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Systematic Significance of Palisade Ratio In Pharmacognostic Applications

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***Abstract**: The palisade ratio is calculated for 117 taxa of tropical Acanthaceae. The mean palisade ratio values range from 1.45 to 25.0, the lowest and highest being observed in Pseuderanthemum reticulatum and Strobilanthes barbatus respectively. Palisade ratio is a reliable taxonomic character, which is constant for a taxon and it will not vary with environment. However it is more useful in delimiting the taxa at tribal and intraspecific levels than at generic and specific levels. As the same category of palisade ratio is reported in many unrelated tribes of the family, it can be used with other conservative characters in a holistic way. This criterion has reliable taxonomic and pharmacognostic applications since it goes in harmony with other conservative characters.*

Keywords: *Palisade ratio, Systematics, Acanthaceae*

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I. Introduction

Zorning &Weiss (1925) for the first time suggested that the relationship between the cells of the epidermis and those of the subjacent mesophyll might be of taxonomic interest. Later, Wallis & Dewar (1933) introduced the term palisade ratio for the average number of palisade cells beneath a single cell of adaxial epidermis. The palisade ratio for certain medicinal plants such as the species of *Digitalis* L., were recorded by Dewar (1933. 1934a, 1934b) and for species *of Atropa,* L., *Scoparia* Jacq. and *Solanum* L., were established by Wallis & Forsdike (1938). Foliar features of Acanthaceae have been studied by Patil & Patil (2011), Verdam et al (2012). Jani & Rudrappa (2014), Kumar et al (2014), Bhogaonkar & Lande (2015), Choopan & Grote (2015) and Noor-syaheera et al (2015). Studies of George (1943) and Edward & Charles (1972) have re-emphasised the pharmacognostic value of palisade ratio. Brown (1958), Bensen (1962) and Teresa (1989) have found this character to be of taxonomic value.

II. Materials And Methods

The leaves of hundred and seventeen taxa (112 species) belonging to 40 genera of *Acanthaceae* have been collected from different localities of South India. The leaves were cut into pieces of 2-3mm.square and were treated with Chloral-Phenol (equal parts by weight of Chloral hydrate and Phenol) in cavity blocks for a few hours (Metcalfe & Chalk, 1979). Adequate standardisations were made in the composition of the clearing fluid as the waxy coating of the leaf surface varied with species.

The cleared leaf pieces were mounted and camera lucida drawings were made. Four adjacent epidermal cells and the palisade cells beneath them were drawn. The number of palisade cells could be then counted and the figure obtained when divided by four gave the palisade ratio values. The procedure was repeated and the mean palisade ratio values were found out. The readings were grouped under four categories such as, palisade ratio less significant (Category A), moderately significant (Category B), highly significant(Category C) and extremely significant (Category D).

III. Results

The mean palisade ratio ranges from 1.45 to 25.0 with the lowest and highest being observed in *Pseuderanthemum malabaricum* and *Strobilanthes barbatus* respectively (Table,I). Based on the present observations, the mean palisade ratio readings are grouped into four categories as under:

Palisade ratio less significant		<	4.5	Category A
Palisade ratio moderately significant	4.5	-	8.5	Category B
Palisade ratio highly significant	8.5	-	12.5	Category C
Palisade ratio extremely significant	12.5	<		Category D

The taxa-wise mean palisade ratio and range are tabulated (Table, I) and the number of species in each category are also given (Fig. I).

IV. Discussion

Metcalfe and Chalk (1979) point out that the palisade ratio is a reliable taxonomic character. The present study based on 117 taxa shows that the palisade ratio varies from species to species, but is constant for each taxon (Table, I). An attempt has been made to categorize the taxa investigated into four groups. Of the 117 taxa under study, 24.79% (29 taxa) come under category A with less significant palisade ratio. 37.61% (44 taxa) of the collected species fall under category B with moderately significant palisade ratio. The categories C and D represent the groups with highly significant and extremely significant palisade ratio values respectively, each category occupying 22 taxa (18.80% each) of the investigated species.

4.1. Tribe *Thunbergieae*

All the six species *Thunbergia* fall under category B. Bremekamp (1953,1955a,1965) raised the tribe to the family status '*Thunbergiaceae*'. However evidences from palisade ratio do not support the contention of Bremekamp (l.c.), since similar palisade ratio values are met with in the species belonging to other tribes viz. *Ruellieae* and *Justicieae* (Table I).

