Taxonomy And Phylogeny Of Some Species Belonging To Subfamily Papilionoideae From Popa Area, Kyaukpadaung Township

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Abstract

Taxonomy and phylogeny of some species from subfamily Papilionoideae found in Popa area, Kyaukpadaung Township within Mandalay Region were studied. Totally 7 species belonging to 7 genera were collected and identified from the year 2019. They are each species from the genus *Cajanus*, *Flemingia*, *Gliricidia*, *Lablab*, *Pueraria*, *Sesbania* and *Tephrosia*. The tree species are *Gliricidia sepium* (Jacq.) Walp., *Sesbania grandiflora* (L.) Poir. The other species are shrubs and herbs. The phenogram and cladogram for the phylogeny of all study species were constructed. *Cajanus albicans* (Wight & Arn.) Maesen, *Lablab purpureus* (L.) Sweet are more closely related and advanced among the study species because they have most similarity. The outstanding characteristics of all species were presented with their photographs of inflorescences. An artificial key to the study species was also constructed.

Key words: Papilionoideae, identification, phenogram and cladogram, more closely related and advanced species

Introduction

The flowering plants are dominant and successful plants in the world. They are fundamental importance to the life and survival of men.

Taxonomy is often defined as a science dealing with the study of classification, including its bases, principles, rules and procedures. Taxonomy is a major part of systematic that includes four components; description, identification, nomenclature and classification (Simpson, 2006).

Taxonomic study is the learning of the kinds of plants on the earth and their names, their distributions and habitat characteristics and correlation of these facts of knowledge with scientific data contributed by research activities of related fields of botanical endeavor. Identification is the determination of a taxon as being identical with or similar to another and already known element; the determination may or may not be arrived at by the arid of literature or by comparison with plants of known identity. Classification is the placing of a plant in groups or categories according to a particular plan or sequence and in conformity with a nomenclatural system (Lawrence, 1951).

Phylogeny deals with the evolutionary history of all taxa, from those in the category of division or phylum down to the species and their subdivisions. It is a function of taxonomic research at all levels of classification. There is a distinction between phylogenetic and taxonomic classification. Taxonomy is based on characters but Phylogeny on changes of characters (Lawrence 1951).

Phylogenetic methods aim at developing a classification based on analysis of phylogenetic data and developing a diagram termed cladogram or phylogenetic tree. Sneath and Sokal, 1973, define Numerical taxonomy as grouping by numerical methods of taxonomic units into taxa on the basis of their character states (Singh 2010).

The present research deals with the Taxonomy and phylogeny of some species from subfamily Papilionoideae in Popa area, Kyaukpadaung Township within Mandalay Region. Popa is located at the Northern side of Kyaukpadaung Township. It is a tropical region in the central Myanmar. Popa area is situated between North Latitude 20° 48′- 20° 58′ and 95° 11′ - 95° 18′ East Longitude. The popa area occupy 43505 acres. Mount Popa is bounded by Shwe

