热带亚热带植物学报　1994, 2(4): 45－57
Journal of Tropical and Subtropical Botany

紫荆族的脉序研究

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摘 要

本文对代表豆科云实亚科紫荆族全部五个属，即紫荆属、腺叶紫荆属、格里芬豆属、拟羊蹄甲属和羊蹄甲属的几乎全部系或亚组的134个种或种下分类单元的叶脉序进行了研究，并描述了本族20个基本脉序类型。

在紫荆族中，腺叶紫荆属和拟羊蹄甲属的脉序式样非常相似；紫荆属的种类的脉式样以全缘叶，一级脉不及缘等特征组合有别于本族其它属；格里芬豆属的脉序高度特化，有别于紫荆亚族的所有类群；羊蹄甲属是叶脉序式样最多样化的类群。

在羊蹄甲属中，羊蹄甲亚属和显托亚属的脉序式样非常多样化。*Elayuna* 亚属的两个组和 *Barklya* 亚属的脉序式样非常相似。*Barklya* 亚属的仅有种丁香叶羊蹄甲的脉序仅以其叶全缘区别于 *Elayuna* 亚属。

脉序性状支持把 *Cansenia* 系、白花羊蹄甲系、羊蹄甲系、绿花羊蹄甲亚组、总状花羊蹄甲亚组、*Elayuna* 亚属、伞房系、*Chloroxanthae* 系、棒花系、掌叶组和萼管组等作为自然类群的观点。

在本族植物的脉序类型中，一级脉及缘、全缘叶、发育完好的脉岛等性状常相关出现；另一方面，一级脉不及缘，具二小叶或叶深裂，脉岛发育不完善及盲脉多分枝等性状常相关出现。

如同形态和花粉性状，脉序性状能为紫荆族的分类提供另一方面的佐证，但只有当与其它方面性状一同使用时，才能得到较可靠的结论。

关键词：紫荆属；腺叶紫荆属；格里芬豆属；拟羊蹄甲属；羊蹄甲属；叶脉序

LEAF VENATION OF CERCIDEAE (LEGUMINOSAE)

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Abstract

Leaves of 134 species or infraspecific taxa, representing almost all series or subsections of the five genera of the tribe Cercideae: *Cercis, Adenolobus, Griffonea, Brenierea and Bauhinia*, have been studied. Twenty venation types have been described.

1993－10－07 收稿；1994－03－09 修回

In the tribe, *Adenolobus* and *Brenierea* have very similar venation patterns. *Cercis* species also have their own characteristics. Venation of *Griffonea* leaf is very specialized and characteristic, while *Bauhinia* is very diverse in venation patterns.

In the genus *Bauhinia*, both subgenera *Bauhinia* and *Phanera* are very diverse in aspects of leaf venation, while venation types of the two sections of Subgen. *Elayuna* are very similar. The leaf venation of *B. syringifolia*, the only species of Subgen. *Barklya*, is one of the best developed venation types and is very similar to that of Subgen. *Elayuna* type.

The venation characters support the distinction, if not necessary being monophylies, of Ser. *Cansenia*, Ser. *Acuminatae*, Ser. *Purpureae*, Subsect. *Viridescentes*, Subsect. *Racemosae*, Subgen. *Elayuna*, Ser. *Corymbosae*, Ser. *Chloroxantheae*, Ser. *Clavatae*, Sect. *Palmatifolia*, and Sect. *Tubicalyx*.

Like other morphological or palynological characters, leaf venational characters can be a source of information for systematics, but it can only be used in systematics together with data from other aspects.

Key words: *Cercis; Adenolobus; Griffonea; Brenierea; Bauhinia;* Leaf venation

Introduction

Although the appearance of bilobed leaf of *Bauhinia* has ever been a fascination to many botanical students[2, 3, 12], *Bauhinia* leaf characters have contributed little to the classification and systematics of the genus. Most authors simply regarded them as too variable. It is unfortunately true for many characters such as degree of fusion and degree of pubescence. But others are taxonomically important at both specific and supraspecific levels.

Venation characters have been used in different taxa by different authors[4, 13, 14]. The venation characters are systematically informative in all groups studied.

The existing classification of the tribe[6], which forms the framework of this study, is based mainly on morphological and palynological data. The purpose of the present study is to obtain information for a better understanding of the evolution and classification of the tribe in general, and in particular, add to the data matrix for a cladistic analysis of *Bauhinia* which is in progress.

Material and methods

Observations of primary, secondary and tertiary veins were made under a magnifying lens. Characters of higher-order veins, veinlets and areoles were observed by using microscope.

Most material were taken from herbarium specimens, a few species from living plants in the Aarhus University (AAU) Greenhouse. All characters are those of leaves on flowering branches. To make clear venation preparations, the basic fuchsin method was used. Pieces of leaves from the outer margin were boiled in 10% KOH solution for about ten minutes, then kept in basic fuchsin solution (1% crystal fuchsin and 10% KOH) at 60℃ for 4－10 days according to the texture of the leaves. The cleared material was rinsed in water for 5 min., then changed to 1N HCl －absolute alcohol solution (Ratio 1:3) for 3 min., dehydrated twice in absolute alcohol for 3 min., then mounted in Euparal on slide for permanent use.

