. In addition, var. *albifructus* named by Makino (1988) was assigned to var. *japonica* f. *leucocarpa*. As shown in fig. 3-II, the plotting site of var. *luxurians* f. *leucocarpa* is located in the plotting range of var. *luxurians*.

Makino (1910) described *Callicarpa shirasawana* as a hybrid between *C. japonica* and *Callicarpa mollis* and he cited a living plant growing at the botanical garden of Tokyo University instead of designation of the holotype in the original description. However the plant can not be found at the botanical garden of Tokyo University anymore. Moreover, examining five specimens identified as *C. shirasawana*, it was found that leaf trichomes were not vestigial. Furthermore, it is revealed that the five specimens have been misidentified. Therefore, the identity of *C. shirasawana* cannot be accepted as concluded by Kim and Song (1997).

The geographical distribution map (Fig. 2) shows that the *C. japonica* complex has a wide geographical variation range. The intense geographical variations prove that the region of eastern Asia was center of origin of the *C. japonica* complex (Fig. 2).

ACKNOWLEDGEMENTS

This work was supported by a grant from the " '97

plan of financial support for research, Jeonju University". I thank the persons concerned from BISH, BM, CAS, CHR, E, F, GH, HIRO, KEW, L, LIV, MICH, MO, NY, OSLO, PC, PE, PH, SING, SNU, SNUA, TAI, TEX, TUS, U, and WAG herbariums who loaned specimens essential to this research. Especially, I thank Dr. B. Y. Sun for critical review of the manuscript and Mr. J. B. Skye for revision of English structures.

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Received November 25, 1997
Accepted October 22, 1998

APPENDIX.
A list of specimens examined for this study

C. japonica* var. *japonica

〈**KOREA**〉 **Cheju**; SNU ?(1979.8.12), SNU 11947 (1935.7.15), SNUA 2731(1963.?.?), JJU 6317(1995.8. 2), JJU 6319(1995.8.2), JJU 6415(1996.9.18), JJU 6416(1996.9.18), JJU 6417(1996.9.18), JJU 6422 (1996.9.17), JJU 6424(1996.9.17), JJU 6425(1996.9. 17), JJU 6426(1996.9.17), JJU 6427(1996.9.17), JJU 6428(1996.9.17), JJU 6399(1996.9.18), JJU 6400 (1996.9.18), JJU 6401(1996.9.18), JJU 6402(1996.9. 18), JJU 6403(1996.9.18), JJU 6404(1996.9.18), JJU 6405(1996.9.18), JJU 6407(1996.9.17), JJU 6408(1996. 9.17), JJU 6409(1996.9.17), JJU 6410(1996.9.17), JJU 6411(1996.9.17), JJU 6412(1996.9.17), JJU 6413 (1996.9.17), JJU 6414(1996.9.17), E 5(1907. 7.?), E 13(1907.8.?), E 11(1908.7.?), E 15(?.?.?), GH ? (1908.7.?), GH ?(?.?.?), **Chonbuk**; SNU 11926(1949. 10.17), SNU 11927(1949.10.17), SNUA ?(1985.8.8), SNUA ?(1980.7.26), **Chonnam**; SNU 63790 (1986. 8.7), SNU 63787(1986.6.22), SNU 63791(1986.8.7), SNUA ?(1959.8.19), SNUA ?(1958.8.13), SNU ? (1959.8.19), SNUA ?(1985.10.17), JJU 6393(1996.7. 22), JJU 6394(1996.7.22), JJU 6395(1996.7.22), JJU 6396(1996.7.22), JJU 6397(1996.7.22), JJU 6398 (1996. 7.22), JJU 6298(1995.7.29), JJU 6299(1995.7.29), JJU 6300(1995.7.29), JJU 6303(1995.7.29), JJU 6304 (1995.7.29), JJU 6305(1995.7.29), JJU 6306(1995.7. 29), JJU 6309(1995.7.29), JJU 6310(1995.7.29), JJU 6311(1995.7.29), JJU 6314(1995.7.29), **Chungbuk**; SNU 70443(1988.8.19), SNU 70444(1988.8.18), SNU 70447(1988.6.28), SNU 58197(1983.7.16), SNUA ? (1982.7.4), **Chungnam**; SNU 67178(1988.6.11), SNU 11945(1944.9.15), SNUA ?(1979.7.1), SNUA ?(1965. 7.2), MICH ?(1948.5.27), **Hwanghai**; SNU 11952 (1939.6.5), **Kangwon**; SNU 52306(1979.9.22), SNU 77673(1993.10.8), SNU 48199(1973.9.29), SNU 45576 (1971.10.8), MO 4254042(1989.10.11), MO 4254854 (1989.9.28), **Kyonggi**; SNU 57524(1986.6.23), SNU 57525(1983.8.18), SNU 73739(1990.7.2), SNU 62201 (1985.7.7), SNU 72594(1985.6.30), SNU ?(1992.10. 15), SNU 69971(1989.6.27), SNU 64549(1986.7.4),