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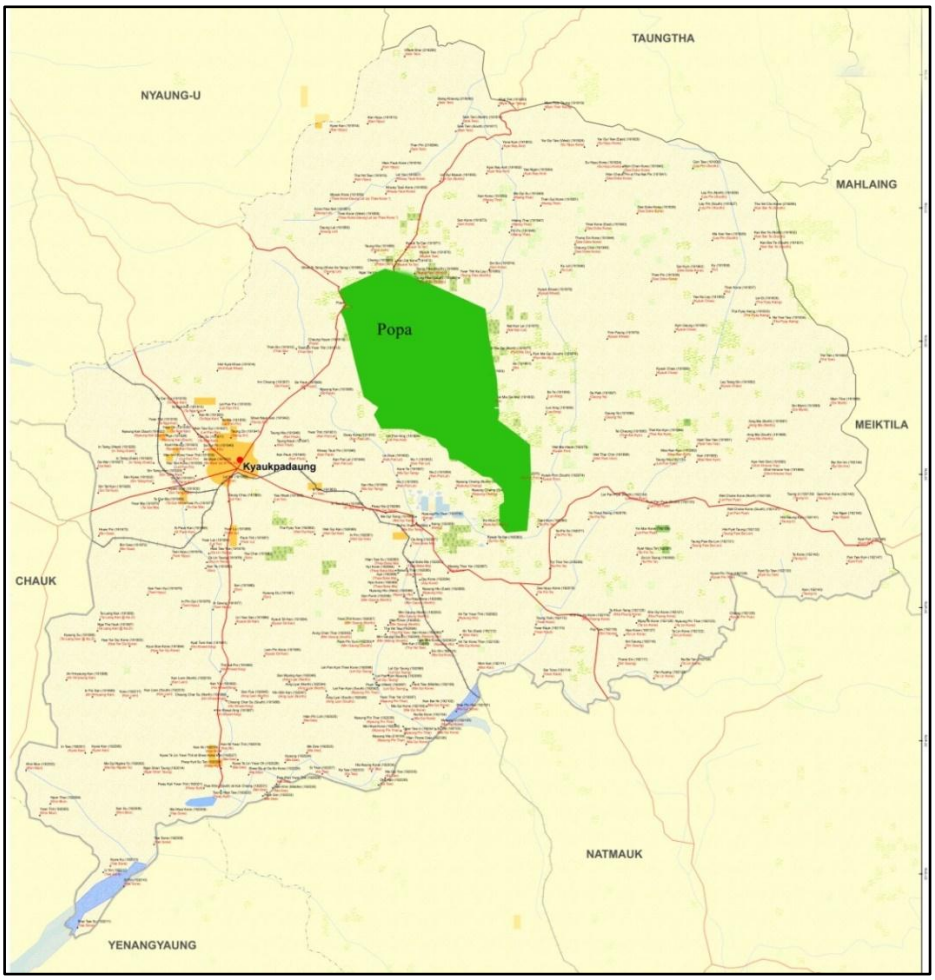
Si Taing Village in the west, Myauk Taww Village in the North, Kyauktaga Village in the South and Lwin I Village in the East. The elevation of mount popa is 4981 feet above sea level.

The aim and objectives of this research are to collect and verify the species belonging to Papilionoideae, to record distinctive characteristics of these species, to construct the phenogram and cladogram for the phylogeny of all study species and to give the knowledge of taxonomic information and phylogenetic relationship of some pea plants to other researchers.

Materials and Methods

The flowering plants from subfamily Papilionioideae in Popa area, Kyaukpadaung Township were collected during December 2018 to August 2019. All the collected specimens were recorded by taking photographs. Their morphological characters were also conducted with the help of dissecting microscope. The genera and species were identified by using the literature of Flora of west Parkistan (Nasir and Ali 1973, 1977) and Flora of Ceylon (Dassanayake, 1980, 1996). The outstanding characters were mentioned with the photographs of inflorescences (Figure 2). Myanmar names were referred to Hundley and Chit Ko Ko (1987). English names and flowering period of the study species were recorded. The phenogram and cladogram for the phylogeny of all study species was created. An artificial key to all species was also constructed.



Source: Department of Meterology and Hydrology in Kyaukpadaung Township

Figure 1. Location Map of Study Area

Results

The 7 species belonging to 7 genera of subfamilies Papilionioideae were identified. The list of these species was presented in Table 1. The genera were arranged alphabetically. The taxonomic characteristics of all taxa were presented in Table 2. Numerical data matrix of taxa and characters was presented in Table 2.1 and the matching coefficients of data matrix was made in Table 2.2. Construction of phenogram and phylogenetic tree (cladogram) based on similar matrix was shown in Figure 3.