The terminology follows that of Hickey[5,6]. Characters are listed below. Different states of the quantitative characters are delimited by comparing all species studied. The classification of the tribe follows that of Wunderlin, Larsen and Larsen[16].

All voucher specimens and slides are deposited in Herbarium AAU.

Leaf and venation characters studied:

1. Degree of fusion: entire(a); bilobed(b); bifoliolate(c)
2. Number of primary veins: 3－5(a); 7－9(b); more than 11(c)(In case of bifoliolate leaves, veins of both lobes were counted)
3. Inter－primary veins (Veins between primary veins but usually ended half－way): present (a); absent(b)
4. Branching of primary veins: no(a); rarely(b); frequently(c)
5. Primary veins marginal: yes(a); partly(b); no(c)
6. Behavior of secondary veins: craspedodromous(a); camptodromous(b)
7. Branching of secondary veins: present(a); absent(b)
8. Secondary veins branching: frequently(a); rarely(b)
9. Secondary veins parallel between primary veins: yes(a); no(b)
10. Tertiary veins: percurrent(a); reticulate(b)
11. Marginal ultimate venation: incomplete(a); looped(b); with a fimbrial vein(c)
12. Distribution of veinlets: in most areoles(a); in fewer areoles(b)
13. Number of veinlets (in more than 80% areoles): more than one per areole(a); only one or not at all(b)
14. Branching status in veinlets (of more than 80%): simple (a); once－branched (b); twice－branched (c)
15. Twice－branched veinlet present in at least some areoles: yes(a); no(b)
16. Once－branched veinlet present in at least some areoles: yes(a); no(b)
17. Developing degree of areoles (of more than 50%): imperfect(a); well developed(b)
18. Areole size: very big(a); big(b); moderate(c); small(d); very small(e)

Description of leaf characters and venation patterns

134 species or infraspecific taxa, representing all genera of the tribe Cercideae, have been studied.

Leaf size is very diverse in Cercideae, ranging from about 1 cm in diameter in *Bauhinia brachycarpa* Wall. ex Benth. var. *microphylla* (Oliv. ex Craib) K. & S.S. Larsen to about 20 cm in *Bauhinia vahlii* Wight & Arn.. Although this character, especially that of basal leaves, is changeable under different ecological conditions, the leaves of flowering branches are more stable in size.

Pubescence and texture are two of the most variable leaf characters in Cercideae, although species with close affinities often have similar pubescence and texture. Undoubtedly these characters are highly homoplasious in the tribe. So these characters have not been listed in this study. Only eighteen less variable characters are included.

Degree of fusion is variable in some groups, especially species of *Bauhinia* Ser. *Fulvae* and Subsect. *Championae*. *B. khasiana*, *B. championii*, and some other species may vary from having leaves with two free leaflets on basal branches to entire leaves on flowering branches. But leaves on the flowering branches are usually stable in the same species.

Venation patterns are very stable in the same species in Cercideae. Number and behavior of primary veins, behavior of secondary and tertiary veins, marginal ultimate venation types, etc. are very stable characters of systematic significance. Although the areole size may change to some degree even in the same species, most closely related species have similar areole sizes. The presence or absence of veinlets and their behavior are also very significant.

Table 1 Leaf and venation characters of Cercideae

Taxa/Char	0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8
Cercis	
C. chinensis	a b b c c b a a b b a a a a b a b a
C. canadensis	a b b c c b a a b b a a a a b a b a
C. occidentalis	a b b c c b a a b b a a a a b a b a
C. siliquastrum	a b b c c b a a b b a a a a b a b a
C. glabra	a b b c c b a a b b a a b a b a b a
C. racemosa	a b b c c b a a b b a a a c a a a a
C. chunian	a a b c c b a a b b a a a c a a a a
C. chingii	a b b c c b a a b b a b b a b b b b
Adenolobus	
A. garipensis	b a a c c b a a b b a a a b a a a b

Taxa/Char	0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8
Griffonea	
G. speciosa	a a b b c b a a b b c b b a b a b b
Brenierea	
B. insignis	c b a a c b a a b b a a a b a a a b
Bauhinia	
Subgen. *Bauhinia*	
Sect. *Bauhinia*	
Ser. *Bauhinia*	
B. divaricata	b b b a a a b ? a b c a a a b a b d
B. ramossisima	b b b c c b a a b b c a a b a a a b
Sect. *Pauletia*	

