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A Systematic Study on *Polygonum* sect. *Tovara* (Polygonaceae): Analysis of Morphological Variation

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여뀌속 *Tovara*절 식물의 분류학적 연구 : 형태변이 분석

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ABSTRACT

Most of the species in *Polygonum* sect. *Tovara* show complicated patterns of morphological variation, resulting in taxonomic confusion in delimiting species boundaries and determining relationships. In this study, patterns of morphological variation in *Polygonum* sect. *Tovara* are examined using numerical analyses, and the taxonomic significance of the taxa in the section is reevaluated. Principal components analyses of the five taxa in the section using major morphological characters revealed the presence of three distinct groups in the section; these correspond to *P. virginianum*, *P. filiforme*, and *P. neofiliforme*. The results also indicated that *P. virginianum* var. *glaberrimum* is not taxonomically distinct, and *Tovara* (=*Polygonum*) *virginiana* var. *kachina* should be treated as a variety of *P. neofiliforme*. Preliminary results from the leaf flavonoid analysis of *P. virginianum* var. *virginianum*, *P. filiforme*, and *P. neofiliforme* also showed significant differences in their flavonoid profiles, and these observations strongly suggest that they should be recognized as distinct species.

INTRODUCTION

Polygonum sect. *Tovara*, originally recognized as a genus by Adanson (1763), is morphologically distinct and usually characterized by large ovate to elliptic leaves, elongate spikelike interrupted inflorescences, and persistent 2-parted styles, which become very rigid and bent obliquely downward in fruit. The species of sect. *Tovara* are erect perennial herbs, all of which usually occupy moist habitats, including margins of ponds and lakes, rich shady forest floors, and soils of streambeds. The section shows an interesting disjunct distribution pattern, and the present distribution is confined to eastern North America (with an isolated population in Mexico) and eastern Asia (Fig. 1).

In eastern North America, a single species, *P. virginianum* L., is found, and it ranges from Quebec to Florida, and westward to Oklahoma and Kansas. In eastern Asia, two to four species belonging to sect. *Tovara* have been traditionally recognized, depending on the emphasis placed on size and shape of leaves, length and density of leaf hairs, and size of achenes; these include *P. filiforme* Thunb., *P. neofiliforme* Nakai, *P. apoense* Elmer, and *Tovara smaragdina*[1] Nakai ex Maekawa. However, the taxonomic status of these taxa is much in dispute, and many different views of species boundaries and relationships have been presented. Maekawa (1932), who stressed the differences in achene shape and size, recognized three species (*P. filiforme*, *P. neofiliforme*, and *T. smaragdina*) in Japan. Li (1952a), however, recognized two species, *P. filiforme* and *P. apoense*, in Asia, and placed *P. neofiliforme* and *T. smaragdina* in synonymy under *P. filiforme*; Li based his treatment mainly on differences in overall plant size, leaf shape, pubescence, and rhizome shape. Later, Hara (1962) pointed out, on the basis of differences in leaf shape and leaf surface texture, that *P. neofiliforme*

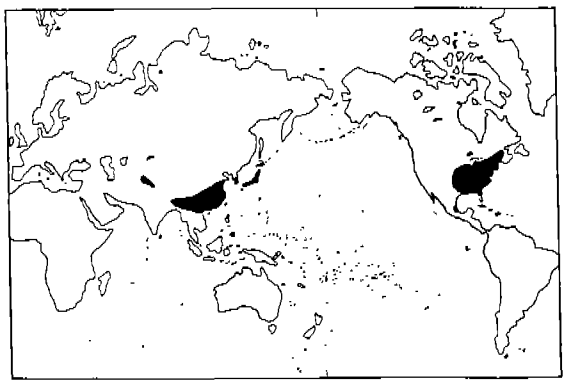

Fig. 1. Worldwide distribution of *Polygonum* sect. *Tovara*.

merits specific status, but reduced *P. apoense* and *T. smaragdina* to a variety and a forma of *P. filiforme*, respectively.

Furthermore, the distinctness of these eastern Asiatic taxa from North American *P. virginianum* is also controversial; some authors (Graham and Wood, 1965; Steward, 1930) treated them as two or three varieties of *P. virginianum*. In addition, most of the species in the section show considerable variation in pubescence and tepal color, and several infraspecific taxa were described on the basis of small differences in these characters from both regions (Fernald, 1937; Hiyama, 1941, 1961). However, no prior attempt has been made to measure patterns of morphological variation in the section to evaluate the taxonomic significance of the taxa mentioned above.