Table 1. List of the study species

Division - Spermatophyta
Subdivision - Magnoliophyta (Angiospermae)
Class - Magnoliopsida (Dicotyledoneae)
Subclass - Magnoliidae
Order - Fabales
Family - Fabaceae

No	Subfamily	Scientific name	Myanmar name
1	Papilionoideae	*Cajanus albicans* (Wight & Arn.) Maesen	Taw pe
2		*Flemingia congesta* Roxb. ex Aiton	Palan phyu
3		*Gliricidia sepium* (Jacq.) Kunth ex Walp.	Thinbaw ngusat
4		*Lablab purpureus* (L.) Sweet	Nwai pe
5		*Pueraria montana* (Lour.) Merr.	Unknown
6		*Sesbania grandiflora* (L.) Poir.	Pauk pan ni
7		*Tephrosia villosa* (L.) Pers.	Me yaing

Diagnostic features of Fabaceae

Herbs, shrubs, trees, woody or herbaceous climbers with usually alternate leaves. Leaves are sometimes simple, usually 3-foliate, palmate, pinnate or bipinnate, the petioles and leaflets with pulvinus. Stipules are present. Flowers are bilaterally or radially symmetrical, bisexual or unisexual, the whorls of 5 sepals, 5 petals and 2 of 5 stamens alternately. Sepals joined or partially so, in bilaterally symmetrical flowers. Petals are 5-4, all free or lower 2 fused to form a keel. Stamens 2 whorls of 5, 10 fused in a tube or 9 fused and 1 free or all free. Carpels usually 1. Fruits is pod (Heywood, 2007).

Subfamily - Papilionoideae

Temperate, tropical and subtropical, mostly herbs but some trees and shrubs, Leaves usually pinnate but sometimes simple and the flowers irregular with the lateral petals enclosed by the standard in the bud. Stamens 10, usually diadelphous but sometimes monadelphous or free (Heywood, 2007).

1. *Cajanus albicans* (Wight & Arn.) Maesen, Agric.Uni.Wagen.Pap. 85:55.1985. (Figure 2(1))

Myanmar name : Taw pe
English name : Unknown
Flowering period : December to March

Twining herbs, stems and branches terete, pubescent. Leaves pinnately trifoliolate compound; stipulate, stipellate; leaflets orbicular-obovate, obtuse at the base, entire along the margin, retuse at the apex, glandular punctate beneath, pubescent on both surfaces. Inflorescences axillary racemes, 1- to 3-flowered. Flowers yellow, about 2.0 cm in diameter; bract ovate, caducous, pubescent. Calyx campanulate, 5-lobed. Standards obovate, purple striate at the base; wings obovate-oblong; keels obovate. Stamens 10, diadelphous, staminal tube 0.9-1.2 cm long; filaments filiform, anthers uniform, basifixed. Ovary oblong, pubescent, few-ovuled; style about 1.7 cm long, curved, pubescent; stigma capitate. Pods oblong, 2.5-3.0 cm long, dehiscent, compressed, 6- to 8-seeded, pubescent.

2. ***Flemingia congesta*** Roxb. ex Aiton, Hort. Kew. (ed. 2)4: 349. 1812. (Figure 2(2))

Myanmar name : Palan phyu
English name : Unknown
Flowering period : January to March

Erect shrubs; stems and branches pubescent. Leaves palmately trifoliolate compound; stipules pubescent; leaflets ovate-oblong, glandular punctate below, oblique at the base, entire along the margin, acute at the apex, pubescent. Inflorescences a dense axillary racemes, many-flowered. Flowers pink, about 0.5 cm in diameter; bracteate; bracteolate. Calyx lobes unequal, dotted with reddish brown gland, pubescent. Standards ovate, white with pink streaks; wings obovate, shortly clawed; keels obovate, shortly clawed. Stamens 10, diadelphous, anthers uniform. Ovary hairy, 2-ovuled; style curved, pubescent at the base, pinkish white; stigma hairy. Pods elliptic, reddish brown, about 1.0 cm long, pubescent, 1-seeded, calyx persistent.