Continued

Taxa/Char	0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8
Ser. *Cansenia*	
B. picta	b b b a b b b ? a a c b b ? b b b e
B. curvula	b b b a b b b ? a a c b b ? b b b e
B. bombaciflora	b b b a b b b ? a a c b b ? b b b e
B. cinnamonea	a b b a b b b ? a a c b b ? b b b e
B. bongardii	b b b a b b b ? a a c b b ? b b b e
Ser. *Acuminatae*	
B. acuminata	b b b b a a a b a a c b b a b a b c
Ser. *Pentandrae*	
B. pauletia	b b b a c b b ? b b c a a c a a a b
Ser. *Ariaria*	
B. tarapotensis	b c b a c b b ? a b b a b a b a b d
Sect. *Amaria*	
Ser. *Stenanthae*	
B. stenantha	b b b c a a a a b b b a a b a a b d
Sect. *Alvesia*	
B. tomentosa	b b b b a a a a b b c a a b a a b c
Sect. *Micralvesia*	
Subsect. *Viridescentes*	
B. saccocalyx	b c b b c b b ? a a b b b a b b b d
B. viridescens	b b b b c a a b a a c b b a b b b d
B. brachycarpa	b c b b c b b b b b c b b a b b b d
var. *microphylla*	b a b c c a a b b b b b b a b a b c
Subsect. *Racemosae*	
B. rufescens	b b a c c b a a b a b a a c a a b c
B. racemosa	b b a c c b a a b b b a a c a a b c
Sect. *Telestria*	
Ser. *Purpureae*	
B. variegata	b b b a a a b ? a a c b b a b a b e
B. purpurea	b b b a a a b ? a a c b b a b a b e
B. xblakeana	b b b a a a b ? a a c b b a b a b e
Ser. *Monoteles*	
B. monandra	b b b a a a b ? a a c b b a b a b e
Sect. *Pseudophanera*	
B. pottsii	b c b a a a b ? a a c b b a b b b e
Sect. *Gigasiphon*	
B. dolichocalyx	a b b c c b a a b b c b b a b a b c
Sect. *Afrobauhinia*	
Ser. *Galpinae*	
B. galpinii	b b b c c b a a b b b a a b a a b c
Ser. *Aurantiacae*	
B. petersiana	b b b a c b b ? b b b b b a b b b e
Subgen. *Elayuna*	
Sect. *Piliostigma*	
B. malabarica	b b b b c b a b b b c b b a b b b b
Sect. *Benthamia*	
B. uruaguayensis	b b b c b b a a b b c b b a b b b b
Subgen. *Barklya*	
B. syringifolia	a b b a c b a b a b c b b a b b b c
Subgen. *Phanera*	
Sect. *Phanera*	
Subsect. *Phanerosiphon*	
B. sylvanii	b c b b a a a a a a c b b a b b b d
Ser. *Fulvae*	
B. pyrrhoclada	b c b c a a b ? b b c b b a b b b b
B. vahlii	b c b c a a b ? b b c b b a b b b a
B. hainanensis	b c b c a a a b b a c a a b a a b a
B. khasiana	a b b a b b b ? b b c a b b a a b a
B. carcinophylla	c b b a b b a b b b c a b a b a b b
B. erythropoda	b b b a b b a b b b c a b a b a b a
B. chalcophylla	b c b b a a a b b b c b b a b a b a
B. paucinervata	a a b a c a a a b b c a b b a a b c
B. integrifolia	b b b b b b b ? b b c a b a a a b e
B. rubro-villosa	b c b a a a a a b a c b b a b b b c
B. aurea	b c b a a a a b b b c b b a b b b c
B. aureifolia	b c b a a a b ? b b c b b a b b b c
B. hypochrysa	b c b a a a b ? b b c b b a b b b c
B. glabrifolia	b c b c a a a a b b c a a b b a b a

Continued

Taxa/Char	0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8
var. *maritima*	b c b c a a a a b b c a a b b a b a
var. *sericea*	b c b c a a a a b b c a a b b a b a
B. ornata	b b b a b b b ? b b c b b a b b b a
var. *kerrii*	b c b c a a a a b b c b b a b b b b
var. *burmanica*	b c b c a a a a b b c b b a b a b a
B. endertii	b c b b a a a b b b c b b a b a b b
Ser. *Corymbosae*	
B. glauca	b b b b c b a a b b b b b a b b b c
B. corymbosa	b b b b c b a a b b b b b a b b b a
B. touranensis	b b b b c b a a b b b b b a b b b c
B. didyma	c b b b c b a a b b b b b a b b b b
Ser. *Yunnanentes*	
B. yunnanensis	c b b c c b a a b b b a a a a a a a
Ser. *Chloroxanthae*	
B. similis	b c b a c b a b b b c b b a b b b d
B. bassacensis	b c b a c b b ? a a c b b a b b b d
B. bracteata	b c b b c b a b b b c b b a b b b d
B. saigonensis	b c b a c b b ? b b c a b a b a b d
Ser. *Loxocalyx*	
B. japonica	b b b c c b a a b b c b b a b b b b
Ser. *Clavatae*	
B. nervosa	b c b a c b b ? b b c b b a b b b c
B. andersonii	b c b a c b b ? b b c b b a b b b c
B. hendersonii	b c b a c b b ? b b c b b a b b b c
B. kostermansii	b c b a c b b ? b b c b b a b b b e
B. pauciflora	b ? b a c b b ? b b c b b a b b b c
B. steenisii	b c b a c b b ? b b c b b a b b b c
B. pachyphylla	b c b a c b b ? b b c b b a b a b e
B. stipularis	b c b a c b b ? b b c b b a b b b a
B. coccinea	b c b a c b b ? b b c b b a b b b e
B. excelsa	b c b a c b b ? b b c b b a b b b c
var. *megalantha*	b c b a c b b ? b b c b b a b b b c
B. merrilliana	b c b a c b b ? b b c b b a b b b a
B. aherniana	b c b a c b b ? b b c b b a b b b b