The main objective of this study is to examine patterns of morphological variation in sect. *Tovara* using numerical analyses, and to provide a basis for delimitation of taxa in the section.

MATERIALS AND METHODS

Data used in this study were obtained from the individuals collected by the authors in Korea and the specimens borrowed from the following herbaria; A, BH, CU, GH, K, KUN, KYO, L, LE, MAK, NEBC, NY, PE, TI, TUS, and US. Approximately 900 specimens, including types, were examined to determine the geographical range and morphological variation of the taxa in the section.

[1]If sect. *Tovara* is recognized as a genus, its correct generic name is *Antenoron* Raf. (see Graham and Wood, 1965; Hara, 1965). However, we will refer to this taxon and *T. virginiana* var. *kachina* by their original names to avoid unnecessary confusion in nomenclature and for ease of communication.

Field observations of *P. filiforme* and *P. neofiliforme* populations throughout South Korea were also made in August and September of 1990 and 1991. Specimens were identified primarily by the characters mentioned in the original descriptions and those used by previous authors (Elmer, 1915; Hara, 1962; Li, 1952a; Maekawa, 1932; Nakai, 1922; Nieuwland, 1912; Steward, 1930). A list of specimens used for this study is available from the first author.

After removal of duplicates and poor specimens, 307 specimens, including 80 of *P. virginianum* var. *virginianum*, five of *P. virginianum* var. *glaberrimum* (Fernald) Steyerm., 135 of *P. filiforme*, 79 of *P. neofiliforme*, and eight of *T. virginiana* (=*P. virginianum*) var. *kachina* Nieuwland, were selected for numerical analyses of morphological variation. Specimens were selected to represent geographical range and morphological variability of each taxon. *Tovara smaragdina* was excluded from the analyses, because there was only one specimen that was matched Maekawa's description. *Polygonum apoense* was also not included in the analyses, because we had only two specimens which were very poorly developed. In the case of *P. virginianum* var. *glaberrimum*, only those collections determined by Fernald himself were used for the analyses, because the delimitation of var. *glaberrimum* was very ambiguous.

From these specimens, 11 leaf characters, four of which were derived ratios, were scored for morphological analyses (Table 1; characters 1-11). Leaf width was measured at three different points, one-quarter, one-half, and three-quarters of the leaf blade length (Fig. 2), since the leaf shape and size has been regarded as important for distinguishing the taxa in the section. Then a subset of 193 specimens, including 69 of *P. virginianum* var. *virginianum*, four of *P. virginianum* var. *glaberrimum*, 77 of *P. filiforme*, 36 of *P. neofiliforme*, and seven of *T. virginiana* var. *kachina*, were measured for 15 additional vegetative, inflorescence, and fruit characters (Table 1; characters 12-26); 114 specimens were excluded from the measurements, because some of these characters could not be readily measured in these specimens due to the condition of material or lack of appropriate organs.

For leaf characters, the largest, fully mature leaf in each individual was used for measurements. Length and density of leaf and ocrea hairs were measured using an ocular micrometer and a mesh-micrometer, respectively, under a stereoscopic microscope. Measurements were made from the identical locations on organs in each specimen to reduce variation. For inflorescence and fruit

Table 1. Twenty-six morphological characters used in numerical analyses of *Polygonum* sect. *Tovara*. See Fig. 2 for further clarification

1. Leaf blade length [cm]
2. Leaf width at the one-quarter point [cm]
3. Leaf width at the midpoint [cm]
4. Leaf width at the three-quarter point [cm]
5. Leaf width at the midpoint/blade length (character 3/character 1)
6. Leaf width at the one-quarter point/width at the midpoint (character 2/character 3)
7. Leaf width at the three-quarter point/width at the midpoint (character 4/character 3)
8. Leaf apex angle [degree]
9. Leaf subapex angle [degree]
10. Leaf base angle/2 [degree]
11. Leaf apex angle/subapex angle (character 8/character 9)
12. Leaf cilia number [no./0.5 cm]
13. Leaf cilia length [mm]
14. Leaf upper surface hair density [no./6.25 mm^2]
15. Leaf upper surface hair length [mm]
16. Petiole length/leaf blade length
17. Ocrea cilia length [mm]
18. Ocrea hair density [no./mm^2]
19. Ocrea hair length [mm]
20. Inflorescence hair density [no./0.5 mm^2]
21. Perianth length [mm]
22. Style length [mm]
23. Stamen length [mm]
24. Achene length [mm]
25. Achene width [mm]
26. Achene width/achene length (character 25/character 24)

characters, a fully matured inflorescence was selected for measurements. Except for characters 1-11 and 16 (Table 1), five to six measurements were made for each character in each specimen, and an average of the measurements was used for the analyses.