3. ***Gliricidia sepium*** (Jacq.) Kunth ex Walp., Repert. Bot. Syst. 1(4): 679.1842. (Figure 2(3))

Myanmar name : Thinbaw ngusat
English name : Quickstick, mataraton
Flowering period : December to March

Small trees; stems and branches terete, young stems puberulent. Leaves unipinnate compound, imparipinnate; stipulate; exstipellate; leaflets 7- to 10-paired, lanceolate to ovate, rounded at the base, entire along the margin, acute at the apex. Inflorescences axillary and terminal clustered racemes, many-flowered. Flowers pinkish lilac, 1.8-2.3 cm in diameter; bracts ovate. Calyx brown. Standards obovate, pale yellow at the base, shortly clawed; wings oblong, claws short; keels oblanceolate, claws short, white, pinkish at the apex. Stamens 10, diadelphous, staminal tube 1.6-2.0 cm long; anthers dorsifixed, uniform, yellow. Ovary linear, few-ovuled, reddish-brown; style curved; stigma capitate, yellow. Pods linear, 12-15 cm long, short stipitate, compressed, 7- to 9-seeded, dehiscent.

4. ***Lablab purpureus*** (L.) Sweet, Hort. Brit. 2: 481.1826. (Figure 2(4))

Myanmar name : Nwai pe
English name : Lablab bean
Flowering period : December to February

Climbing herbs; stems and branches terete, pubescent. Leaves pinnately trifoliolate compound; stipulate; stipels lanceolate, pubescent; leaflets rounded ovate, truncate and rounded at the base, entire along the margin, attenuate at the apex, pubescent on both surfaces. Inflorescences axillary and terminal racemes, 4- to 9-flowered. Flowers purple, about 2.0 cm in diameter; bracts pubescent, persistent; bracteoles pubescent. Calyx lobes unequal, acuminate.

Standards orbicular, clawed short; wings ovate, claws short; keels oblong, shortly clawed. Stamens 10, diadelphous, anthers uniform, basifixed. Ovary hairy 3-4-ovuled; style curved, pubescent. Pods oblong, curved, 5.0-6.0 cm long, compressed, dehiscent, 2- to 4-seeded.

5. *Pueraria montana* (Lour.) Merr.,Trans.Amer. Phil. Soc.,n.s. 24(2): 210. 1935. (Figure 2(5))

Myanmar name : Unknown
English name : Kudzu
Flowering period : February to March

Woody climbing shrubs; stems and branches pubescent. Leaves pinnately trifoliolate compound, imparipinnate; stipules persistent; stipels linear-lanceolate, persistent; leaflets rounded ovate, shortly attenuate at the base, entire along the margin, acuminate at the apex, pubescent on both surfaces. Inflorescences axillary racemes; many-flowered. Flowers purple, about 1.5 cm in diameter; bracts ovate, pubescent; bracteoles ovate-lanceolate, pubescent. Calyx campanulate; lobes unequal, pubescent. Standards orbicular, shortly clawed, distinct pale yellow at the middle, auricled at the base; wings oblong, purple, claws short; keels obovate, claws short, pale purple. Stamens 10, diadelphous; anthers uniform, Ovary linear-oblong, pubescent, few-ovuled; style curved; stigma capitate. Pods oblong, compressed, 2.5-6.0 cm long, hispid, brown, 15- to 30-seeded.

6. *Sesbania grandiflora* (L.) Poir. in Lam., Encycl. 7: 127. 1806. (Figure 2(6))

Myanmar name : Pauk pan ni
English name : Unknown
Flowering period : November to January

Trees; stems and branches terete, pubescent. Leaves unipinnate compound, paripinnate; stipulate; stipellate; leaflets oblong, 15- to 22-paired, rounded at the base, entire along the margin, obtuse at the apex, pubescent on both surfaces. Inflorescences axillary racemes, 2- to 4-flowered. Flowers red, 3.5-4.5 cm in diameter; pedicels 1.0-2.0 cm long, pubescent; bracts and bracteoles ovate-lanceolate, pubescent. Calyx campanulate; lobes broadly triangular. Standards ovate, red, clawed; wings lanceolate, clawed; keels lanceolate, clawed. Stamens 10, diadelphous; anthers uniform, dorsifixed, yellow. Ovary linear, many-ovuled; style curved. Pods linear, dehiscent, 23.0-24.5 cm long, pale yellow, many-seeded.