SNU 64550(1986.7.4), SNU 64551(1986.7.4), SNU 64573(1986.7.4), SNU 81611(1991.8.5), SNU ? (1930.?.?), SNUA ?(1982.8.5), SNUA ?(1984.8.9), SNUA ?(1982.8.28), SNUA?(1982.8.28), SNUA ? (1963.7.1), SNUA ?(1952.8.20), GH ?(1984.7.29), GH ?(1984.8.1), MICH ?(1949.7.?), MICH ?(1947.6. 15), MICH ?(1947.9.20), MICH ?(1949.6.27), **Kyongpuk**; SNU 78383(1993.9.19), SNU 65262(1987.8. 28), SNU 65261(1987.7.23), GH ?(1986.7.8), MICH ?(1949.6.3), MICH ?(1948.7.1), **Kyongnam**; SNUA ? (1968.8.?), SNUA ?(1958.7.?), SNUA ?(1965.8.17), SNUA ?(1965.8.18), GH ?(1938.8.6), MICH ?(1949.6. 17), KEW 15(1989.10.7), **Seoul**; SNU 63792 (1986.10. 3), SNU 63793(1986.10.3), SNU 63794(1986.10.3), SNU 63795(1986.10.3), SNU 63796 (1986.10.3), SNU 63797(1986.10.3), SNU 63802(1987.7.10), SNU 63798 (1987.7.10), SNU 63799(1987.7.10), SNU 63800 (1987.7.10), SNU 63801(1987.7.10), SNU 63803(1987. 7.10), SNU 72962(1990.9.8), SNU 75637(1991.7.3), SNU 11943(1930.6.20), JJU 6334(1996.7.29), JJU 6335 (1996.7.29), JJU 6336(1996.7.29), JJU 6382(1996.7.28), JJU 6383(1996.7.28), JJU 6384(1996.7.28), JJU 6385 (1996.7.28), JJU 6386(1996.7.28), JJU 6387(1996.7.28), JJU 6388(1996.7.28), JJU 6389(1996.7.28), JJU 6379 (1996.7.28), JJU 6380(1996.7.28), JJU 6391(1996.7.29), JJU 6392(1996.7.29), SNUA ?(1958.7.2), SNUA ? (1972.9.24), SNUA ?(1982.9.25), SNUA ?(1959.7.?), SNUA ?(1986.9.27), SNUA ?(1982.9.25), SNUA ? (1959.9.?), SNUA ?(1959.9.12), GH ?(1905.9.20), BM 49821(1979.10.16), ?; SNU 11975(?.?.?), SNU 11954(1947.7.28), SNUA ?(?.?.?), GH ?(1908.6.29), GH ?(1981.9.27), E 6(1906.8.?), BM 49807(1918.7. 16), LIV ?(1978.9.27), MO 865851(1918.6.30), KEW 13(1908.6.?) 〈**JAPAN**〉 **Hokkaido**; L 28(1861.?.?), NY ?(1861.?.?), PC ?(1861.?.?), GH ?(1892.?.?), GH ?(1980.7.26), CAS 31983(1914.7.31), NY ?(1861.?.?), **Hondo**; BM 49825(1952.?.?), BM 49829(1984.9.20), BM 49830(1862.?.?), MICH ?(1984.9.20), MO 2697588 (1970.7.23), MO 3895592(1987.6.29), MO 2418116 (1961.6.18), MO 2029169(1970.6.22), MO 4023360 (1989.7.14), MO 4131179(1991.8.12), MO 4327313 (1992.10.17), MO 4013476(1977.6.15), MO 3887944 (1989.7.24), MO 2697566(1974.7.6), MO 4017154 (1989.7.15), MO 3915147(1989.10.11), MO 3894548 (1989.6.25), MO 2793997(1981.7.16), MO 3891608 (1989.8.4), MO 2339311(1973.7.13), MO 4028004 (1986.9.20), MO 4015988(1976.7.9), MO 2976224 (1974.7.8), MO 2679046(1971.8.10), MO 4381547 (1987.6.13), MO 1961651(1968.7.7), MO 4368268 (1990.7.23), MO 4047792(1990.7.18), MO 2996151 (1979.7.5), MO 3893527(1982.9.27), TUS 80787 (1983.7.31), TUS 71952(1980.10.13), GH ?(1955.7. 28), GH ?(1955.7.23), GH ?(1955.6.2), GH ?