To describe better the patterns of morphological variation in the section, data sets derived from the above measurements were subjected to principal components analysis. The principal components analysis was performed in two stages, (1) analysis of 193 individuals representing five taxa using 26 vegetative, inflorescence, and fruit characters (Table 1), and (2) analysis of 307 individuals of same five taxa using seven leaf shape characters (Table 1; characters 5-11). The analyses were carried out using Statistical Analysis System (SAS Institute, 1987; Release 6.04) on an IBM PC. Data matrices used for the analyses are available from the first author upon request.

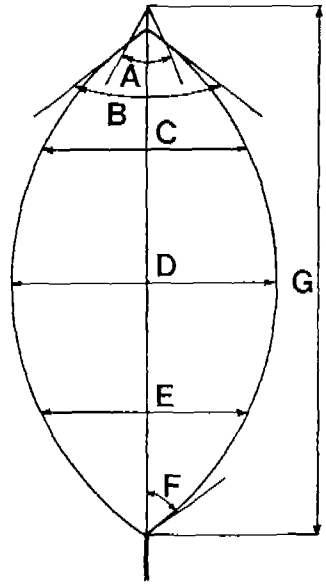

Fig. 2. Diagram of leaf characters. Parenthetical numbers correspond to character numbers in Table 1. A=apex angle (8); B=subapex angle (9); C=width at the three-quarter point (4); D=width at the midpoint (3); E=width at the one-quarter point (2); F=base angle/2 (10); G=blade length (1).

RESULTS AND DISCUSSION

Most taxa described in sect. *Tovara* are primarily based on quantitative differences in morphological characters, including leaf size and shape, leaf hair length and density, and achene size (Elmer, 1915; Fernald, 1937; Maekawa, 1932; Nakai, 1922; Nieuwland, 1912). However, they exhibit considerable variation and some degree of overlap in most distinguishing characters (Table 2), making taxonomic circumscription difficult.

To evaluate the degree of morphological distinctness of the taxa in sect. *Tovara*, measurements of 26 vegetative, inflorescence, and fruit characters (Table 1) from 193 individuals representing five taxa in the section were analyzed using principal components analysis. The first three principal components accounted for 30.7, 15.1 and 10.6 percent of the total variance, respectively (Table 3), and subsequent components contributed less than nine percent each. The first principal component reflected

Table 2. Means and standard deviations of important morphological characters of *Polygonum* sect. *Tovara* taxa. Measurements were taken from herbarium specimens. Character numbers correspond to those in Table 1. VIR=*P. virginianum* var. *virginianum;* GLA=*P. virginianum* var. *glaberrimum;* FIL=*P. filiforme;* NEO=*P. neofiliforme;* KAC=*T. virginiana* var. *kachina*