4.2. Tribe *Nelsonieae*

All the three genera (3 species) of the tribe Nelsonieae investigated, show close similarity in the mean palisade ratio values and fall under the third category C with highly significant palisade ratio. This category is commonly met with in many other members of the family, especially in *Asystasia, Justicia, Adhatoda* and *Barleria.* Though the systematic position and treatment of the tribe within *Acanthaceae* is in dispute (Bremekamp, l.c.), the observations in palisade ratio support the retention of the tribe within *Acanthaceae* rather than in *Scrophulariaceae* against Bremekamp (l.c.). Another strong evidence for the retention of the tribe *Nelsonieae* in *Acanthaceae* is that the category C of palisade ratio is again encountered in *Acanthaceae.* The palynological evidences of Valsaladevi (1987) also show that Bentham and Hookers (1876) *Nelsonieae* and *Acanthaceae* are similar.

4.3. Tribe *Ruellieae*

4.3.1. Subtribe Hygrophileae

Nees (1847), Bentham & Hooker(l.c.), Clarke (1884-85) and Lindau (1895) place
This tribe in a primitive position, while Bremekamp (l.c.) accommodates this taxon in a much advanced level (in Ruellieae) nearer to Justicieae. From cytopalynological evidences, Valsaladevi (l.c.) also suggests an advanced position for *Hygrophila.*

. The four species of *Hygrophila* under study belong to either category A or B. *H.auriculata* and *H. balsamica* show close similarity in the palisade ratio and fall under category B. Previously, generic status was assigned to these taxa as *Asteracantha* (Nees, 1832) and *Cardanthera* (Bentham and Hooker,1876) respectively. *H. quadrivalvis* and *H. salicifolia* represent category B of the tribe and palisade ratio values support the close affinity between these two species as reported by Ahmad (1976). The present placement of these four species in the adjacent categories A and B based on palisade ratio
values, strengthens the broad taxonomic conception of *Hygrophila* of Heine (1962) as supported by Cramer (1989,1992) who considers *Hygrophila* complex as a natural ecological group. It is noteworthy that the group A with less significant palisade ratio is frequently met with in the tribe *Justicieae* and the observations from palisade ratio justify the placement of *Hygrophileae* in an advanced position as done in Bremekamp's classification.

4.3.2. Subtribe *Trichanthereae*

The species *Sanchezia nobilis* of this tribe shows a less significant palisade ratio belonging to category A. Apart from the two species of *Hygrophila* under study, this is the only taxon from *Ruellieae* coming under the group A. Lindau (1865) has assigned a primitive position to the taxon while Bremekamp (l.c.) gives it a relatively advanced placement. The less significant range of palisade ratio is a character seen in advanced tribe *Justiciae* and Bremekamp's placement is justified in this context.

4.3.3. Subtribe *Euruellieae*

The palisade ratio is calculated for eight species of this subtribe and they fall under a wide range of categories *viz*., B, C and D. It is evident that category A is not available in this group (Table I). The two species od *Dyschoriste* under study belong to category B. A similar range is represented in *Hygrophila* and *Hemigraphis.* Ahmad (1974) points out a general similarity between these two genera. The present study favours the above reports. As *Hygrophila* is considered as a 'natural ecological group' the placement of *Dyschoriste* in the nearest subtribe will be justified. Bentham & Hooker (1876), Bremekamp (1953,1955) and Clarke (1884-85) place these two genera in the same tribe under different subtribes.

The genus *Ruellia* in the study falls in both group B and D with significant range in palisade ratio values. The two species of *Dipteracanthus* show highly significant palisade ratio and come under category C. Within the subtribe, this category is confined to the above species which were formerly included in *Ruellia* by many authors such as Bentham & Hooker (1876). However,the present work suggests the generic status of *Dipteracanthus* as supported by Bremekamp (1948), Santapau (1951) and Cramer (1992).

4.3.4. Subtribe *Petalidieae*

The genus *Phaulopsis* under this group falls under category C. Reference has to be made that species of *Eranthemum* of *Justicieae* formerly treated under this tribe as *Daedalacanthus* come under the category C.

4.3.5. Subtribe *Strobilantheae*

The present study includes single species each of the genera *Hemigraphis, Stenosiphonium, Kanjarum, Calacanthus* and ten species (11taxa) of *Strobilanthes*. Majority of the taxa fall under category D and two species come in category C. Group C with moderately significant palisade ratio is met with in *Hemigraphis colorata* and a similar range is not reported in any other taxon of the subtribe. However,category B is seen in the members of *Ruellia, Dyschoriste and Hygrophila*, as discussed earlier.
Anderson(1867) transferred many species formerly plced in *Ruellia* to *Hemigraphis* Ahmad(1972) based on foliar epidermal features find much similarity between these two genera. Balkwill and Norris (1988) commend that *Hemigraphis* poses many problems at the generic level. The observations on palisade ratio shows that category B is represented by many genera and generic delimitations are not possible with this character . However, as suggested by Balkwill and Norris (l.c.) *Hemigraphis* appears to be a misfit in *Strobilantheae* since all the taxa investigated under the tribe show a high rate of palisade ratio (Fig.II).