Taxa/Char	0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8
B. ferruginea	b c b a c b b ? b b c b b a b b b e
var. *griffithi*	b c b a c b b ? b b c b b a b b b d
B. ridleyi	b c b a c b b ? b b c b b a b b b c
B. lingua	b c b a c b b ? b b c b b a b b b c
var. *riedelii*	b c b a c b b ? b b c b b a b b b c
B. lorantha	b c b a c b b ? b b c b b a b b b d
B. havilandii	b c b a c b b ? b b c b b a a a b d
Ser. *Insignis*	
B. audax	b b b a c b b ? a b c a b a b a b c
Sect. *Lasiobema*	
Subsect. *Scandentes*	
B. scandens	c b b c c b a a b b b a a b a a a a
Subsect. *Pullae*	
B. pulla	b c b c c b a a b b c b b a b a b b
Subsect. *Championae*	
B. championii	b b b b c b b ? b b c b b a b b b c
B. lingyuenensis	b b b b c b b ? b b c b b a b b b b
B. venustuta	b b b b c b b ? b b c b b a b b b b
B. apertilobata	b b b b c b b ? b b c b b a b b b b
B. flava	b b b b c b b ? b b c b b a b b b a
B. delavayi	b b b c c b a a b b a a a a b a a a
B. comosa	b b b b c b b ? b b a a a b a a a a
B. harmsiana	b b b c c b a a b b a b b a b b b c
B. penicilliloba	b b b a c b b ? b b c b b a b b b a
B. curtisii	a b b b c b b ? b b c b a b b b b c
B. esquirolii	b b b b c b b ? b b a a a b a a a a
B. longistipes	b b b b c b b ? b b a a b a b a b a
B. hypoglauca	b b b b c b b ? b b c b b a b b b c
B. concreta	b b b b c b b ? b b c b b a b b b c
Sect. *Austrocercis*	
B. williamsii	b b b c c b a a b b c b b a b b b c
Sect. *Palmatifolia*	
B. pyrrhoneura	a c b a c b b ? b b c b b a b b b c
B. wrayi	a b b a c b b ? b b c b b a b b b b

Continued

Taxa/Char	0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8
B. posthumi	a b b a c b b ? b b c b b a b b b d
B. lucida	a a b a c b b ? b b c b b a b b b b
B. kockiana	a a b a c b b ? b b c b b a b b b d
var. *serinervia*	a a b a c b b ? b b c b b a b b b b
B. decumbens	b c b c a a a a b b c b b a b b b d
B. cardiophylla	a a b b c b b ? b b c b b a b b b b
B. bidentata	a b b b c b a b b b c b b a b b b b
ssp. *bicornata*	a b b b c b a b b b c b b a b b b b
B. finlaysonian	a a b a c b b ? b b c b b a b b b d
var. *leptopus*	a a b a c b b ? b b c b b a b b b d
Sect. *Lysiphyllum*	
Ser. *Australes*	
B. cunninghamii	c b a c c b a a b b c a a b b a b c
Ser. *Hookerae*	
B. binata	c c a c c b a a b b b a a b b a b a
B. hookerii	c c a c c b a a b b b a a b b a b c
Ser. *Dipterae*	
B. diptera	c b b a b b b ? a a c b b a b b b e

Taxa/Char	0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8
Ser. *Winitae*	
B. winitii	c b a b c b a b b b b a a b a a b a
Sect. *Tubicalyx*	
B. cardinalis	a a b a c b b ? b b c b b a b b b c
B. strychnifolia	a a b a c b b ? b b c b b a b b b c
Sect. *Semla*	
B. roxburgiana	b c b c a a a a b b c b b a b b b c
Sect. *Tylosema*	
B. fassoglensis	b c b c c b a a b b b a a b b a b c
Sect. *Schnella*	
B. microstachya	b b b b b b a a b b c a b a b a b a
Sect. *Caulotretus*	
Subsect. *Binaria*	
B. glabra	c c b a c b a a a b c b b a b b b c
Subsect. *Latisiliquae*	
B. herrerae	b c b a c b b ? b b c a a a a a b a
Sect. *Pseudobauhinia*	
B. bohniana	b c b b c b a a b b b a b a b a b c

Some basic leaf venation types can be summarized from the data shown in table 1.