Character No.	VIR	GLA	FIL	NEO	KAC
1	13.00 ± 2.49	11.30 ± 1.65	13.16 ± 2.01	15.98 ± 2.65	15.66 ± 2.11
2	5.01 ± 1.45	4.60 ± 0.79	5.11 ± 1.19	4.82 ± 1.09	4.41 ± 0.73
3	5.47 ± 1.41	4.78 ± 0.86	6.84 ± 1.29	6.55 ± 1.33	5.73 ± 0.96
4	2.93 ± 0.81	2.62 ± 0.52	5.00 ± 1.01	4.19 ± 1.00	4.05 ± 0.96
5	0.42 ± 0.07	0.43 ± 0.07	0.52 ± 0.06	0.41 ± 0.05	0.36 ± 0.03
6	0.91 ± 0.11	0.97 ± 0.09	0.74 ± 0.07	0.74 ± 0.08	0.78 ± 0.09
7	0.54 ± 0.07	0.55 ± 0.02	0.73 ± 0.06	0.64 ± 0.06	0.70 ± 0.08
8	28.39 ± 5.63	35.60 ± 8.76	46.44 ± 11.33	23.86 ± 5.94	24.13 ± 5.62
9	61.55 ± 10.53	63.80 ± 13.48	92.57 ± 10.46	71.78 ± 9.59	71.25 ± 10.48
10	46.73 ± 9.56	45.80 ± 10.40	42.62 ± 7.35	33.35 ± 5.85	31.38 ± 7.61
11	0.47 ± 0.12	0.56 ± 0.11	0.50 ± 0.12	0.34 ± 0.09	0.34 ± 0.08
12	11.07 ± 1.74	10.75 ± 0.50	16.01 ± 3.21	13.17 ± 2.05	11.00 ± 1.63
13	0.79 ± 0.24	0.55 ± 0.16	0.72 ± 0.27	0.34 ± 0.08	1.68 ± 0.27
14	10.01 ± 9.14	2.75 ± 2.50	7.26 ± 3.56	16.06 ± 6.29	4.29 ± 0.95
15	0.65 ± 0.34	0.14 ± 0.10	0.81 ± 0.38	0.11 ± 0.04	1.93 ± 0.28
16	0.10 ± 0.03	0.10 ± 0.04	0.12 ± 0.04	0.09 ± 0.02	0.09 ± 0.03
17	2.45 ± 0.49	2.12 ± 0.39	2.28 ± 0.49	1.73 ± 0.29	3.40 ± 0.49
18	6.71 ± 3.07	3.50 ± 0.58	3.86 ± 2.19	7.17 ± 3.51	3.00 ± 1.00
19	1.77 ± 0.36	1.43 ± 0.21	1.85 ± 0.51	0.66 ± 0.20	3.44 ± 0.65
20	8.38 ± 7.18	15.00 ± 3.65	4.49 ± 8.07	15.25 ± 5.77	10.43 ± 8.79
21	4.89 ± 0.43	4.78 ± 0.39	3.88 ± 0.46	4.20 ± 0.30	5.16 ± 0.37
22	3.04 ± 0.30	2.93 ± 0.36	2.33 ± 0.36	2.63 ± 0.31	3.13 ± 0.24
23	1.91 ± 0.23	1.81 ± 0.20	1.38 ± 0.17	1.57 ± 0.15	1.78 ± 0.11
24	3.38 ± 0.27	3.35 ± 0.23	2.91 ± 0.23	2.94 ± 0.22	3.61 ± 0.20
25	2.27 ± 0.21	2.19 ± 0.18	2.05 ± 0.15	2.01 ± 0.19	2.29 ± 0.18
26	0.67 ± 0.05	0.65 ± 0.03	0.71 ± 0.05	0.69 ± 0.07	0.63 ± 0.04

high positive loadings for leaf width at the midpoint (3; parenthetical numbers here and subsequently refer to Table 1), leaf width at the three-quarter point (4), ratio of leaf width at the midpoint/blade length (5), ratio of leaf width at the three-quarter point/width at the midpoint (7), leaf apex angle (8), and leaf subapex angle (9), and high negative loadings for perianth length (21), style length (22), stamen length (23), and achene length (24). The second component was weighted heavily for leaf cilia length (13), leaf upper surface hair length (15), ocrea cilia length (17), and ocrea hair length (19). Characters related to the third component included leaf blade length (1), leaf width at the one-quarter point (2), leaf width at the midpoint (3), and leaf base angle (10) (Table 3).

The plot of individuals projected on the first two principal components (Fig. 3) revealed the presence of three major groups in the section; one including individuals of *P. filiforme,* a second with individuals of *P. neofiliforme,* and a third including mainly those of *P. virginianum.* In the plot (Fig. 3), individuals of *P. filiforme* were separated from those of *P. virginianum* with little overlap by the first principal component, which is primarily a function of characters related to the leaf shape and the size of floral parts and achenes (Table 3). The relative positions of individuals of these two taxa on the first component (Fig. 3) suggest that plants of *P. filiforme* tend to have leaves with much broader upper and apical portions and smaller floral parts and achenes as compared to those of *P. virginianum.* These observations agree with the contention (Hara, 1952, 1965; Li, 1952a, b) that eastern Asiatic *P. filiforme* is distinct from North American *P. virginianum,* and it is sufficiently differentiated to be treated as a distinct species. Individuals of *P. neofiliforme* occupied an intermediate position between *P. filiforme*