Venu (2006) enlists species of Strobilanthes in peninsular India. Most of the specimens of this tribe are the collections from Western Ghats. An extremely high rate of palisade ratio is encountered in these plants especially in *Stenosiphonium parviflorum, Strobilanthe szenkerianus* and *S.kunthianus* and attains a climax value of 25.0 in *S.barbatus* (Table I).

4.4. Tribe *Acantheae*

All the four species under study belong to group C. Apart from the genera *Blepharis* and *Acanthus* Bremekamp (l.c.) includes *Crossandra* also to this tribe. However, the palisade ratio values do not agree with this. Dee (1967) is of opinion that the petiolar anatomy of *Acanthus* is different from that of *Crossandra*

4.5. Tribe *Justiceae*

4.5.1. Subtribe Barlerieae

The taxa under study shows a wide range of mean palisade ratio values from 3.10 to 17.70 falling under all the categories (Table,I; Fig.II). Valsaladevi (1987) reports a high level of polyploidy in the genus *Barleria.* Recent reports of Vijayavalli & Mathew (1986) confirms the view of Kliphius(1967) that changes in the chromosome numbers are sometimes associated with notable differences in plant morphology. The diversity in the palisade ratio values may be due to the cytological variations within the taxa.

4.5.2. Subtribe *Asystasieae*

The five species of *Asystasia* investigated fall under either category A or C with mean palisade ratio values ranging from 2.70 to 9.65. These extremities are available even in the two varities of *A.gangetica.* Literature shows that *A.gangetica* complex has attracted the attention of both cytologists and morphologists (Valsaladevi,1987; Ugborogho and Adetula,1988). The extreme difference in the palisade ratio values may be indicating genetic variations. The categories A and C are also met with in the other species of *Asystasia* and this character is not useful in the delimitation of the species.

4.5.3. Subtribe *Eranthemeae*

The two species of *Eranthemum* fall under the categories C and D while four species of *Pseuderanthemum* fall under the category A. The taxa of *Eranthemum* shows close similarity with that of the tribe *Ruellieae* in the range of palisade ratio. The species of *Pseuderanthemum* fall under category A which is commonly met within the *Justicieae* of Bentham&Hooker(l.c.) The present study is in support with the placement given by Lindau (l.c.) and Bremekamp (l.c.)

4.5.4. Subtribe *Andrographideae*

The palisade ratio reported for the tribe comes either under category A or B and is constant for each taxon. Thus, neither *Gymnostachyum* nor *Diotacanthus* is a misfit in this subtribe. Lindau (l.c.) and Bremekamp (1965) place the genus *Diotacanthus* in *Strobilantheae.* In this subtribe palisade ratio values are extremely high. As *Andrographideae* represents a subtribe with less and moderately significant palisade ratio values, *Diotacanthus* is placed well in *Andrographideae*, rather than in *Strobilantheae*. Cytopalynological observations of Valsaladevi(l.c.) also support this view. Whether *Indoneesiella echioides* deserves a generic status is a matter of dispute among Acanthologists. The palisade ratio values do not give any strong evidence in support but the readings are relatively higher than the species of *Andrographis*.

4.5.5. Subtribe *Eujusticieae*

The systematic position of *Lepidagathis* is a long-standing controversy. However recent reports (Ahmed, 1975; Valsaladevi, l.c.; Balkwill and Norris, l.c.) do not welcome the placement of the genus in *Barleriae* as done by Lindau (l.c.) and Bremekamp (l.c.). The present observation is based on three species (five taxa) of *Lepidagathis* and all the taxa come under category B. *L. incurva* shows much morphological variations with regard to both seasonal and environmental changes. In the taxa examined, the author could not find any reliable change in the palisade ratio values. Balkwill and Norris (l.c.) report some striking similarity between the South African species of *Lepidagathis* and *Hygrophila* and places the genus near *Hygrophileae*, under a separate subtribe. Palisade ratiovalues do not reject such a proposal, but it will be too superficial to suggest a tribal status based on palisade ratio values alone, as category B is the most widely spread category among the various tribes of *Acanthaceae*

Of the 14 taxa of *Justicieae*, 11 species come under category B. Whether *Adhatoda* deserves a generic status is still a matter of dispute. The recent reports of Graham (1988) and Cramer (1992) do not support its generic status and they have put it in *Justicia* as J. *Adhatoda.* However the palisade ratio value of *A. vasica* comes under category A, which is not found in the other species of *Justicia.* Since categories A, B and rarely C are repeatedly seen in the genera of the tribe *Justicieae,* these values do not give any clue for the generic delimitations. A—B, B—C, A—C, combinations of categories are encountered in the taxa belonging to the genera *Beloperone Adhatoda and Ecbolium.* Valsadevi (l.c.) has reported intraspecific polyploidy in all the above genera.