1. ***Cercis* type**　Leaves of the genus *Cercis* species are very similar in having a strong midrib, frequently branched primary and secondary veins and incomplete marginal ultimate venation. Based on the differences in higher order veins, areole shape and veinlets behavior, three groups can be recognized. *Cercis chingii* Chun can be distinguished by its much smaller areoles, only with simple veinlets in few areoles. *C. racemosa* Oliv. and *C. chuniana* Metc., two Chinese species with elongated racemes, differ from other species in having imperfect areoles, twice to three times branched veinlets. Other species all have well developed areoles but sometimes branched veinlets. (Plate I: 2, 4)

2. ***Adenolobus* type**　Leaves of the genera *Adenolobus* and *Brenierea* have inter－primary veins, big and imperfect areoles and branched veinlets, and incomplete marginal ultimate veins. Leaf of *Brenierea insignis* Humbert differs from that of the *Adenolobus* in having two free leaflets. (Plate I: 5)

3. ***Griffonea* type**　Leaf venation pattern of the genus *Griffonea* is that of very specialized type. That is the entire leaves with strong midrib, fimbrial marginal vein and very small areoles, are very different from those of *Cercis* and *Adenolobus*.(Plate I: 6)

4. ***Cansenia* type** The studied species of *Bauhinia* Ser. *Cansenia* have almost identical venation patterns, i.e. having unbranched primary and secondary veins, parallel tertiary veins, and very small areoles with simple veinlets occurring only in very few areoles. The primary veins are not marginal in this type. (Plate I: 8)

5. ***Acuminatae* type** The species of *Bauhinia* Series *Acuminatae* have leaves with primary veins marginal. But the primary and secondary veins are occasionally branched and the areoles are slightly bigger. This type is very close to the *Telestria* type. (Plate I: 9)

6. ***Alvesia* type** In Sect. *Amaria* and Sect. *Alvesia* of *Bauhinia*, two species, which represent each section respectively, viz., *B. stenantha* Diels and *B. tomentosa* L., were studied. Leaves of them are similar in having marginal primary veins, but the tertiary veins are not parallel. Simple or sometimes branched veinlets are well developed. (Plate I: 10)

7. ***Viridescentes* type** Primary veins in species of *Bauhinia* Subsection *Viridescentes* are not marginal. Instead of a fimbrial vein as in other groups in Subgen. *Bauhinia*, the leaf margin is looped with arches of tertiary veins. But areoles are well organized; veinlets are not developed in most areoles. (Plate I:11)

8. ***Racemosae* type** In leaf venations of *B. racemosa* Lam and *B. rufescens* Lam. of *Bauhinia* Subsect. *Racemosae*, interprimary veins developed; marginal ultimate venation looped; areoles are sometimes imperfect; veinlets are once or even twice branched. This type is similar to the *Lysiphyllum* type. (Plate I:12)

9. ***Telestria* type** *Bauhinia* Sect. *Telestria* is a very natural group in aspects of leaf characters. Three species of Ser. *Purpureae: B. purpurea* L., *B. variegata* L. and a hybrid species, *B. X blakeana* Dunn. have identical venation pattern. With primary veins marginal, tertiary veins parallel, very small and regular areoles and simple veinlets only occur in a few areoles. The venation pattern is similar to that of *Cansenia* type. *B. monandra* Kurz., the only species of Ser. *Momoteles*, has the same type of leaf venation pattern as Ser. *Purpureae*. Leaf characters and venation patterns of *B. pottsii* G. Don. of Sect. *Pseudophanera* can also be included in this type. (Plate I: 1,13)

10. ***Elayuna* type** Leaf venations of sections of subgenera *Elayuna* and *Barklya* are characterized by having a fimbrial marginal ultimate vein, equal-sized big or moderate sized areoles and simple veinlets only developed in very few areoles. *B. uruaguayensis* Benth., *B. malabarica* Roxb. and *B. syringifolia* (F. v. Muell) Wunderlin have very similar venation patterns, although the latter has entire leaves, while the former two have bilobed leaves. A species of Subgen. *Bauhinia* Sect. *Gigasiphon*, *B. dolicocalys* Merr., also belongs to this type. (Plate I: 14; Plate II: 2)

11 ***Fulvae* type** Most species of *Bauhinia* Ser. *Fulvae* have similar patterns of venation in having fimbriate marginal ultimate vein, marginal primary veins, well developed areoles,

and simple veinlets present or absent. But some species, such as *B. pyrrhoclada* B. Drake, *hainanensis* Merr. et Chun, *B. khasiana* Baker and *B. integrifolia* Roxb. differ in a few characters. These species usually have branched veinlets; sometimes not all primary veins are marginal. Albeit all these inconcordances, all species of Ser. *Fulvae* can be regarded as having the same venation type. (Plate II: 4)

12. ***Corymbosae* type** Although leaves of different species have different size, degree of fusion, species of *Bauhinia* Sect. *Phanera* Ser.*Corymbosae* have the same venation pattern with primary veins not being marginal, the marginal ultimate venation looped, well developed areoles and simple veinlets. (Plate I: 3; Plate II: 5)