Table 3. Loadings of the first three principal components for 26 morphological characters from the analysis of 193 individuals of *Polygonum* sect. *Tovara*. Character numbers correspond to those in Table 1

Character No.	Component		
	1	2	3
1	0.0732	−0.1847	0.3824
2	0.1337	0.0000	0.5211
3	0.2450	−0.0227	0.4065
4	0.3024	0.0336	0.2174
5	0.2581	0.1589	0.1449
6	−0.1813	0.0284	0.1966
7	0.2597	0.0937	−0.1328
8	0.2417	0.2363	−0.1569
9	0.2892	0.1270	0.0762
10	−0.0058	0.1502	0.3126
11	0.0408	0.1882	−0.2736
12	0.2401	0.0045	−0.0872
13	−0.1093	0.3897	0.0422
14	−0.0431	−0.2014	0.0553
15	−0.0240	0.4180	0.0147
16	0.1265	0.1425	−0.0007
17	−0.1211	0.3171	0.0598
18	−0.1311	−0.1648	0.0534
19	−0.0622	0.4282	0.0274
20	−0.1287	−0.1918	0.0014
21	−0.2960	0.0811	0.1054
22	−0.2859	0.0427	0.1002
23	−0.2940	0.0332	0.1236
24	−0.2652	0.1339	0.1329
25	−0.1805	0.1847	0.1215
26	0.1254	0.0515	−0.0283
Eigenvalue	7.9932	3.9114	2.5080
Cumulative % of eigenvalues	30.7	45.8	56.4

and *P. virginianum* individuals on the first component, but they were well-separated from those of the latter two species by the second component (Fig. 3). The second component is related primarily to hair and cilia lengths (Table 3), indicating that plants of *P. neofiliforme* have relatively short hairs and cilia as compared to those of *P. filiforme* and *P. virginianum*.

Tovara virginiana var. *kachina* was described from Burma by Nieuwland (1912), mainly on the basis of densely pubescent leaves and ocreae. Individuals of var. *kachina* formed a loose cluster and appeared to hold a position close to *P. virginianum* var. *virginianum* in the plot

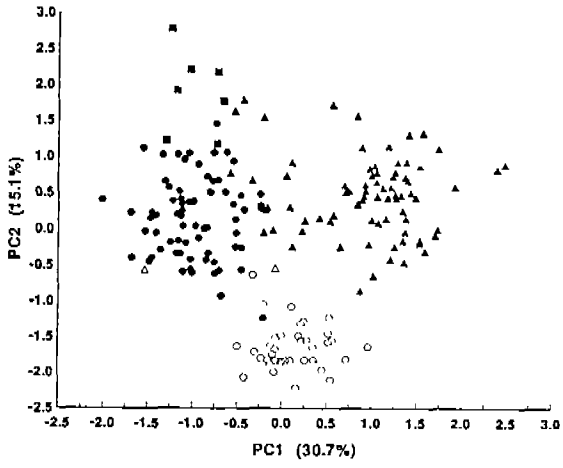

Fig. 3. Principal components analysis of *Polygonum* sect. *Tovara* taxa using 26 vegetative, inflorescence, and fruit characters (cf. Table 1). Some individuals are hidden due to the same values. Symbols: Open circles=*P. neofiliforme*. Closed circles=*P. virginianum* var. *virginianum*. Open triangles=*P. virginianum* var. *glaberrimum*. Closed triangles=*P. filiforme*. Closed squares=*T. virginiana* var. *kachina*.

(Fig. 3). Except for the differences in hair length and density, however, var. *kachina* is morphologically and geographically closer to *P. neofiliforme* than to *P. virginianum* var. *virginianum*. Its close phenetic relationship with *P. virginianum* suggested by this principal component analysis is probably due to their high values in achene size characters (Table 2); plants of both *T. virginiana* var. *kachina* and *P. virginianum* var. *virginianum* tend to have larger achenes as compared to those of *P. neofiliforme*. In the case of *P. virginianum* var. *glaberrimum*, a glabrous variety originally described by Fernald (1937) from the southeastern United States, the individuals did not form a distinct cluster and interspersed among those of *P. virginianum* var. *virginianum* (Fig. 3), reflecting the absence of diagnostic characters correlating with it. This result strongly suggests that plants of var. *glaberrimum* are well within the range of variability of *P. virginianum* var. *virginianum*, and should not be recognized as taxonomically distinct.