(1955.7. 1), GH ?(1955.7.3), GH ?(1955.6.11), GH ?(1955.7. 22), GH ?(1952.11.16), GH ?(?.?.?), GH ?(1955.8.7), GH ?(1955.8.2), GH ?(1955.8.5), GH ?(1955. 8.2), GH ?(1929.10.?), GH ?(1961.6.18), GH ?(1954.7.11), GH ?(1955.6.25), GH ?(1955.8.25), GH ?(1935. 6.16), GH ?(1935.6.15), GH ?(1955.6.14), GH ? (1955.6.12), GH ?(1955.10.28), GH ?(1953.7.5), GH ?(1984.9.20), GH ?(1952.7.26), GH ?(1957.7.3), GH ?(1912.6.2), GH ?(1951.6.5), GH ?(1991.6.26), GH ? (1955.11.7), GH ?(1955.11.6), GH ?(1952.9.6), GH ? (1862.?.?), HIRO ?(1970.11.?), HIRO ?(1972.6.21), HIRO ?(1970.10.?), SING 519834(1964.10.24), TUS 142125(1989.10.11), TUS 210054(1992.7.5), TUS 144486(1988.9.20), TUS 75585(1982.9.27), TEX ? (1961.6.18), TEX 274182(1964.10.24), U 75497(1950.6 .25), U 118554(1959.6.29), U 192852(1964.10.24), U 315723(1971.10.23), U 89530(1958.7.13), WAG 55(1970.6.22), WAG 52(1971. 10.23), WAG 54 (1971.10.25), CAS 704557(1977.6.15), CAS 886365 (1960.11.7), CAS 741295(1969.?.?), CHR 423657 (1976.7.9), CHR 298253(1976.10.23), CHR 298254 (1971.10.25), NY 3106(1933.6.29), NY ?(1975.10. 23), NY ?(1964.10.24), NY ?(1987.6.13), L 18(1975. 10.23), L ?(1964.10.24), L 7(1862.?.?), PH ?(1876. 5.?), PC ?(?.?.?), F 1527092(1866.?.?), **Shikoku**; HIRO ?(1972.8.8), MO 2678868(1975.9.11), MO 3630922(1975.9.11), GH ?(1982.8.9), **Kyushu**; BM 49855(1899.6.?), BM 49836(1863.?.?), CHR 444463 (1985.6.8), MO 3895550(1987.7.14), GH ?(1946.6.?), GH ?(1942.5.?), **Okinawa**; MICH ?(1945.8.6), **Awaji**; GH ?(1955.8.26), **Tsushima**; GH ?(1859.?.?), **?**; PH ? (1890.6.25), CAS 31987(1914.6.9), CAS 31988(1914. 11.8), KEW 34(1966.10.18), GH ?(1889.7.5), GH ? (1930.?.?), KEW 23(1880,?.?), GH ?(1914.?.?), GH ? (1892.?.?), GH ?(1892.?.?), GH ?(1982.6.21), L 22 (?.?.?), L 21(?.?.?), L 72(?.?.?), BISH 435766 (1868.?.?), U 11543(?.?.?), BM 49854(1903.7.?), BM 49828(1912.7.24), NY ? (?.?.?), PC ?(1866.?.?), L 51(?.?.?), L 52(?.?.?), L 53(?.?.?), L 56(?.?.?), L 70(?.?.?), L 71(?.?.?), L 73(?.?.?), L 74(?.?.?), L 75 (?.?.?), L 76(?.?.?), L 77(?.?.?), L 78(?.?.?), L 79 (?.?.?), L 80(?.?.?) 〈CHINA〉 **Anhui**; MO 3668809 (1984.7.20), GH ?(1933.8.17), GH ?(1933.8.21), **Chekiang**; GH ?(1922.6.?), KEW 35(1926.7.24), **Kiangsi**; GH ?(1933.6.28), GH ?(1933.7.6), GH ?(1933. 7.11), E 26(1907.?.?), MO 902781(1922.6.26), **Kweichow**; PH ?(1959.6.30), **Szechuan**; OSLO ?(?.?.?), **Shantung**; PE 869543(1959.6.2), GH ?(1930.6.21), NY ?(1930.6.21), NY ?(1930.6.21), **?**; PE 622534(1957. 6.22), GH ?(1986.9.22) 〈**BRITIAN**〉 BM 49816(1972. 7.31), BM 49819(1973.7.17) 〈**U.S.**〉 NY ?(1932.10.