4.6. Subtribe *Dicliptereae*

Except two species of *Rungia* which fall in category C, all the taxa belonging to *Rungia, Dicliptera and Peristrophe* come under category B Valsaladevi (l.c.) has reported intraspecific polyploidy in the species of *Rungia*

V. Conclusion

The forgoing account shows that the palisade ratio is a reliable taxonomic character, which is constant for a taxon and it will not vary with environment. However it is more useful in delimiting the taxa at tribal and intraspecific levels than at generic and specific levels. As the same category of palisade ratio is reported in many unrelated tribes, it can be used with other conservative characters in a holistic way. The present observations together with the evidences from other disciplines show that this character goes in harmony with other parameters and at many instances it reveals the relationship between closely related genera. In short the study is in keeping with the remarks of Metcalfe and Chalk (l.c.) that "palisade ratio is constant in different parts of an individual leaf and showed the same to be true in the leaves of a single species from a range of habitats, and finally in leaves of a single species collected over a sequence of years."

Table I showing the palisade ratio of the taxa investigated.

Name of the taxon	Palisade ratio	Category
TRIBE THUNBERGIEAE		
1. *Thunbergia alata* Boj. ex Sims.	4.65 (4.00-5.00)	B
2. *T. erecta* T. Anders.	8.15 (7.00-9.00)	B
3. *T.fragrans* Roxb.	5.70 (5.00-6.25)	B
4. *T .grandiflora* Roxb.	5.80 (5.00-6.50)	B
5. *T. kirkii* Hook. F..	4.70 (4.00-5.25)	B
6. *T.mysorensis* T. Anders.	5.75 (5.25-6.50)	B
TRIBE NELSONIEAE		
7. *Elytraria acaulis* (L.f) Lindau.	10.05 (7.75-12.5)	C
8. *Nelsonia campestris* R. Br.	9.85 (7.00-11.50)	C
9. *Staurogyne zeylanica* O. Ktze.	12.40 (10.5-16.25)	C

TRIBE RUELLIEAE			
Subtribe *Hygrophileae*			
10. *Hygrophila auriculata* (Schum.) Heine	7.60	(6.00-9.00)	B
11. *H.balsamica* (L.f.) Raf.	5.40	(4.50-6.00)	B
12. *H.quadrivalvis Nees*	3.60	(3.00-4.50)	A
13. *H.salicifolia* Nees	2.90	(2.50-3.25)	A
Subtribe Euruellieae			
14. *Dyschoriste depressa* Nees	7.50	(6.75-9.00)	B
15.*D. madurensis*(Burm.f.) Kuntze	7.95	(7.25-8.50)	B
16. *Ruellia formosa* Humb.	13.10	(10.25-16.25)	D
17. *R. repens* L.	5.00	(4.50-5.50)	B
18. *R. tuberosa* L.	16.50	(13.0-17.25)	D
19. *R. tweediana* Griseb.	6.95	(6.50-7.25)	B
20. *Dipteracanthus patulus* Nees	8.70	(6.75-9.25)	C
21. *D. prostratus* . Nees	8.75	(7.75-10.50)	C
Subtribe Petalidieae			
22*Phaulopsis imbricata* (Forsk.) Sweet	10.55	(9.25-11.75)	C
Subtribe Tricanthereae			
23. *Sanchezia nobilis* Hook.f.	2.15	(1.75-2.50)	A
Subtribe Strobilantheae			
24. *Hemigraphis colorata* Hall.f.	6.45	(5.75-7.00)	B
25. *Stenosiphonium parviflorum* T. Anders.	23.95	(21.0-26.75)	D
26. *Strobilanthes adenophorus* Bedd.	17.15	(15.00-20.00)	D
27. *S. barbatus* Nees	25.00	(23.00-28.00)	D
28. *S. ciliatus* Nees	10.20	(8.00-12.00)	C
29 . *S.heyneanus* Nees var. I	18.90	(17.25-21.25)	D
30. *S. heyneanus* Nees var. II.	14.80	(14.00 –15.00)	D
31. *S.kunthianus* T. Anders.	21.75	(21.00-24.50)	D
32. S.lawsoni Gamble	12.75	(10.75-14.75)	D
33. *S. perrottetianus* Nees	14.35	(13.50-15.75)	D
34. *S.pulneyensis* Clarke.	15.80	(12.50-18.75)	D
35. *S.urcceolaris* Gamble	12.70	(10.00-15.00)	D
36 *S. zenkerianus* T. Anders	24.00	(21.00-27.00)	D
37. *Kanjarum palghatense* Ramamurthy	15.95	(13.00-17.75)	D
38. *Calacanthus dalzellianus* T. Anders.	9.85	(8.75-10.75)	C
TRIBE ACANTHEAE			
39. *Blepharis asperrima* Nees	8.75	(8.25-9.50)	C
40. *B.boerhaaviaefolia* Pers.	11.35	(10.25-13.00)	C
41. *B. molluginifolia* Pers.	10.00	(9.00- 11.25)	C
42. *Acanthus ilicifolius* L.	8.50	(8.00-9.00)	C
TRIBE JUSTICIEAE			
Subtribe Barlerieae			
43 *Barleria acuminata* Wight	11.00	(10.00- 12.00)	C
44 . *B. buxifolia* L.	13.00	(12.00- 15.00)	D
45. *B. courtallica* Nees	3.25	(2.50-4.00)	A
46. *B.cristata* L. var. I (Purple flowered form)	12.65	(11.25- 15.00)	D
47. B.cristata L. var. II (White flowered form)	13.25	(11.50-14.50)	D
48. *B. involucrata* Nees	4.20	(3.50-4.75)	A
49. *B .lupulina* T. anders.	5.40	(4.75-6.25)	B
50. *B. montana* Nees	3.10	(2.50-3.75)	A
51. *B. mysorensis* Heyne	14.00	(12.00-16.00)	D
52. *B. nitida* Nees	14.70	(12.50-17.00)	D
53. *B.prionitis* L.	11.00	(9.75-13.75)	C
54. *B. strigosa* Willd.	6.20	(4.75-6.75)	B
55. *Crossandra infundibuliformis* (L.) Nees	5.50	(4.50- 6.25)	B

