

Comparative Foliar Structure of *Vicia* L. Species from China

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Abstract

The genus *Vicia* L. includes about 190 species around the world and approximately 40 species in China. The genus includes minor food crops and forage plants. This study gives a detailed description of foliar structure of some *Vicia* species from China. Leaf characters showed considerable variation among studied taxa including petiole and tendril length; leaflets number, length, width, shape, apex, base; blade surface, trichome shape, type, base and length; stipules shape, base, length, width and surface. Numerical analysis of these characters was used to construct a phenogram illustrating the relationship between the studied taxa and to build an artificial key to identify *Vicia* species. Moreover, variation in leaf characters helped in overcoming the overlapping among harmful taxa.

Keywords

Vicia, Fabaceae, Stipules, Trichomes, Numerical Taxonomy, Micro-Morphology

1. Introduction

Taxonomic significance of the foliar structure has been well documented [1] [2] [3]. Leaf micro-morphological characters show systematic significance in different levels in family Fabaceae [4] [5] [6]. Trichomes micro-morphology is one of the most significant leaf micro-morphological characters studied in species of different genera [7] [8].

The genus *Vicia* L. of the Fabaceae family includes about 190 species [9]. About 40 species have economic importance. The genus includes some minor food crops and more than a dozen forage plants; the most important is common vetch, *V. sativa*, cultivated in many countries [10].

Taxonomic delimitation is necessary to solve the overlapping between economic crops and harmful species. Morphological characters of leaf feature which may provides information for understanding species relationship in the genus *Vicia*, have not been studied. This work was initiated with the objectives of using leaf features to identify taxa.

2. Material and Methods

2.1. Seed Source and Morphological Examination

Vicia species seeds in this study were obtained from Desert Legume Program (DELEP) and The Germplasm Bank of Wild Species, Southwest China.

Seeds of each taxon were germinated in perlite sand; Ten days after germination (Seed were treated as germinated when the radical protruded from the envelopes), the young seedlings were transferred to pots containing peat moss soil. 60 days later, complete leaves were collected from each taxon, all the leaves were collected from the fifth nodes.

Stereo-microscope and light microscope were used for morphological measurement of the leaves.

2.2. Statistical Analysis

The extracted leaf characters were coded as 1 to 0 codes and used for numerical analysis; forty eight characters were recorded for each taxon. Phenogram illustrating the relationship between the studied taxa were constructed using the NTsys2.1 [11].

3. Results and Discussion

Considerable variation of leaf characters were observed among studied taxa as shown in **Figures 1-3**; for example, leaf consisted of 2 leaflets or 4 - 8 leaflets with their shape varying from elliptic, lanceolate, oblong, obovate to ovate. Leaflet apex was acute, acuminate, obtuse or truncate and the base was cuneate or obtuse. Leaf surface was hairy to glabrous. Stipules shape varied from sagittate to hastate with acute to forked base. Observed variations summarized in **Table 1** and **Table 2** enabled us to identify species.

Several natural systems had been constructed to divide the genus *Vicia* based on morphological characters such as stems, flowers, and fruits [12]-[17]. In addition to species identification, this work leaf characters were used to help in overcoming the overlapping among these systems.

In the natural system of [18], *V. sativa* subsp. *nigra* was treated as *V. angustifolia* subsp. *pusilla*; on the other side, [12] treated it as a subspecies of *V. sativa*; this suspicion may be dangerous as *V. angustifolia* is an important forage plant, belonging to the first group of fodder vetches [13], while *V. sativa* ssp. *nigra* is possibly contains gluco-alkaloids and neurotoxic cyanoamino acids which have toxic effect [19]. The phenogram in **Figure 4** show that *V. sativa* subsp. *nigra* is more closely related to *V. sativa* (0.2 - 0.5 mm, acute, multicellular trichomes

Table 1. Leaf characters of studied species.