17), NY ?(1933.10.17), NY ?(1944.6.6), WAG 59 (1963.11.29) 〈**THE NETHERLANDS**〉 L 37(1953. 9.4), L 38(1954.8.3), L 41(1940.7.20), L 44(1953.9. 30), WAG 23(1952.7.3), WAG 24(1952.7.3), WAG 28(1947.7.31), WAG 35(1954.8.3), WAG 37(1954.8. 3), WAG 38(1953.9.4), WAG 40(1954.8.3), WAG 41(1968.8.22), WAG 42(1968.8.22), WAG 44(1968. 8.22), WAG 46(1968.8.22), WAG 47(1968.8.22) 〈**THAILAND**〉 BISH 641094(1971.12.10) 〈**HONG KONG**〉 MICH ?(1972.8.20), MICH ?(1972.11.5), MICH ?(1973.8.1), MICH ?(1972.8.20), MICH ?(1973. 10.10), 〈**?**〉 CHR 125846(1962.2.1), CHR 156008 (1965.2.15), LIV 101775(?.?.?), NY ?(1845.?.?), PC 102(?.?.?), NY ?(?.?.?)

C. japonica **var.** *japonica* **f.** *leucocarpa*
〈**KOREA**〉 **Kyonggi**; JJU 6323(1996.7.29), KEW ? (1989.10.7), **Shantung**; **?**; GH ?(1930.?.?), GH ? (1930.6.21), PE ?(1959.6.30), PH ?(1978.3.22) 〈**U.S.**〉 WAG 59(1966.6.25) 〈**BRITIAN**〉 BM ?(1973.7.17) 〈**THE NETHERLANDS**〉 L 44(1953.9.30), U ? (1960.12.?)