13. ***Chloroxanthae* type** Venation of leaves of Ser. *Chloroxanthae* have their own characteristics: primary veins not marginal, secondary veins camptodromous, marginal ultimate venation fimbriate. It is closely related to the *Clavatae* type. (Plate II: 6)

14. ***Loxocalyx* type** Species of Ser. *Loxocalyx* of Sect. *Phanera*, Sect. *Semla*, Sect. *Austrocercis* and Subsect. *Pullae* of Sect. *Lasiobema* can be grouped together by having bilobed leaves with frequently branched primary and secondary veins, primary veins not marginal, secondary veins camptodromous, ultimate marginal venation fimbriate, well developed areoles and simple veinlets. This type is closely related to the *Championae* type.(Plate II: 7)

15. ***Tubicalyx* type** Sect. *Tubicalyx* species are characterized by having entire leaves with only three or five unmarginal primary veins, camptodromous secondary veins, well developed areoles and simple veinlets. This type is most similar to the *Griffonea* type. (Plate II: 9)

16. ***Clavatae* type** Bilobed leaves usually with more than 11 not branched unmarginal primary veins. Marginal ultimate venation fimbriate. Areoles well developed with simple veinlets. All species of Ser. *Clavatae* have the same venation pattern. (Plate II: 8)

17. ***Scandentes* type** This type is characterized by incomplete marginal ultimate venation, primary veins not marginal, imperfect areoles and branched veinlets. Leaves of *B. scandens* L. of Subsect. *Scandentes*, *B. delavayi* Franch., *B. comosa* Craib, *B. esquirolii*, *B. longistipes* of Subsect. *Championae*, and also *B. yunnanensis* Franch. of Ser. *Yunnanentes* belong to this type. Species in this type differ in having entire, bilobed or bifoliolate leaves, morphology and behavior of veinlets. (Plate II: 10)

18. ***Championae* type** Bilobed leaves with primary veins not marginal, secondary veins camptodromous, marginal ultimate venation fimbriate, well developed areoles with simple veinlets. This type includes all species of Subsect. *Championae* except those belonging to the *Scandentes* type. *B. audax* de Wit of Sect. *Phanera* Ser. *Insibnis* has similar venation pattern. This type is most closely related to the *Loxocalyx* type. (Plate II:11, 16)

19. ***Palmatifolia* type** This type is characterized by leaves usually entire, primary

veins not marginal, secondary veins camptodromous, fimbriate marginal ultimate venation, well developed areoles and simple veinlets. All species of Sect. *Palmatifolia* belong to this type. But *Bauhinia decumbens* Henders. is also somewhat related to the *Clavatae* type. (Plate II: 12)

20. ***Lysiphyllum* type** Bifoliolate leaves with inter-primary veins, unmarginal primary veins frequently branched, looped marginal ultimate venation, veinlets branched. Species of Sect. *Lysiphyllum* except *B. diptera* Bl. ex Miq. belong to this type. (Plate II: 13)

Leaf venation patterns of the species listed below can not be referred to any of the types mentioned above. In some cases, only one or two representative species were studied in those taxonomic groups. More leaf venation types may be found from these groups when additional material become available. In other cases, even though the leaf venation patterns of some taxonomically very isolated species is very different from the types mentioned above, they have not been assigned to their own venation types.

Bauhinia divaricata L. (Plate I: 7)

B. ramossisima Benth.

B. pauletia Pers.

B. tarapotensis Benth.

B. galpinii N. E. Brown (Plate I: 15)

B. petersiana Bolle. (Plate II: 1)

B. sylvanii (de Wit) Cusset (Plate II: 3)

B. diptera Bl. ex Miq. (Plate II: 14)

B. fassoglensis Kotschy ex Schweinf.

B. microstachya Macbr.

B. glabra Jack. (Plate II: 17)

B. herrerae (britt. & Rose) Standl. & Steyerm (Plate II: 18)

B. bohniana L. Chen (Plate II: 15)

Two species of Sect. *Bauhinia*, *B. divaricata* L. and *B. ramossisima* Benth., have very different venation patterns. *B. ramossisima* Benth. is more similar to *B. pauletia* Pers. of Ser. *Pentandrae*, while *B. divaricata* L. is more closed to *B. tarapotensis* Benth. of Ser. *Ariaria* of Sect. *Pauletia*.

B. galpinii N. E. Brown and *B. petersiana* Bolle. of Sect. *Afrobauhinia* also have very different venation patterns. Leaf of *B. galpinii* N. E. Brown is characterized by branched primary and secondary veins, well developed and branched veinlets. Leaf of *B. petersiana* Bolle. has usually unbranched primary and secondary veins, and veinlets absent in most areoles.

B. sylvanii (de Wit) Cusset of Subsect. *Phanerosiphon* is similar to some species of Ser. *Fulvae* in having marginal primary veins and craspedodromous secondary veins. But it is also similar to species of Section *Palmatifolia* in having very small areoles.