Subtribe Asystasieae

56. *Asystasia chelonoides* Nees	3.85	(3.00-4.50)	A
57. *A. dalzelliana* Santapau	9.65	(9.00-10.00)	C
58. *A.gangetica* T. Anders. var.I (Yellow flowered form)	2.70	(2.25-3.00)	A
59. *A.gangetica* T. Anders. var. II (Mauve flowered form)	9.15	(8.75-9.50)	C
60. *A. lawiana* Dalz.	3.80	(3.00-4.50)	A

Subtribe Eranthemeae

61. *Eranthemum capense* L.	11.90	(9.00-13.75)	C
62. *E. nervosum*. R. Br. .	14.15	(12.50-15.50)	D
63. *Pseuderanthemum bicolour* (Schrank) Radlkf.	2.20	(1.75- 2.75)	A
64. *P. malaabaricum* (Clarke) Gamble	2.40	(2.25-2.75)	A
65. *P. reticulatum* Radlkf.	1.45	(1.25-1.75)	A
66. *P. variable* (R. Br.) Radlkf.	3.35	(3.00-4.00)	A

Subtribe Andrographideae

67. *Andrographis elongata* T. Anders.	4.25	(3.75-4.75)	A
68. *A. macrabotrys* Nees	4.10	(3.50-4.70)	A
69. *A. neesiana* Wight	3.16	(3.00-3.50)	B
70. *A. ovata* Benth & Hook	5.75	(4.75-6.25)	B
71. *A. paniculata* Nees	4.35	(4.00-5.00)	A
72. *A. serpyllitolia* Wight	3.20	(2.75-3.50)	A
73. *A. stenophylla* Clarke	3.55	(2.75-4.25)	A
74. *A. wightiana* Arn ex Nees	4.83	(4.25-5.75)	B
75. *Indoneesiella echioides* (L.) Sreemadh.	6.35	(6.00-6.75)	B
76. *Gymnostachium febrifugum* Benth. & Hook.	2.95	(2.25-4.00)	A
77. *G. latifolium* T. Anders	2.3	(2.00-2.50)	A
78. *Diotacanthus albiflorus* Benth.	6.55	(6.00-7.25)	B