Species	Petiole		Leaflets					Trichomes					
	length (cm)	N	Length (cm)	Width (mm)	Shape	Apex	Base	Surface	Shape	Type	Length (mm)	Distance (mm)	Base
<i>V. amoena</i>	0.5 - 0.8	2	1.9 - 2.2	4 - 5	Lanceolate	Acute	Obtuse	Glabrous	-	-	-	-	-
<i>V. angustifolia</i>	0.8 - 1.1	4	0.8 - 1.1	2 - 3	Oblong	Acuminate	Obtuse	Hairy	Linear	Unicellular	1 - 2	0.1 - 0.3	Nonglandular
<i>V. bungei</i>	0.5 - 0.8	2	0.9 - 1.2	7 - 9	Obovate	Obtuse	Cuneate	Glabrous	-	-	-	-	-
<i>V. costata</i>	0.7 - 1.2	2	0.7 - 0.9	2 - 3	Oblong	Acuminate	Obtuse	Glabrous	-	-	-	-	-
<i>V. hirsuta</i>	0.5 - 0.7	4	0.7 - 0.9	2 - 3	Oblong	Truncate	Cuneate	Glabrous	-	-	-	-	-
<i>V. japonica</i>	0.3 - 0.5	4	0.8 - 1	3 - 4	Oblong	Obtuse	Cuneate	Glabrous	-	-	-	-	-
<i>V. sativa</i> subsp. <i>nigra</i>	0.7 - 1	2	1.5 - 1.7	3 - 4	Lanceolate	Acuminate	Obtuse	Hairy	Acute	Multicellular	0.2 - 0.4	0.1 - 0.5	Glandular
<i>V. sativa</i> subsp. <i>sativa</i>	0.8 - 1.2	2	1.2 - 1.4	4 - 5	Ovate	Acute	Obtuse	Hairy	Acute	Multicellular	0.2 - 0.5	0.2 - 0.5	Glandular
<i>V. tenuifolia</i>	0.7 - 1	2	1.3 - 1.5	4 - 5	Ovate	Acute	Cuneate	Hairy	Acute	Unicellular	1 - 2	0.6 - 0.8	Nonglandular
<i>V. tetrasperma</i>	0.7 - 1	2	0.7 - 0.9	2 - 3	Elliptic	Acute	Cuneate	Glabrous	-	-	-	-	-
<i>V. villosa</i> subsp. <i>dasycarpa</i>	0.5 - 0.8	4 - 8	0.8 - 1.1	2 - 3	Oblong	Acuminate	Cuneate	Hairy	Linear	Unicellular	1 - 2	More than 2	Nonglandular
<i>V. villosa</i> subsp. <i>varia</i>	0.3 - 0.4	6	0.9 - 1.1	2 - 3	Lanceolate	Acuminate	Cuneate	hairy	Acute	Unicellular	1 - 2	0.8 - 1.3	Nonglandular

Table 2. Stipules structure of studied species.

Species	Shape	Base	Length (mm)	Width (mm)	Blade length (mm)	Base length (mm)	Surface	Hair length (mm)	Distance between trichomes (mm)	No. of trichomes in (1mm)
<i>V. amoena</i>	Sagittate	Acute	1 - 1.2	0.2 - 0.3	0.5 - 0.6	0.5 - 0.6	Smooth	-	-	-
<i>V. angustifolia</i>	Sagittate	Acute	1.5 - 1.7	0.4 - 0.5	0.8 - 1	0.7 - 0.8	Hairy	0.16 - 0.4	0.08 - 0.1	12 - 16
<i>V. bungei</i>	Hastate	Acute	2.5 - 2.7	1.5 - 1.8	0.3 - 0.4	2.2 - 2.4	Smooth	-	-	-
<i>V. costata</i>	Sagittate	Acute	0.6 - 0.8	0.2 - 0.3	0.4 - 0.5	0.2 - 0.3	Smooth	-	-	-
<i>V. hirsuta</i>	Sagittate	Forked	1.6 - 2	0.4 - 0.5	0.8 - 1	0.8 - 1	Smooth	-	-	-
<i>V. japonica</i>	Sagittate	Acute	1.8 - 2	0.4 - 0.5	1 - 1.2	0.8 - 0.9	Smooth	-	-	-
<i>V. sativa</i> subsp. <i>nigra</i>	Sagittate	Acute	2.1 - 2.4	0.2 - 0.3	1.3 - 1.4	0.8 - 1	Hairy	0.08 - 0.16	0.008 - 0.16	5 - 7
<i>V. sativa</i> subsp. <i>sativa</i>	Sagittate	Forked	3.5 - 3.8	0.4 - 0.5	2.3 - 2.5	1.2 - 1.4	Hairy	0.16 - 0.28	0.12 - 0.36	7 - 9
<i>V. tenuifolia</i>	Sagittate	Acute	1.5 - 1.8	0.2 - 0.3	1.2 - 1.4	0.3 - 0.4	Smooth	-	-	-
<i>V. tetrasperma</i>	Hastate	Acute	1 - 1.2	0.2 - 0.3	0.8 - 1	0.2 - 0.3	Smooth	-	-	-
<i>V. villosa</i> subsp. <i>dasycarpa</i>	Hastate	Acute	2 - 2.2	0.4 - 0.5	1.7 - 1.9	0.3 - 0.4	Smooth	-	-	-
<i>V. villosa</i> subsp. <i>varia</i>	Sagittate	Acute	1.3 - 1.5	0.4 - 0.5	1 - 1.1	0.3 - 0.4	Hairy	0.16 - 0.2	0.1 - 1	3 - 4