Leaf venation of *B. diptera* Bl. ex Miq. of Ser. Dipterae is very different from other groups of Sect. *Lysiphyllum*, but more or less similar to the leaves of *Palmatifolia* type in having camptodromous secondary veins, well developed and very small areoles. In the aspect of having only one pair of primary veins being marginal, it is more like *B. khasiana* Baker of the *Fulvae* type. It is characterized by its parallel secondary veins, percurrent tertiary veins, and being bifoliolate.

Leaf of *B. fassoglensis* Kotschy ex Schweinf. of Sect. *Tylosema*, with its frequently branched primary and secondary veins, marginal ultimate venation looped, is somewhat like that of *B. bohniana* L. Chen of Sect. *Pseudobauhinia*.

Only one species of Sect. *Schnella*, *B. microstachya* Macbr., has been studied. It has a bilobed leaf with some primary veins marginal, secondary veins camptodromous, marginal ultimate venation fimbriate, well developed areoles with simple or branched veinlets.

In Sect. *Caulotretus*, *B. glabra* Jack. of Subsect. *Binaria* has bifoliolate leaf, well developed areoles, simple veinlets not developed in most areoles, while *B. herrerae* (Britt. & Rose) Standl. & Steyerm of Subsect. *Latisiliquae* has a bilobed leaf and usually branched veinlets in most areoles. Both species have not marginal primary veins, camptodromous secondary veins, and fimbriate marginal ultimate venation.

Discussion and conclusion

Cusset[3] recognized seven types of leaves in a treatment of leaves of *Cercideae*. But the venation patterns of the species studied are not compatible with her classification. Entire leaves of *Cercis*, *Griffonea*, Sect. *Gigasiphon*, Subgen. *Barklya*, Sect. *Tubicalyx*, some species of Sect. *Pauletia*, Sect. *Phanera*, Sect. *Palmatifolia* and Sect. *Lasiobema* have little in common in venation patterns. Entire leaf is always correlated with fimbriate marginal ultimate venation in all species studied except those of *Cercis*. Bifoliolate leaves of *B. diptera*, *B. yunanensis* and *B. hookerii* also have very different venation patterns.

In most cases, species of the same taxonomic group, which are based on morphological and palynological data, have the same venation type. Like in the genus *Cercis*, all species can be grouped to the same venation type. Furthermore, morphologically more similar species have more similar venation patterns. The genus *Griffonea*, and some groups of the genus *Bauhinia*, i.e., Ser. *Cansenia*, Ser. *Acuminatae*, Subsect. *Viridescentes*, Subsect. *Racemosae*, Sect. *Telestria*, Subgen. *Elayuna*, Ser. *Fulvae*, Ser. *Corymbosae*, Ser. *Chloroxanthae*, Sect. *Tubicalyx*, Ser. *Clavatae*, and Sect. *Palmatifolia*, all have its own leaf venation type.

Like any other characters, taxonomically unrelated species may also have very similar or even the same venation types. Venation patterns of the genera *Adenolobus* and *Brenierea are* very similar. Venation pattern of *Bauhinia stenantha* Diels of Sect. *Amaria* is very similar to that of *B. tomentosa* L. of Sect. *alvesia*, although they are very different morphologically

and palynologically. Venation pattern of Sect. *Pseudophanera* is similar to Sect. *Telestria*, while venations of Sect. *Gigasiphon* and Subgen. *Barklya* are similar to that of Subgen. *Elayuna*.

Morphologically very closely related species can have diffeerent venation types. In Subsect. *Championae* of Sect. *Lasiobema*, some species have venation patterns more similar to venations of *B. scandens* L. of Subsect. *Scandentes* and *B. yunnanensis* Franch. of Ser. *Yunnanentes*, than to the species in the same subsection. In Sect. *Bauhinia*, *B. divaricata* L. and *B. ramossisima* Benth. there are very different venation patterns, although morphologically they are very similar.

Palynologically closely related but morphologically very different species may have very similar or the same venation patterns. *B. yunnanensis* Franch., which has the same pollen type as Sect. *Lasiobema* species[11], also has the same venation pattern as some species of this section. *B. japonica* Maxim., *B. pulla*, the two morphologically quite different species with the same pollen type, also have the same venation type.

Leaf and venation characters do not have the same phylogenetic significance. The interprimary veins only occur in the African and Madagascaran genera (*Adenolobus* and *Brenierea*), in *Bauhinia* Subsect. *Racemosae* and Sect. *Lysiphyllum* excluding Ser. *Dipterae* (*B. diptera*). Subsect. *Racemosae* has two species disjunctly distributed in Africa and tropical Asia. Sect. *Lysiphyllum* was regarded as "closely related to ancestral taxa of the Bauhinieae" (Cercideae) by de Wit[15] or "less specialized than the remaining eight paleotropical sections of the subgenus" by Wunderlin et al[16]. These facts may indicate that this character is of some kinds of antiquity. Branching of veins, incomplete or looped marginal ultimate venation, branched veinlets and not well developed areoles are among the characters usually occured in less specialized groups. On the contrast, the parallel secondary veins and percurrent tertiary veins are two characters usually related to morphologically more specialized groups in both subgenera *Bauhinia* and *Phanera* in the genus *Bauhinia*.