Subtribe Eujusticieae

79. *Lepidagathis cristata* Willd.	5.20	(4.50-6.00)	B
80. *L.incurva* Buch – Ham ex D Don var I	7.65	(7.00-8.50)	B
81. *L.incurva* Buch – Ham ex D Don var II	8.00	(7.00-9.00)	B
82. *L. pungens* Nees	7.10	(6.50-7.75)	B
83. *Justicia betonica* L. var. I	4.80	(4.25-5.50)	B
84. *Justicia betonica* L. var. II	6.33	(5.50-7.50)	B
85. *J.diffusa* Willd var. *hedyotifolia* Clarke	16.60	(12.50-21.50)	D
86. *J. gendarussa* Burm. f.	7.05	(6.25-8.25)	B
87. *J. glauca* Rottl.	5.00	(4.50-5.50)	B
88. *J. micrantha* Wall	15.20	(14.50-15.50)	D
89. *J. montana* Wall.	8.25	(6.50-9.00)	B
90. *J.procumbens* L.	5.30	(4.75-6.00)	B
91. *J. prostrata* (Clarke) Gamble	9.85	(8.50-11.50)	C
92. *J. quinqueangularis* Koen ex Roxb.	5.50	(4.50-6.50)	B
93. *J. simplex* D. Don	8.25	(7.25-8.75)	B
94. *J. tranquebariensis* L.	4.56	(4.00-5.00)	B
95. *J. trinervia* Vahl	5.00	(4.75-5.25)	B
96. *J. wyanaadensis*.Heyne	7.05	(6.25-7.75)	B
97. *Beloperone guttata* Brandegee	8.85	(8.50-9.75)	C
98. *B. plumbaginifolia* Nees	6.30	(5.00-7.00)	B
99. *Pachystachys coccinea* Nees	3.65	(3.00-4.50)	A
100. *Pachystachis lutea* Nees	3.30	(2.75-4.00)	A
101. A*dhatoda beddomei*Clarke	9.65	(8.25-11.00)	C
102. *A. vasica* Nees	2.70	(2.25-3.25)	A
103. *Rhinacanthus communis* Nees	5.70	(4.50-7.00)	B
104. *Dianthera candicans* Benth. &Hook.	6.65	(6.25-7.25)	B

105. *Jacobinia carnea* Nichols	4.00	(3.50-4.50)	A
106. *Fittonia gigantea* Linden ex Andre	2.20	(2.00-2.50)	A
107. *F. verschaffeltii* Coemans	2.35	(2.00-2.75)	A
108. *Ecbolium linneanum* Kurz var. *laetevirens*	4.10	(3.00-5.00)	A
109. *Ecbolium linneanum* Kurz var. rotundifolia	7.90	(6.75-9.25)	B
110. *Graptophyllum pictum* (L.) Griff.	1.90	(1.50-2.50)	A
Subtribe Dicliptereae			
111. *Rungia linifolia* Nees	11.00	(10.00-12.00)	C
112. *R. parviflora* Nees var. pectinata	11.30	(9.50-12.50)	C
113. *Rungia repens* Nees	5.40	(4.75-6.50)	B
114. *R. wightiana* Nees	4.75	(4.50-5.00)	B
115. *Dicliptera cuneata* Nees	6.39	(5.75-7.25)	B
116. *Peristrophe bicalyculata* Nees	6.55	(5.25-8.00)	B
117. *P. montana* Nees	5.90	(5.25-6.00)	B

Note: Mean values are followed by range in parentheses.