7. *Tephrosia villosa* (L.) Pers., Syn. Pl. 2(2) : 329.1807. (Figure 2(7))

Myanmar name : Me yaing
English name : Unknown
Flowering period : June to October

Erect herbs; stems and branches pubescent. Leaves unipinnate compound, imparipinnate; stipules persistent; exstipellate; leaflets 6- to 8-paired, opposite, obovate-oblong, cuneate at the base, entire along the margin, retuse at the apex, pubescent beneath with conspicuous parallel lateral veins. Inflorescences terminal and axillary racemes, many-flowered. Flowers pale purple, 0.6-1.0 cm in diameter; bracts subulate. Calyx campanulate, villous, persistent. Standards orbicular, claws short; wings obovate, clawed; keels ovate, whitish-pink, clawed. Stamens 10, diadelphous; anthers uniform. Ovary oblong, pubescent, few-ovuled; stigma pubescent. Pods linear, 2-3 cm long, curved, compressed, yellowish-brown, densely villous, 5- to 8-seeded, dehiscent.

Figure 2. Inflorescences

(1) *Cajanus albicans* (Wight & Arn.) Maesen (2). *Flemingia congesta* Roxb. ex Aiton

(3) *Gliricidia sepium* (Jacq.) Walp. (4) *Lablab purpureus* (L.) Sweet

(5) *Pueraria montana* (Lour.) Merr. (6) *Sesbania grandiflora* (L.) Poir.

(7) *Tephrosia villosa* (L.) Pers.

Table 2. Characters and Taxa matrix

	Habit	Leafles No	Stipel	Flowers no	Flowers colour	Ovary	Ovules no	Pod
Cajanus	Herb	3	Present	Few	yellow	Pubescent	Few	oblong
Flemingia	Shrub	3	Absent	Numerous	pink	Pubescent	Few	elliptic
Gliricidia	Tree	15-21	Absent	Numerous	Pinkish liliac	Glabrous	Few	linear
Lablab	Herb	3	Present	Few	Purple	Pubescent	Few	oblong
Pueraria	Shrub	3	Present	Numerous	Purple	Pubescent	Numerous	oblong
Sesbania	Tree	20-24	Present	Few	Red	Glabrous	Numerous	linear
Tephrosia	Herb	13-15	Absent	Numerous	Pale purple	Pubescent	Few	linear