C. japonica **var.** *taquetii*
〈**KOREA**〉 **Chejudo**; JJU 6359(1996.9.18), JJU 6360 (1996.9.18), JJU 6361(1996.9.18), JJU 6362(1996.9. 18), JJU 6363(1996.9.18), JJU 6348(1996.9.18), JJU 6349(1996.9.18), JJU 6350(1996.9.18), JJU 6351(1996. 9.18), JJU 6352(1996.9.18), JJU 6353(1996.9.18), **Chonnam**; SNU 63824(1987.10.17), SNU 63827(1987.10.17), SNU 63838(1987.7.18), SNU 63836(1987.7.18), SNU 63835 (1987.7.18), SNU 63834(1987.7.18), SNU 63825 (1987.10.17), SNU ?(1953.8.4), SNU ?(1953.8.4), SNUA ?(1953.8.4), JJU 6251(1995.7.29), JJU 6252 (1995.7.29), JJU 6253(1995.7.29), JJU 6254(1995.7. 29), JJU 6255(1995.7.29), JJU 6256(1995.7.29), JJU 6257(1995.7.29), JJU 6258(1995.7.29), JJU 6283(1995. 7.29), JJU 6272(1995.7.29), JJU 6276(1995.7.29), JJU 6277(1995.7.29), JJU 6279(1995.7.29), JJU 6280(1995. 7.29), JJU 6281(1995.7.29), JJU 6284(1995.7.29), JJU 6285(1995.7.29), JJU 6343(1996.7.22), JJU 6344 (1996.7.22), JJU 6345(1996.7.22), JJU 6346(1996.7. 22), JJU 6347(1996.7.22), JJU 6356(1996.7.22), JJU 6259(1995.7.29), JJU 6260(1995.7.29), JJU 6261 (1995.7.29), JJU 6263(1995.7.29), JJU 6264(1995.7. 29), JJU 6265(1995.7.29), JJU 6266(1995.7.29), JJU 6268(1995.7.29), JJU 6269(1995.7.29), JJU 6270 (1995.7.29), JJU 6271(1995.7.29), SNUA ?(1964.8. 13), SNUA ?(1964.8.13), **Kyonggi**; SNU 63823 (1986.10.12), SNU 63821(1986.10.12), SNU ?(1939.8. 17), SNU ?(1939.8.17), **Seoul**; SNU 63842(1987. 7.10), SNU 63841(1987.7.10), SNU 63839(1987.7. 10), SNU 63840(1987.7.10), SNUA ?(1975.5.21) 〈**JAPAN**〉 **Hondo**; GH ?(1951.10.27), TUS 54688 (1980.6.28), **Kyushu**; WAG 53(1974.7.2), CHR 303242 (1974.7.2), **?**; GH ?(1955.7.3) 〈**CHINA**〉 **Chekiang**; GH ?(1932.11.4)