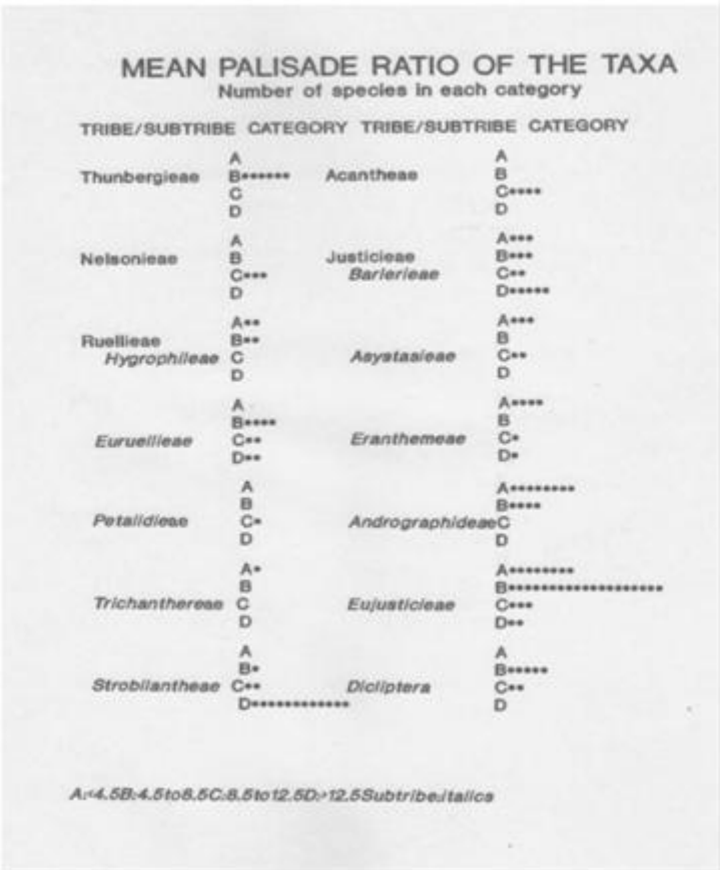

FIGURE 1

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References

[1]. Ahmad, K.J. 1972. Cuticular studies in some *Acanthaceae* and *Solanaceae* Ph.D. thesis. Lucknow University.
[2]. Ahmad, K.J. 1976.epidermal studies in some species of *Hygrophila* and *Dyschoriste*. *J. Ind. Bot. Soc* 55:41-52.
[3]. Anderson T. 1867. An Enumeration of Indian Species of *AcanthaceaeJournal of Linnean Society of Botany* 7: 425 – 526.
[4]. Benson L. 1962. Plant Taxonomy, Ronald press, New York.
[5]. Bentham G. 1874. Recent progress and present state of systematic Botany, Report of British Association.

