

## NUMERICAL ANALYSIS OF THE GENUS *POGOSTEMON* DESF. (LAMIACEAE)

MAHBUBA KHANAM, ALASTAIR CULHAM,  
SYED Z. HUSAIN AND SYEDA S. TAHIR\*

*Department of Botany,  
Plant Science Laboratories, University of Reading  
P.O.Box 221, Reading RG6 2AS, England.*

### Abstract

Numerical phenetic analysis of *Pogostemon* Desf. (Lamiaceae) species was carried out using a Reading Taxonomy Computer Programme. Thirteen species found in Bangladesh were analyzed for 34 characters. Three Phenograms derived from nearest neighbour, furthest neighbour and group average clustering were produced. The results obtained are discussed in the light of previous classification.

### Introduction

Numerical taxonomy is the grouping of O.T.U.s (Operational taxonomic units) by numerical methods into group on the basis of their character states. It provides a logical means of expressing the relationships among taxa of known relationship on the one hand and taxa of uncertain affinities on the other (Sneath & Sokal (1973). It is based on the assumption that all kinds of characters should be used in classification and aim to give equal weight to each character. In the course of the study of the genus *Pogostemon*, data from comparative morphology (light and Scanning electron microscopy), flavonoid survey were gathered. All these data were subjected to numerical phenetic analysis by using Reading taxonomy programme.

### Material and Methods

Herbarium specimens of the genus *Pogostemon* were obtained on loan from the Bangladesh National herbarium, Dhaka University herbarium, British Museum of Natural History, London and Royal Botanic Gardens, Kew. For the numerical analysis, Reading University Taxonomy Programme ASF-4, was used to analyse the 13 O.T.U.s. to determine the systematic structure. Three types of characters viz., Binary, multistate ordered and multistate unordered characters were used, which includes 27 morphological and 7 chemical characters. Binary characters which have just two states, where 0 was scored for absent and 1 for present. Multistate ordered characters are those whose variation is continuous but where the variation is broken up for scoring (e.g., stem indumentum, which varies continuously, these are scored as; glabrous = 0, pubescent = 1, tomentose = 2, hirsute = 3). The classes are selected so that the magnitude of the difference between state 0 and 2 is twice that between state 0 and 1. Multistate unordered characters were scored 0, 1, 2, 3 up to the number of states recognised in each character; difference between states 0 and 1 is no greater or less than between states 2 and 3 or state 0 and 3 (e.g. leaf base; lineate = 0, attenuate = 1, cordate = 2 and truncate = 3).

\*Present address: Department of Botany, University of Sindh, Jamshoro, Sindh, Pakistan.

Table 1. The characters scored, their states, and character types.

Characters	Character state	Types of Characters
<b>Morphological Character</b>		
<b>Habit</b>		
1. type	Herb = 0, Shrub = 1	B
2. Nature	Marshy = 0, Dry = 1	B
<b>Stem</b>		
3. Nature	Ascending = 0, erect = 1	B
4. Form	Simple = 0, constricted = 1	B
5. Hair	Glabrous = 0, Pubescent = 1, Tomentose = 2, Hirsute = 3	M.O.
<b>Petiole</b>		
6. Length	Absent = 0, c. 2 mm = 1, more than 2 mm = 2	M.O.
<b>Leaves</b>		
7. Number	2 = 0, 4-10 = 1, 11-14 = 2	M.O.
8. Type	Membranous = 0, Non membranous = 1	
9. Shape	Linear = 0, Elliptic = 1, Ovate = 2, Rhomboid = 3	M.O.
10. Base	Cuneate = 0, Attenuate = 1, Cordate = 2, Truncate = 3	M.O.
11. Apex	Acute = 0, Acuminate = 1	B
12. Margin	Entire = 0, Serrate = 1, Dentate = 2, Crenate = 3	M.O.
13. Trichome	Absent = 0, Small = 1, Medium = 2, Long = 3	M.O.
<b>Bract</b>		
14. Type	Non-membranous = 0, Membranous = 1	B
15. Shape	Linear = 0, Ovate = 1, Oblanceolate = 2, elliptic = 3	B M.O.
16. Hair	Pubescent = 0, Tomentose = 1, Villous = 2, Ciliate = 3	MUO
<b>Bracteoles</b>		
17. Longer/shorter than calyx	Shorter = 0, Longer = 1	B
18. Bract longer/shorter than calyx	Shorter = 0, Longer = 1	B

Table 1 (Cont'd)