with glandular base) and not to *V. angustifolia* (1 - 2 mm, linear, unicellular trichomes with non-glandular base) supporting the classification of [12].

An artificial key to *Vicia* species was constructed as follow:

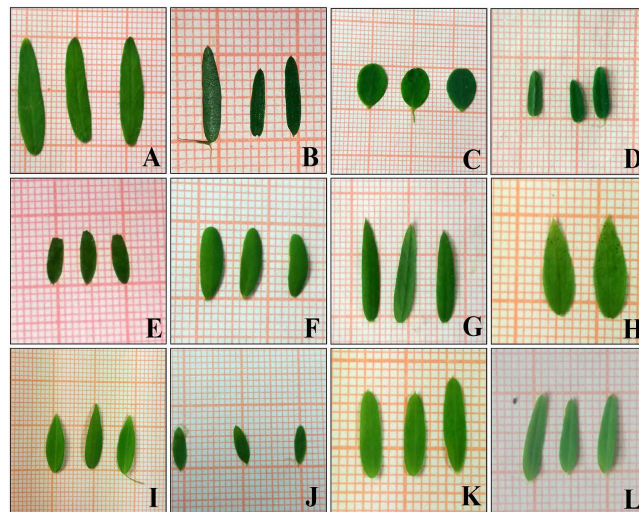


Figure 1. Leaflets structure in studied *Vicia* species. (A) *V. amoena*; (B) *V. angustifolia*; (C) *V. bungei*; (D) *V. costata*; (E) *V. hirsuta*; (F) *V. japonica*; (G) *V. sativa* subsp. *Nigra*; (H) *V. sativa* subsp. *Sativa*; (I) *V. tenuifolia*; (J) *V. tetrasperma*; (K) *V. villosa* subsp. *dasycarpa*; (L) *V. villosa* subsp. *varia*.

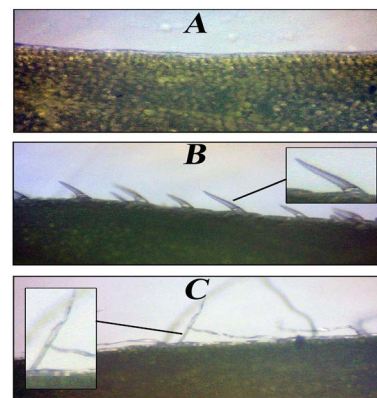


Figure 2. Blade surface in studied *Vicia* species. (A) Smooth surface; (B) Glandular trichomes; (C) Non-glandular trichomes.