Character phylogeny of some venation characters can be found in cercideous leaf venation patterns, this in turn may help the reconstruction of phylogeny of the tribe.

Acknowledgements: Most of this work was made in Aarhus University, Denmark. First of all, I wish to thank Prof. Kai Larsen and Mrs. Supee S. Larsen, M. Sc., who helped me academically and personally so much. I am also indebted to Mrs. Anni Sloth for technical assistance, to Drs. Ivan C. Nielsen and Susanne S. Renner, Profs. C. M. Hu and Q. G. Wu for reading and criticizing my manuscripts, to Prof. Te-chao Chen and Mr. Zelian Chen who first stimulated my interests in *Bauhinia* leaf venation, to Biological Institute, Aarhus University for supporting the neccessary facilities, and to the Danish Research Academy for the financial support I received.

References

1 Chen T. *Bauhinia*. In Chen T (ed.). Flora Reipubl. Popular. Sin. Tomus 39. Science Press, Beijing. 1988 (In Chinese)

2 Coetzer L A, Robbertse P J, Reyneke W F. The node and petiole morphology of the South African representatives of the genera *Adenolobus* (Harv.) Torre & Hillc., *Bauhinia* L., *Piliostigma* Hochst and *Tylosema* (Schweinf.) Torre & Hillc. Jour. South Afr Bot 1976; 42(1):1－12

3 Cusset G. Essai d'une taxinomie foliaire dans la tribu des Bauhinieae. Adansonia n. s. 1966; 6:251－280

4 Guptes A K, Murty Y S. Leaf architecture in Tamariaceae. Proc Ind Acad Sci Pl Sci, 1988; 98(6):471－474

5 Hickey L J. Classification of the architecture of dicotyledonous leaves. Am Jour Bot, 1973;60:17－33

6 Hickey L J. A Revised classification of the architecture of dicotyledonous leaves. In Metcalf C R (ed.) "Anatomy of the dicotyledons" Oxford, 1979: 25－39

7 Larsen K, Larsen S S. *Bauhinia chrysophylla*, a new species from Thailand (Leguminosae－Caesalpinioideae). Nord J Bot, 1989; 9(3):253－256

8 Larsen K, Larsen S S. Notes on the genus *Bauhinia* (Leguminosae: Caesalpinioideae) in SE Asia. Nord J Bot, 1991; 11(6):629－634

9 Larsen K, Larsen S S, Vidal J E. Légumineuses－Césalpinioidées. In Flora du Cambodge, de Laos et du Viêt－Nam. Paris, 1980; 18:1－226

10 Larsen K, Larsen S S, Vidal J E. Leguminosae－Caesalpinioideae. In Smitinand T, Larsen K (eds.). Flora of Thailand, Bangkok, 1984; 4(1):1－129

11 Larsen S S. Pollen morphology of Thai species of *Bauhinia* (Caesalpiniaceae). Grana, 1975; 14:114－131

12 Pijl L van der. The leaf of *Bauhinia*. Acta Bot Neerl, 1951; 1:287－309

13 Thakur C. Leaflets architecture in *Cassia* spp. Acta Bot Ind, 1988; 16(1):63－72

14 Yu Chenghong, Chen Zelian. Leaf architecture of the woody dicotyledons from South China. I. Terminology and methods. Acta Bot Austr Sin, 1986; 2:83－97 (In Chinese with English summary)

15 Wit H C D de. A revision of the Malaysian Bauhinieae. Reinwardtia, 1956; 3:381－541

16 Wunderlin R M, Larsen K, Larsen S S. Reorganization of the Cercideae (Fabaceae: Caesalpinioideae). Dan Biol Skarift, 1987; 28:1－40

Legends of plates

Plate I

1. *Bauhinia blakeana;* 2. *Cercis chinensis;* 3. *B. didyma;* 4. *C. racemosa;* 5. *Brenierea insignis;* 6. *Griffonea speciosa;* 7. *Bauhinia divaricata;* 8. *B. picta;* 9. *B. acuminata;* 10. *B. tomentosa;* 11. *B. viridescens;* 12. B. *racemosa;* 13. *B. variegata;* 14. *B. dolichocalyx;* 15. *B. galpinii.*

Plate II

1. *Bauhinia petersiana;* 2. *B. uruaguayensis;* 3. *B. sylvanii;* 4. *B. glabrifolia* var. *maritima;* 5. *B. corymbosa;* 6. *B. similis;* 7. *B. japonica;* 8. *B. merrilliana;* 9. *B. cardinalis;* 10. *B. comosa;* 11. *B. hypoglauca;* 12. *B. finlaysoniana;* 13. *B. cunninghamii;* 14. *B. diptera;* 15. *B. bohniana;* 16. *B. audax;* 17. *B. glabra;* 18. *B. herrerae*