Proc. Indian Acad. Sci. (Plant Sci.), Vol. 96, No. 1, March 1986, pp. 1–7.

Distribution pattern of phenolic constituents in species of *Bauhinia* Linn. and its taxonomic significance

G NAGESHWAR, S M J ANURADHA, M RADHAKRISHNAIAH and L L NARAYANA*

Department of Botany, Nizam College, Osmania University, Hyderabad 500001, India

* Department of Botany, Kakatiya University, Vidyaranyapuri, Warangal 506009, India

MS received 12 August 1985; revised 3 March 1986

Abstract. Quantified chromatographic data on the distribution pattern of phenolic constituents in 15 species of *Bauhinia* expressed as synthetic numerical indices and polygons indicate a close biochemical kinship among them and do not warrant the splitting of the genus, as has been done on morphologic grounds. However, the grouping of the species, based on similarity coefficients clustered successively by WPGM, does not conform to the grouping on traditional grounds.

Keywords. Phenolic constituents; chemotaxonomy; *Bauhinia*

1. Introduction

The compendia by Harborne *et al* (1971) and Gibbs (1974) present a patchy account of chemotaxonomy of *Bauhinia*. The distribution of secondary metabolites and free amino acids in *Bauhinia* spp. has been studied recently (Nageshwar *et al* 1984). This paper deals with the distribution pattern of phenolic constituents and its significance to the relationship among 15 species of *Bauhinia*.

2. Materials and methods

Twigs of 17 taxa of *Bauhinia* were procured from the Indian Botanic Garden, Howrah, or from different localities of Hyderabad (table 1). The voucher specimens are deposited in the Department of Botany, Nizam College, Hyderabad. For detection of phenolic constituents the dried leaf and stem materials were digested in 2 N HCl over boiling water bath for 20 min. The digest was cooled and filtered. The filtrate was treated with diethyl ether; the separated ether layer was concentrated and used for bidirectional ascending paper chromatography in 1% HCl and propanol: ammonia: water (20:1:4 v/v) solvent systems. The air-dried chromatograms were observed under UV light for blue fluorescent spots and sprayed with the visualizing agent, 0·2% diazotized sulphanilic acid. The phenolic acids were identified by comparing the UV fluorescent spots, R_f values and spot colours with those of the authentic samples, chromatographed under identical conditions. However, for the spots that could not be identified, the hR_f values (one hundred × R_f) in both directions and the spot colours were noted. The spots on separate chromatograms presumed to be identical in position and colour reaction both under UV and with the visualising agent were marked on a 'master chromatogram' with marginal adjustments of R_f values to minimize the differences and were assigned

Table 1. Species and varieties of *Bauhinia* studied.

Taxon	Place of Collection	Native distribution	Voucher specimen no.
1. *Bauhinia acuminata* Linn	Indian Botanic Garden, Howrah	China	46
2. *B. corymbosa* Roxb. ex DC		China	36
3. *B. diphylla* Buch-Ham		India	40
4. *B. ferruginea* Roxb		Asia	44
5. *B. galpinii* N E Brown		South Africa	37
6. *B. hookeri* F Muell		Australia	32
7. *B. petersiana* Bolle		Africa	52
8. *B. purpurea* Linn. var *purpurea* De Witt	Vidyanagar, Hyderabad	China	21
9. *B. purpurea* Linn. var. *violacea* De Witt		China	13
10. *B. retusa* Buch Ham. ex Roxb (= *B. roxburghiana* Voigt)	Indian Botanic Garden, Howrah	India	39
11. *B. rufescens* Lam		West Africa	35
12. *B. scandens* Linn. var. *horsfieldii* (Miq.) Ohashi (= *B. anguina* Roxb)		Asia	41
13. *B. semibifida* Roxb		Malacca	43
14. *B. tomentosa* Linn	Chikkadpally, Hyderabad	Africo-Asia	25
15. *B. vahlii* Wight and Arn	Indian Botanic Garden, Howrah	India	38
16. *B. variegata* Linn. var. *alboflava* De Witt	Public Garden, Hyderabad	Asia	1
17. *B. variegata* Linn. var. *variegata* De Witt	Osmania Univ. Campus, Hyderabad	Asia	4

the same code. A numerical assessment (Ellison *et al* 1962) of the distribution of phenolic constituents has been depicted as polygons (see Hutchinson 1936). The cluster analysis has been done according to Sokal and Sneath (1963)

3. Results and discussion

Of the phenolic acids identified (table 2), *p*-hydroxybenzoic acid and vanillic acid were present in all the members. Protocatechuic acid was recorded in one instance, namely *B. tomentosa*. From among the unidentified phenolic constituents spots I-42/27 and J-42/55 were of universal occurrence. The phenolic compounds A'-44/54, P-66/70 and U-68/60 were present in about 60% of the taxa studied.