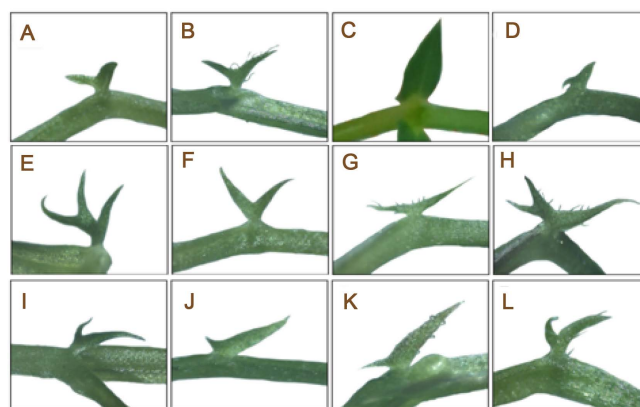


Figure 3. Stipules structure in studied *Vicia* species. (A) *V. amoena*; (B) *V. angustifolia*; (C) *V. bungei*; (D) *V. costata*; (E) *V. hirsuta*; (F) *V. japonica*; (G) *V. sativa* subsp. *nigra*; (H) *V. sativa* subsp. *sativa*; (I) *V. tenuifolia*; (J) *V. tetrasperma*; (K) *V. villosa* subsp. *dasycarpa*; (L) *V. villosa* subsp. *varia*.

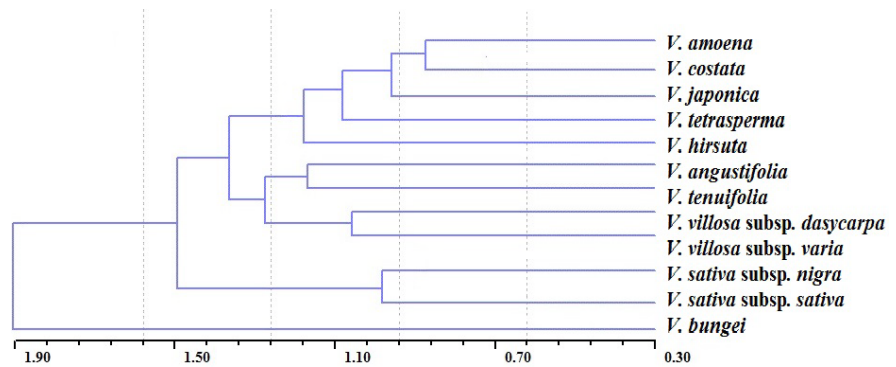


Figure 4. Phenogram illustrating the relationships between the studied *Vicia* species on the bases of the micro morphological characters of the leaf, the total number of the recorded characters is (48) in each taxon.

- | | |
|---|---|
| 1a. Leaflets obovate, | <i>V. bungei</i> |
| 1b. Leaflets elliptic | (2) |
| 2a. Blade with multicellular trichomes | (3) |
| 2b. Blade smooth or with unicellular trichomes | (4) |
| 3a. Leaflets ovate. Stipules base forked | <i>V. sativa</i> subsp. <i>sativa</i> |
| 3b. Leaflets lanceolate. Stipules base acute | <i>V. sativa</i> subsp. <i>nigra</i> |
| 4a. Leaflets blade hairy | (5) |
| 4b. Leaflets blade smooth | (8) |
| 5a. Leaflets oblong. Blade surface with linear trichomes | (6) |
| 5b. Leaflets lanceolate or ovate. Blade surface with acute trichomes | (7) |
| 6a. Blade with 0.1 to 0.5 mm distances between trichomes. Stipules with hairy surface | <i>V. angustifolia</i> |
| 6b. Blade with more than 2 mm distances between trichomes. Stipules with smooth surface | <i>V. villosa</i> subsp. <i>dasycarpa</i> |
| 7a. Leaf with 2 leaflets | <i>V. tenuifolia</i> |
| 7b. Leaf with 4-8 leaflets | <i>V. villosa</i> subsp. <i>varia</i> |
| 8a. Stipules with forked base | <i>V. hirsuta</i> |
| 8b. Stipules with acute base | (9) |
| 9a. Leaflets elliptic. Stipules hastate | <i>V. tetrasperma</i> |
| 9b. Leaflets lanceolate or oblong. Stipules sagittate | (10) |
| 10a. Leaflets with obtuse apex and cuneate base | <i>V. japonica</i> |
| 10b. Leaflets with acute or acuminate apex and obtuse base | (11) |
| 11a. Leaflets oblong | <i>V. costata</i> |
| 11b. Leaflets lanceolate | <i>V. amoena</i> |

In conclusion, our results show that leaf morphological characters are variable and helpful in distinguishing various species and could be used to construct an artificial key to identify *Vicia* species.

Acknowledgements

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