Since the leaf shape has been regarded as most important for distinguishing the taxa in the section (Hara, 1952, 1962; Li, 1952a; Maekawa, 1932; Nakai, 1922; Steward, 1930), measurements of seven leaf shape characters (Table 1; characters 5-11) from 307 individuals of the above five taxa were analyzed by principal components analysis.

Table 4. Loadings of the first three principal components for seven leaf shape characters from the analysis of 307 individuals of *Polygonum* sect. *Tovara*. Character numbers correspond to those in Table 1

Character No.	Component		
	1	2	3
5	0.4547	0.1979	0.3110
6	−0.2470	0.5755	0.0991
7	0.4407	−0.3029	−0.0252
8	0.4918	0.1848	−0.3062
9	0.4724	−0.1041	0.4076
10	0.0980	0.6194	0.3400
11	0.2518	0.3306	−0.7192
Eigenvalue	3.3446	1.9401	1.1023
Cumulative % of eigenvalues	47.8	75.5	91.2

Results of the analysis are given in Table 4, and an ordination of individuals projected on the first two principal components is shown in Fig. 4. The first three components accounted for 91.2 percent of the total variance; 47.8, 27.7, and 15.7 percent, respectively (Table 4). Subsequent components contributed less than five percent each. The first principal component was weighted heavily for ratio of leaf width at the midpoint/blade length (5) and those characters related to the shapes of upper and apical portions of the blade such as ratio of leaf width at the three-quarter point/width at the midpoint (7), apex angle (8), and subapex angle (9). The second component reflected high positive loadings for ratio of leaf width at the one-quarter point/width at the midpoint (6) and base angle (10) (Table 4).

In general, the same three major groups suggested by the first principal component analysis were also discernable in this analysis (Fig. 4). In the plot (Fig. 4), individuals of *P. filiforme* were separated from those of *P. virginianum* and *P. neofiliforme* by the first principal component; it confirms the result of the first analysis that plants of *P. filiforme* have tendency for leaves with broader upper and apical portions as compared to those of the latter two species. The second component, which is primarily related to the shape of leaf base (Table 4), separated individuals of *P. virginianum* from those of *P. neofiliforme*. The relative positions of individuals of these two species on the second component (Fig. 4) suggest that leaves of *P. virginianum* tend to be broad in basal portion, whereas those of *P. neofiliforme* tend to

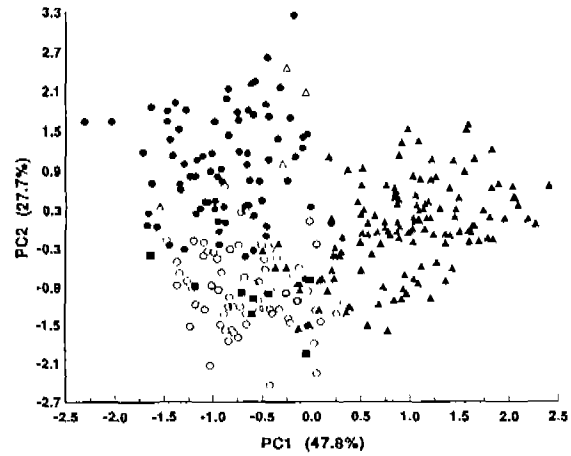

Fig. 4. Principal components analysis of *Polygonum* sect. *Tovara* taxa using seven leaf characters. Some individuals are hidden due to the same values. Symbols: Open circles=*P. neofiliforme*. Closed circles=*P. virginianum* var. *virginianum*. Open triangles=*P. virginianum* var. *glaberrimum*. Closed triangles=*P. filiforme*. Closed squares=*T. virginiana* var. *kachina*.