Studies on distribution of phenolic compounds provide useful information on taxonomic problems at all levels of hierarchy and also in presumed instances of interspecific hybridization (Alston and Turner 1963; Prayer *et al* 1983). The distribution of phenolic constituents in *Bauhinia* species (table 2) suggests a fair degree of kinship among the taxa studied. This is supported by paired affinity indices (PAI, table 3) calculated according to the formula of Ellison *et al* (1962). The polygonal graphs (figures 1–17) based on PAI, indicate the affinities at a glance. Each polygon depicts the comparative quantitative affinity of a taxon with all other taxa studied. The sum total of PAI values of one taxon with each other taxon, that is the group affinity index (GAI), provides a numerical expression to each polygon. Thus the GAI values ranging from

Table 2. Distribution of phenolic constituents in the species and varieties of *Bauhinia*.

Phenolic constituent	Taxon (number as in table 1)																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
p-OH Benzoic acid	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Caffeic acid			+				+		+				+	+			+
p-Coumaric acid	+	+	+	+	+		+	+	+	+		+		+	+	+	+
Gallic acid	+	+	+			+	+			+		+	+		+		
Protocatechuic acid														+			
Salicylic acid	+	+	+	+	+		+			+	+		+	+	+		+
Vanillic acid	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Unidentified phenolic constituents*																	
A-18/5												+					+
B-20/60		+															
C-26/20	+		+					+	+				+				+
D-32/20						+											
E-32/30	+		+		+				+					+		+	+
F-32/60		+															
G-40/45		+															
H-42/8																+	+
I-42/27	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
J-42/55	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
K-50/10			+	+	+				+							+	
L-50/52	+					+					+						
M-56/20						+	+			+					+		
N-58/5			+				+				+	+			+		
O-60/17														+			
P-66/70	+			+		+		+	+	+	+	+			+	+	+
Q-68/12	+	+	+	+	+	+	+	+	+	+	+	+			+	+	
R-68/25											+						
S-68/37					+		+	+		+							
T-68/50	+	+	+	+	+	+	+				+	+	+		+	+	+
U-68/60		+	+	+	+		+			+	+	+	+	+			
V-68/70														+			
W-68/80	+		+	+				+	+						+		+
X-70/5							+										
Y-70/57									+	+	+					+	+
Z-80/85					+												
A'-44/54			+	+		+				+	+	+	+		+	+	+

\+ Represents presence of phenolic constituent.