C. japonica **var.** *luxurians*
〈**KOREA**〉 **Cheju**; SNU 11929(1935.7.20), SNU 11930(1935.7.20), E 18(1911.7.?), E 20(1908.7.?), E 21(1908.7.?), MICH ?(1948.7.8), MICH ?(1947.8. 30), MICH ?(1947.8.30), MICH ?(1949.6.24), F ? (1947.8.30), **Chonnam**; SNUA ?(1967.7.30), SNUA ?(?.?.?), SNU 63818(1987.7.17), SNU 63815(1987.7. 17), SNU 63816(1987.7.17), SNU 63817(1987.7.17), JJU 6286(1995.8.8), JJU 6287(1995.8.8), JJU 6288 (1995.8.8), JJU 6375(1996.7.23), JJU 6376(1996. 7.23), JJU 6377(1996.7.23), JJU 6378(1996.7.23), SNUA ?(1964.8.17), SNUA ?(?.?.?), SNUA ? (1964. 8.17), MICH ?(1949.8.8), MICH ?(1949.8.5), **Kyonggi**; SNU 63810(1986.10.3), SNUA ?(1952.8.3), **Kyongpuk**; SNU 11936(1937.7.16), SNU 11934(1937.7.15), SNU 11937(1937.7.20), SNU 63808(1986.8.1), SNU 63805(1986.8.1), SNU 63804(1986.8.1), SNU 11931 (1937.7.15), SNU 11962(1947.8.19), SNU 11935(1937. 7.15), SNU 11938(1947.8.21), SNU 63806(1987. 8.1), JJU 6294(1995.8.11), JJU 6295(1995.8.11), JJU 6296(1995.8.11), JJU 6364(1996.7.27), JJU 6365(1996. 7.27), JJU 6366(1996.7.27), JJU 6367(1996.7.27), JJU 6373(1996.7.27), SNUA ? 1966.7.26), SNUA ?(1972.8. 10), SNUA ?(1961.8.1), SNUA ?(1961.7.29), MICH ? (1949.6.3), MICH ?(1949. 6.3), KEW 24(1982.10.1), **?**; SNU 11987(1936.4.14), SNU 11985(1936.4.14), SNU 11989(1936.4.14), SNU 11924(1916.7.15), KEW 20 (1863.?.?) 〈**JAPAN**〉 **Hokkaido**; BM 49827(1900.7.?), **Hondo**; CAS 542608(1959.6.28), CAS 542956(1965. 8.20), CAS 542607(1965.7.10), E 29(1982.7.10), MO 3004869(1977.11.19), MO 2727890(1974.8.21), GH ? (1955.6.3), GH ?(1940.12.8), HIRO ?(1971.7.26), GH ? (1969.10.20), L 64(1987.10.12), PC 102(1866.?.?), TUS 81609(1983.7.24), TUS 60623(1976.7.9), **Kyushu**; BM 49823(1861.6.?), GH ?(1982.7.23), GH ?(1862.?.?), KEW 32(1862.?.?), U 182857(1964.8.5), CHR 423563 (1982.7.23), L 57(1982.7.23), SING 519902(1964.8.5), **Iriomote**; MO 2667783(1976.10.20), **Okinawa**; GH ? (1951.5.4), GH ?(1993.6.27), GH ?(1950.6.8), GH ? (1950.5.4), WAG 61(1972.7.16), L ?(1951.6.24), KEW 27 (1973.7.2), **?**; GH ?(1887.8.?), GH ?(1892.?.?), GH ? (1927.8.11), GH ?(1946.6.9), GH ?(1949.1.6), GH ? (1949.1.6), GH ?(1956.11.22), WAG 60(1978.6.25), PC 102(1986.?.?), L 83(?.?.?), L 9(?.?.?), L 10(?.?.?), L 20(1853.?.?), KEW 25(1951.8.4), 〈**BRITIAN**〉 WAG 57(1908.9.18) 〈**THAILAND**〉 TAI 223497(1992.8.4),

NY 16493(1925.7.29)

C. japonica **var.** *luxurians* **f.** *leucocarpa*
〈**JAPAN**〉 GH ?(1949.1.6)

C. japonica **var.** *angustata*
〈**CHINA**〉 **Hupeh**; L 46(1976.?.?), L 47(1976.?.?), E 25(1907.?.?), E 27(1976.?.?), GH ?(1885.?.?), GH ?(1976.?.?), GH ?(?.?.?), NY ?(?.?.?), MO 2730158(1976.?.?), MO 811589(1907.7.?), BM 49809(1976.?.?), MO 49810(1907.7.?), F 477713(1907.7.?), TEX ?(1976.?.?), KEW 19(?.?.?), **Hunan**; GH ?(1935.7.3), **Kwangsi**; GH ?(1933.9.8), **Shensi**; GH ?(1910.?.?), **Jiangxi**; GH ?(1917.7.7), GH ?(1907.?.?), GH ?(1983.10.3), GH ?(1991.6.?), NY ?(1933.7.6), NY ?(1928.7.20), NY ?(1983.10.3), MO 809675(1907.7.30), MO 3692407(1983.10.3), **Kweichow**; GH ?(1931.?.?), **Kwangtung**; NY ?(1932.7.?), NY ?(1933.7.21), **Szechuan**; NY ?(1928.8.5), **?**; KEW 18(1904.?.?), GH ?(1925.7.12) 〈**TAIWAN**〉 PH ?(1959.8.7), PH ?(1961.7.24), PH ?(1956.8.9), PH ?(1952.7.8), PH ?(1952.7.14) 〈**THE NETHERLANDS**〉 L 48(1954.8.26), WAG 58(1954.8.26)