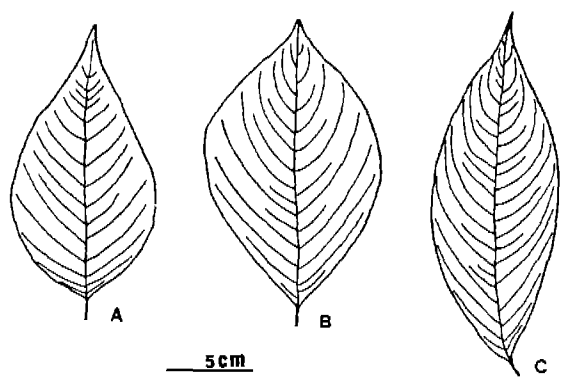

Fig. 5. Representative leaves of *Polygonum* sect. *Tovara*. A: *P. virginianum* var. *virginianum*. B: *P. filiforme*. C: *P. neofiliforme*.

have narrow, attenuating basal portions with acute bases. This result supports the view (Hara, 1962, 1965; Maekawa, 1932; Nakai, 1922; Ohki, 1926) that *P. neofiliforme* is separable from *P. filiforme* and *P. virginianum* by its leaf shape and should be recognized as a distinct species. Especially noteworthy are the positions of individuals of *T. virginiana* var. *kachina* in the plot. In Fig. 4, the individuals are interspersed among those of *P. neofiliforme*, indicating that plants of var. *kachina* are basically identical to those of *P. neofiliforme* in terms of leaf shape. In

addition, var. *kachina* is geographically closer to *P. neofiliforme*, and these observations strongly suggest that it should be treated as a variety of *P. neofiliforme*.

CONCLUSION

Although most taxa in the sect. *Tovara* show complicated patterns of morphological variation, results from the both principal components analyses (Tables 3, 4; Figs. 3, 4) revealed the presence of three distinct groups in the section; these correspond to *P. virginianum*, *P. filiforme*, and *P. neofiliforme*. The results of the analyses also suggest that these taxa can be distinguished by their leaf shapes (Tables 3, 4). Diagnostically, *P. virginianum* has ovate leaves with gradually acuminating apical portions and relatively broad bases (Fig. 5A), while *P. filiforme* has broadly elliptic to oval leaves with relatively broad acute apices and acute to round bases (Fig. 5B). In *P. neofiliforme*, the leaves are much narrower as compared to *P. virginianum* and *P. filiforme*, and usually oblong with sharp acuminate apices and acute bases (Fig. 5C). Preliminary results from the leaf flavonoid analysis of these three taxa (Park, unpubl.) also showed that they are different in terms of flavonoid profiles (Fig. 6), and these observations strongly suggest that they should be recognized as distinct species.

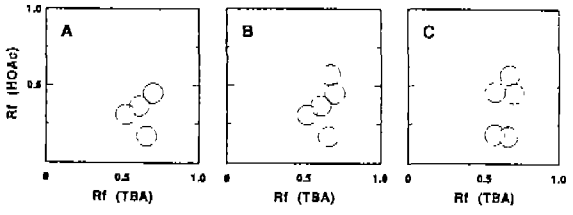

Fig. 6. Leaf flavonoid profiles of *Polygonum* sect. *Tovara* on cellulose TLC plates. A: *P. virginianum* var. *virginianum*. B: *P. filiforme*. C: *P. neofiliforme*.

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적 요

여뀌속 *Tovara*절 식물은 매우 복잡한 양상의 형태변이를 나타내기 때문에 각 분류군의 한계 및 위치 설정, 계통적 유연관계 해석에 있어 많은 혼란이 나타나고 있다. 따라서 본 연구에서는 본 절 분류군에서 나타나는 형태 변이의 양상을 수리분류학적으로 분석하여, 각 분류군의 한계를 명확히 설정하고 그 분류학적 타당성을 검토하고자 하였다. 본 절 분류군의 주요 식별형질에 대한 주성분 분석을 수행한 결과, 본 절은 형태적으로 크게 *P. virginianum*, *P. filiforme*, *P. neofiliforme*의 3 분류군으로 구분되며, 이들은 주로 잎의 형태에 의해 식별되는 것으로 밝혀졌다. 또한 *P. virginianum* var. *glaberrimum*은 그 분류학적 타당성이 없는 것으로 나타났으며, *Tovara* (=*Polygonum*) *virginiana* var. *kachina*는 형태적으로 볼때 *P. neofiliforme*의 변종으로 취급하는 것이 타당한 것으로 판명되었다. *Polygonum virginianum*, *P. filiforme*, *P. neofiliforme*는 그 flavonoid 조성에 있어서도 명확한 차이를 나타내며, 이러한 결과를 종합해 볼때 이들은 각각 독립된 종으로 인식하는 것이 타당한 것으로 판단된다.

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