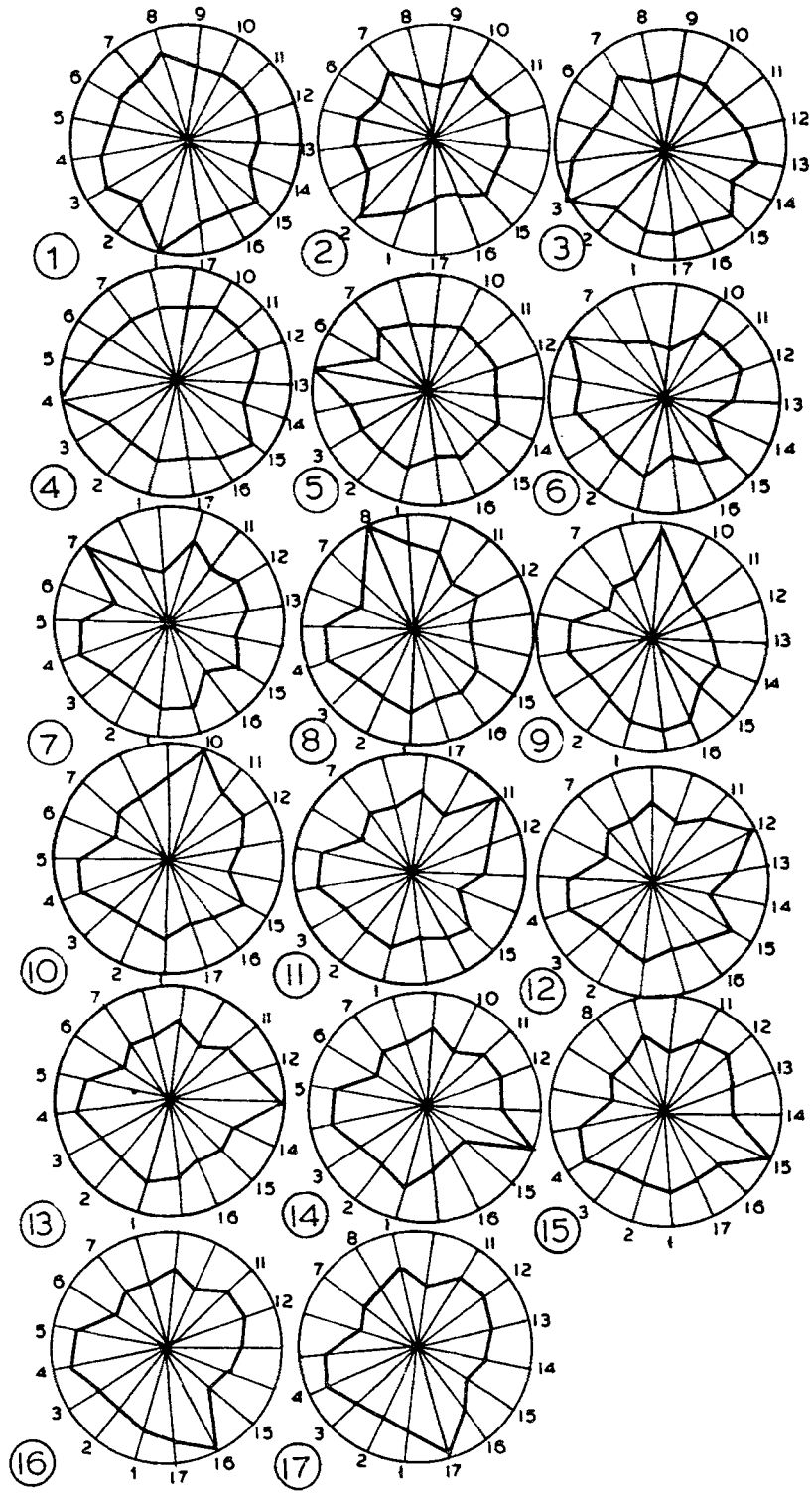
* The alphabet numerator and denominator indicate the code, the hRf values in direction I and direction II, respectively.

942–1213 (table 3) indicate a high degree of affinity. The isolation values (Ellison *et al* 1962) are negligent (3 each in *B. petersiana* and *B. rufescens*, 9 each in *B. corymbosa* and *B. tomentosa* or zero as in the remaining taxa) and suggest close chemical ties among the species of *Bauhinia*, which are native to different regions of the world and have become naturalised in India.

On morphologic grounds *Bauhinia* Linn. is divided into 4 subgenera: *Lasiobema* (Korth) Miq., *Phanera* Lour, *Piliostegma* and *Bauhinia* Linn. (*Sensu stricto*). The commonness in the distribution of phenolic constituents as indicated by the numerical

Table 3. Synthetic numerical indices.

Taxon (No. as in table 1)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Group affinity index	Isolation value
	Paired affinity index																		
1	100	66	77	74	66	69	62	75	69	64	64	66	64	53	78	71	73	1191	0
2		100	66	69	69	56	71	52	45	66	59	69	66	56	66	51	49	1076	9
3			100	80	73	55	75	59	68	64	64	73	78	62	77	70	72	1213	0
4				100	76	64	64	69	64	74	74	76	66	56	81	74	68	1229	0
5					100	48	71	60	56	66	59	61	58	64	59	66	55	1107	0
6						100	59	54	41	69	69	72	60	33	76	61	50	1036	0
7							100	56	44	75	62	71	69	59	75	48	76	1137	3
8								100	72	66	50	60	47	45	66	66	61	1058	0
9									100	53	46	48	52	58	53	76	78	1023	0
10										100	71	74	64	53	78	64	60	1161	0
11											100	74	64	46	71	64	60	1097	3
12												100	66	48	81	66	62	1167	0
13													100	60	64	56	72	1106	0
14														100	46	46	57	942	9
15															100	64	60	1201	0
16																100	80	1123	0
17																	100	1139	0



Figures 1–17. Paired affinity values of the 17 taxa (table 3) with all other taxa Affinity values are expressed along the radii from 0–100% beginning at the centre.