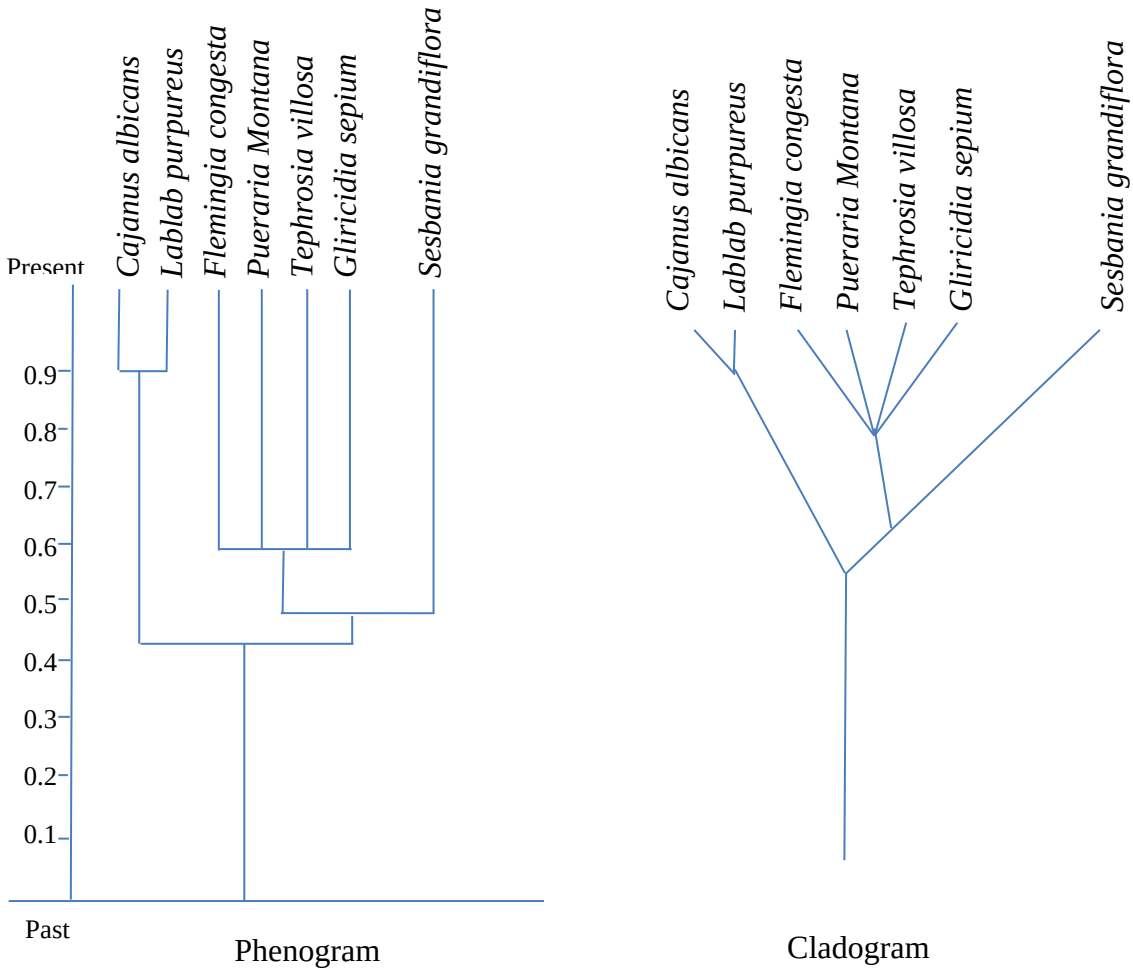
Table 2.1 Numerical data matrix of taxa and characters scored as 0 (plesiomorphic) and 1 (apomorphic)

	Habit	Leaflets No	Stipel	Flowers no	Flowers colour	Ovary	Ovules no	Pod
Cajanus	1	0	0	1	1	1	0	1
Flemingia	0	0	1	0	0	1	0	1
Gliricidia	0	1	1	0	0	0	0	0
Lablab	1	0	0	1	0	1	0	1
Pueraria	0	0	0	0	0	1	1	1
Sesbania	0	1	0	1	0	0	1	0
Tephrosia	1	1	1	0	0	1	0	0

Table 2.2. The matching coefficients of data matrix

	Cajanus	*Flemingia*	*Gliricidia*	*Lablab*	*Pueraria*	*Sesbania*	*Tephrosia*
Cajanus	1						
Flemingia	0.5	1					
Gliricidia	0.1	0.6	1				
Lablab	0.9	0.6	0.3	1			
Pueraria	0.5	0.8	0.4	0.6	1		
Sesbania	0.3	0.3	0.6	0.4	0.5	1	
Tephrosia	0.4	0.6	0.8	0.5	0.4	0.4	1

Figure 3. Construction of phenogram and phylogenetic tree (cladogram) based on similar matrix



An Artificial key to the species:

1. Plants herbaceous----------2
1. Plants shrubby or woody ----------4
2. Plants erect; stipels absent---------- 7. *Tephrosia villosa*
2. Plants climbing; stipels present----------3
3. Leaflets glandular punctate; flowers yellow ---------- 1. *Cajanus albicans*
3. Leaflets eglandular punctate; flowers purple ----------4. *Lablab purpureus*
4. Leaflets more than 15 ----------5
4. Leaflets less than 5 ----------6
5. Leaves paripinnate; flowers red ---------- 6. *Sesbania grandiflora*
5. Leaves imparipinnate; flowers pinkish lilac ---------- 3. *Gliricidia sepium*
6. Stipels present; flowers purple ---------- 5. *Pueraria montana*