[6]. Bentham G. & Hooker J.D. 1876. Genera Plantarum *Acanthaceae* in 2 – 1060 1122. Reeves and Co. London
[7]. Bhogaonkar P.Y. & S.K. Lande 2015. Anatomical characterization of *Lepidagathis cristata* Willd.- A Ethanomedicinal herb. Journal of global biosciences 4(5):2282-2288.
[8]. Bremekamp C. E. B. 1948. Notes on the *Acanthaceae* of Java. Nederal. Acad. Wetnesch. Verh. (Tweedle Sect.) 45: 1 78.
[9]. Bremekamp C. E. B. 1953. The delimitation of *Acanthaceae*Proc. Kon. Nederl. Akad. Wetensch. (Ser, C.) 56 : 533 – 546
[10]. Bremekamp C. E. B. 1955. A revision of Malasian *Nelsonieae* (Scrophulariaceae)Reinwardtia 3: 157 – 261.
[11]. Bremekamp C. E. B. 1965. Delimitation and subdivision of the *Acanthaceae* Bulletin of Botanical Survey of India. 7: 21 – 30.
[12]. Brwn W. V. R. 1258. Leaf anatomy in grass systematics. Botanical Gazette 199: 170-178
[13]. Chaubal P. D. 1966. Palinologocal studies on the family *Acanthaceae* University of Poona, India.
[14]. Choopan T. & P. J. Grote 2015. Cystoliths in the leaves of the genus *Pseuderanthemum* (Acanthaceae)in Thailand. International Journal of Science 12(2) : 13 – 20.
[15]. Clark C. E. B. 1984-1985. *Acanthaceae* In Hooker J. D. Flora of British India 4: 387-558.
[16]. Cramer M. H. 1989. The *Hygrophila* complex (*Acanthaceae*) in India and Cyleon. *Nordian journal of Botany*. 9: 261 – 263.
[17]. Cramer M. H. 1992. Name changes in the *Acanthaceae* of india and *Cylon. Journal of National Science Council, Srilanka*. 20: 59 – 69.
[18]. De A. 1967. Cytological anatomical and palinological studies as an aid in tracing the affinity and phylogeny in the family *Acanthaceae.* III General anatomy. Trans. Bose Research Institute. 30: 51 – 65.
[19]. Dewar T. 1933. The histology of the leaves of Digitalis thapsi *Q. J. Pharm. Pharmae* 6; 443 – 453.
[20]. Dewar T. 1934 a. The histology of the leaves of Digitalis lutea. *Q. J. Pharm. Pharmae* 7: 1 – 22.
[21]. Dewar T. 1934 b. The histology of the leaves of Digitalis lanata. *Q. J. Pharm. Pharmae* 7: 331 – 345.
[22]. Edward T. J. and Charles E. W. 1972. Pharmacognocy 10th Ed. Bailliere Tindall, London
[23]. George E. 1943. Senna leaflets and their palisade ratio values and ranges. *Pharm J. Ser*. 97: 52.
[24]. Graham, V. A. 1988. Delimitation and infrageneric classification of *Justicia (Acanthaceae). Kew.Bull.* 43:551-624.
[25]. Heine H. 1962. Notes on some West African *Acanthaceae*: The reduction of the genus Asterantha Nees to *Hygrophila* R.Br. *Kew Bull.*
[26]. Heine H. 1971.Notes on *Sur. Les.Acanthaceae Africaines. Adensonia* 11:561-569.
[27]. Jani S. & H.C. Rudrappa 2014. Morphological, structural and micrometric study of cystolith of family Acanthaeceae W.S.R. to Kalmegh. International Journal of Green Pharmacy . 8(1):13
[28]. Kliphius E. 1967. Cytotaxonomic notes on *Gallium* species. *Acta.bot. Neerl.* 15:535-538
[29]. Kumar R.S., Reddy R.P., Rao S.G.& K. Nethaji 2014. Botanical Pharmacognosy on the Leaves of Medicinally Important Plant *Andrographis paniculata* (Nees) Collected from the Forest Area of Medak District, Andhra Pradesh, India. Int. J. Pharm. Sci. Rev. Res., 25(2):292-295.
[30]. Lindau G. 1895. *Acanthaceae*. In Engler A. and Prantl K. Die naturalichen pflanzenfamilien 4: 274 – 354.
[31]. Mathew K. M. 1983. Flora of Tamil Nadu and Karnatic. Ranipet Herbarium,Thiruchirappalli, India.
[32]. Mcdade, L. A., Daniel T. F., Carrie A. K., and Vollessen K.(2005.) Phylogenetic Relationships Amonth Acantheae (Acanthaceae) Major Lineages Present Contrasting Patterns of Molecular Evolution and Morphological Differentiation. Systematic Botany 30 (4) Pp 834 -862.
[33]. Metcalfe and Chalk 1979. Anatomy of Dicotyledons Vol. I, II Edition. Oxford.
[34]. Moylan , E. C. , J. R. Bennett , M. A. Carine , R. G. Olmstead , and R. W. Scotland 2004 . Phylogenetic relationships among Strobilanthes s.l. (Acanthaceae): Evidence from ITS nrDNA, trnL-F cpDNA, and morphology. American Journal of Botany 91 : 724 – 735
[35]. Nees Von Esenbeck C. G. 1832. Acantheae Indiae Orientalis. *In* Wallich, *Pl. As. Rar*. 3: 70-117.
[36]. .Noor-syaheera M.Y., Noraini T., Radhiah A.K. & C. A. C. Che-nurul-Aini 2015. Leaf anatomical characteristics of Avicennia L.and some selected taxa in Acanthaceae. Malayan Nature Journal 67(1): 81-94.
[37]. Patil A.M. & D.A Patil 2011. Occurrence and significance of cystoliths in Acanthaceae. J. Curr. Bot. 2(4): 01-05.
[38]. Santapau, H. 1951. *The Acanthaceae of Bombay. Bot. Memories 2.* Bombay University Press, Bombay.
[39]. Scotland, R. W. And K. Vollesen (2000) Classification of Acanthaceae. Kew Bulletin, Vol. 55, No. 3, Pp. 513-589
[40]. Teresa, M.M.V. 1989. Autecological studies on some species of *Polygala* L. Ph. D. Thesis, University of Poona
[41]. Ugborogho, R.E. and O.A. Adetula, 1988The biology of *Asystasia gangetica* complex (*Acanthaceae*) in Lagos State, Nigeria. Feddes Reportorium 99: 507 – 517.
[42]. Valsaladevi G. 1987. Cytological and Palynological studies on the south Indian *Acanthaceae* Ph.D. Thesis, University of Kerala, Trivandrum.
[43]. Valsaladevi G. and Mathew P. M. 1983. On the operculate aperture in the pollen of *Sanchezia parvibractea, Current Science*, 52: 371.
[44]. Venu, P. 2006. Strobilanthes Blume (Acanthaceae) in Peninsular India. Botanical Survey of India, Calcutta
[45]. Verdam Maria C.S., Ohana D.T., Araújo Maria G. P., Guilhon Simplicio F., Mendonça M. S. de, M.M. Pereira 2012. Morphology and anatomy of Justicia acuminatissima leaves. Revista Brasileira de Farmacognosia Brazilian Journal of Pharmacognosy. Rev. bras. farmacogn. vol.22 no.6
[46]. Vijayavalli B. and Mathew P. M. 1986. New report of polyploid cytotypes in smilax ovalifolia *Current Science* 55: 666.
[47]. Wallis T. E. and Diwar T. 1933. Buchu and other leaves of other species of *Barsoma O. J. Pharm. Pharmc*. 6: 347 – 362.
[48]. Wallis T. E and Forsdike J. L. 1938. palisade ratio, its value for detecting certain adulterants of *Belladona* leaf and *Stramonium* especially *Scopolia carniolica* and *Solanum nigrum. Q. J. Pharm. Pharmc*. 1: 700 – 708.
[49]. Zorning H. Weiss G. 1925. In Metcalfe and Chalk (1979) Anatomy of Dicotyledons Vol. I. Oxford.

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