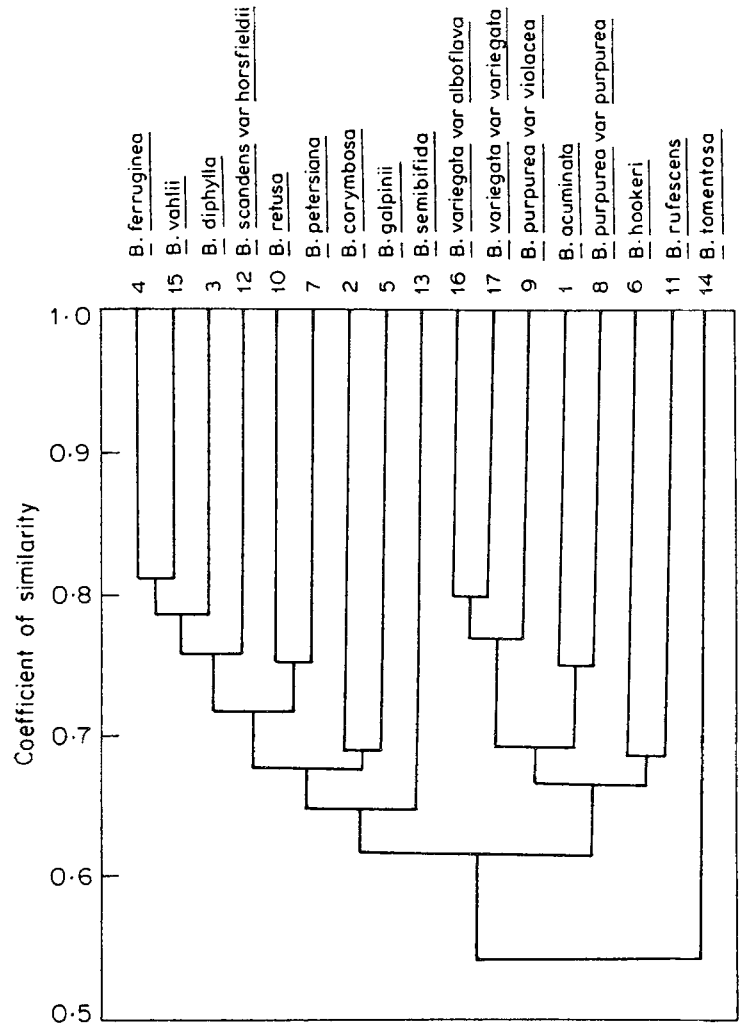


Figure 18. Dendrogram of cluster analysis based on the coefficients of similarity by weighted pair group method.

indices does not warrant the splitting of the genus. Although the dendrogram of cluster analysis (figure 18) based on similarity coefficients by weighted pair group method (Sokal and Sneath 1963) indicates 3 clusters among 15 species studied, the clusters do not conform to the division of the genus on morphologic grounds. Hence, *Bauhinia* Linn. be treated in a comprehensive sense. Nageshwar *et al* (1984) arrived at a similar conclusion by their studies on the distribution pattern of free amino acids and certain other chemical constituents of the genus.

Acknowledgements

We are grateful to the Director, Botanical Survey of India, for the permission to collect live materials of some of the taxa from the Indian Botanic Garden, Howrah. GN, SMJA

and MR are grateful to Dr Bharat Kumar for encouragement. GN and SMJA thank the CSIR and UGC, New Delhi for the award of fellowships.

References

Alston R E and Turner B L 1963 *Biochemical systematics* (New Jersey: Prentice Hall)

Ellison W L, Alston R E and Turner B L 1962 Methods of presentation of crude biochemical data for systematic purposes with special reference to the genus *Bahia* (Compositae); *Am. J. Bot.* **49** 599–604

Gibbs R D 1974 *Chemotaxonomy of flowering plants* I-IV (Montreal, London: McGill Queen's Univ. Press)

Harborne J B, Boulter D and Turner B L (eds) 1971 *Chemotaxonomy of Leguminosae* (New York, London: Academic Press)

Hutchinson A H 1936 Polygonal representation of polyphase phenomena; *Trans. R. Soc. Can.* **3** 19–36

Nageshwar G, Radhakrishnaiah M and Narayana L L 1984 Numerical chemotaxonomy of *Bauhinia*; *Proc. Indian Acad. Sci. (Plant Sci.)* **93** 621–627

Prayer K M M, Britton D M and McNeill J 1983 A numerical analysis of the chromatographic profiles in North American taxa of the fern genus *Gymnocarpium; Can. J. Bot.* **61** 2592–2602

Sokal R R and Sneath P H A 1963 *Principles of numerical taxonomy* (San Francisco, London: W H Freeman and Co.)