6. Stipels absent; flowers pink ----------2. *Flemingia congesta*

Discussion and Conclusion

The present research work deals with the study of taxonomy and phylogenetic relationship of some species belonging to subfamily Papilionioideae found in Popa area, Kyaukpadaung Township.

The family Fabaceae (Papilionaceae) is the third largest family of flowering plants. They were distributed in tropical, subtropical and temperate region. They are mostly herbs, consists of 478 genera and 13,600 - 14,060 species (Heywood, 2007). In the present research, 7 species belonging to 7 genera were studied.

The different morphological characteristics of the study species were observed. According to the resulting data on the studied species, 2 species are trees, 2 species are shrubs and the rest three species are herbs. The tree species are *Gliricidia sepium* (Jacq.) Walp. and *Sesbania grandiflora* (L.) Poir. Tree and shrub are more primitive than herbs. So, *Cajanus albicans* (Wight & Arn.) Maesen, *Lablab purpureus* (L.) Sweet, and *Tephrosia villosa* (L.) Pers. are more advanced species than others.

All of the study species possess compound leaves. The species with numerous leaflets are more advanced than those of few leaflets. So, *Tephrosia villosa* (L.) Pers. is more advanced than other two herbaceous species.

The presence of stipels is more primitive. Among herbaceous species, the species possessing stipels are *Cajanus albicans* (Wight & Arn.) Maesen and *Lablab purpureus* (L.) Sweet. So these two species are more primitive and closely related than *Tephrosia villosa* (L.) Pers. Among the tree species, *Gliricidia sepium* (Jacq.) Walp is more advanced than *Sesbania grandiflora* (L.) Poir because of absence of stipels. The flower's colours are variable. Yellow colour is more primitive than others. So, *Cajanus albicans* (Wight & Arn.) Maesen is more primitive than other two herbaceous species.

The stamens of all species are diadelphous. The shapes of ovaries and the numbers of ovules are variable. The fruits of *Gliricidia sepium* (Jacq.) Walp., *Sesbania grandiflora* (L.) Poir and *Tephrosia villosa* are linear in shape whereas the other are oblong or elliptic. The fruit shape linear is more primitive than others.

Among the studied species, *Gliricidia sepium* (Jacq.) Walp. and *Sesbania grandiflora* (L.) Poir. are cultivated plants. *Gliricidia sepium* (Jacq.) Walp. is cultivated for ornamental. *Sesbania grandiflora* (L.) Poir. benefits not only for food but also shading and medicine. The rest species were widely distributing in the study area.

According to the phylogenetic point of view, *Cajanus albicans* (Wight & Arn.) Maesen, *Lablab purpureus* (L.) Sweet are more closely related and advanced among the study species because they have most similarity. The second closely related and advanced species are *Pueraria montana* (Lour.) Merr, *Flemingia congesta* Roxb. *Gliricidia sepium* (Jacq.) Walp. and *Tephrosia villosa* (L.) Pers.

Sesbania grandiflora (L.) Poir is more related to *Flemingia congesta* Roxb. *Gliricidia sepium* (Jacq.) Walp. *Pueraria montana* (Lour.) Merr, and *Tephrosia villosa* (L.) Pers. than *Cajanus albicans* (Wight & Arn.) Maesen and *Lablab purpureus* (L.) Sweet.

The present research partially accomplished in the development on the list of some species belonging to Papilionoideae in Popa area, Kyaukpadaung Township. The morphological characteristics will give the information for identification and classification to

the pea plants. Moreover the phylogenetic relationship of all species will be understand. It is hoped that the present research work will give the valuable information to other researchers.

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