Characters	Character state	Types of Characters
<b>Calyx</b>		
19. Shape	Campanulate = 0, Tubular = 1	B
20. Teeth in fruiting	Incurved = 0, Erect = 1	B
21. Hairs on	Margin = 0, Teeth = 1, Whole surface = 2	M.O.
<b>Corolla</b>		
22. Lobe	4 equal = 0, 4 unequal = 1, 5 unequal = 2	M.O.
23. Colour	White with pink spot = 0, White = 1	B
24. Hair	Hairy = 0, Glabrous = 1	B
<b>Nutlet</b>		
25. Colour	Brown = 0, Blackish = 1	B
26. Shape	Orbicular = 0, Ellipsoid = 1	B
27. Surface	Uneven = 0, Reticulate = 1	B
<b>Chemical characters</b>		
<b>Flavonoids</b>		
28. Lu 7-gl	Absent = 0, Present = 1	B
29. Ap.7-gl	Absent = 0, Present = 1	B
30. Fl. C-gl	Absent = 0, Present = 1	B
31. 6-OH lu.	Absent = 0, Present = 1	B
32. Spot no. C	Absent = 0, Present = 1	B
33. Spot no. F	Absent = 0, Present = 1	B
34. Aglycones	Absent = 0, Present = 1	B

Key: B = binary; M.O. = multistate ordered; MUD = multistate unordered; Lu 7-gl = luteolin-7-glucoside; Ap.7-gl = Apigenin-7-glucoside; Fl.C-gl = flavonoid-C-glycoside; 6-OH, Lu = 6-hydroxy luteolin.

## Results and Discussion

Thirteen species of the genus *Pogostemon* were cladistically analyzed for 34 attributes, which includes macromorphological, micromorphological and phytochemical characters. Three phenograms using the nearest neighbour, furthest neighbour, and group average strategy were developed. In all the three phenograms generated by above strategies, two major groups come out fairly clearly. The results of furthest neighbour and nearest neighbour strategy are more or less similar to the results obtained for group average strategy, except the positions of a few OTU has been changed, hence only one phenogram produced by group average analysis is provided which gives most satisfactory classifications of the genus *Pogostemon*. In this phenogram (Fig.1) two major groups are produced.

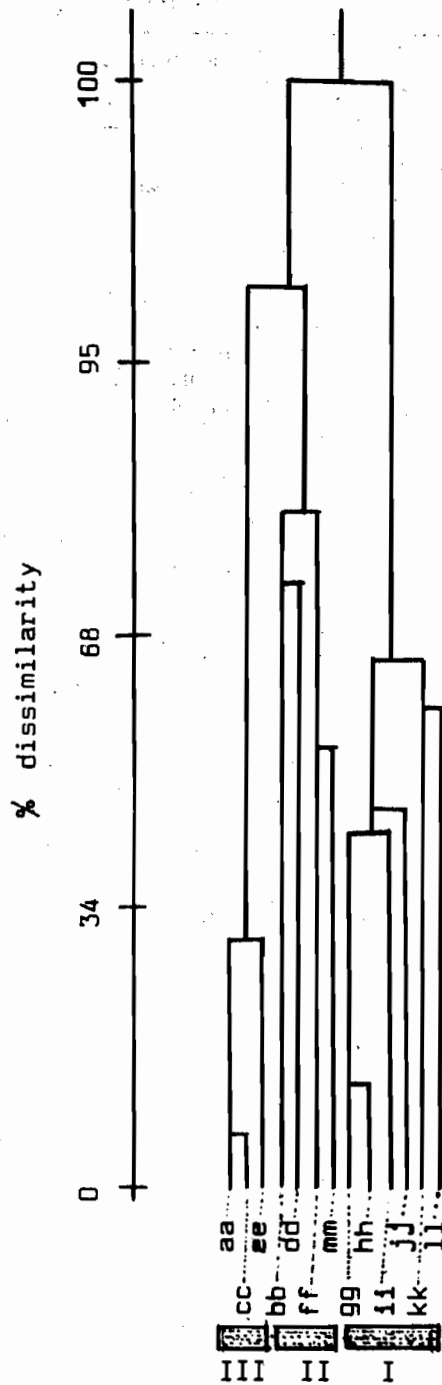


Fig.1. Phenogram of group average numerical analysis of *Pogostemon* species.

**Group 1:** with 7 taxa, includes *P. crassicaulis*, *P. cruciata*, *P. pumilus*, *P. quadrifolius*, *P. stellatus*, *P. auricularius* and *P. strigosus*.

**Group II:** with 6 taxa, includes *P. suavis*, *P. hispidus*, *P. paniculatus*, *P. parviflorus*, *P. plectranthoides* and *P. villosus*.

Within group I three species viz., *P. crassicaulis*, *P. pumilus* and *P. stellatus* forms a sub-group. They are held together by habit type, habit nature, stem type and other chemical characters. This sub-group is included to the main stem of the phenogram before the group I joins the group II of the phenogram.

Bentham (1832-36) recognized two sections within the genus *Pogostemon* viz., (i) Paniculatae and (ii) Racemosae, on the basis of inflorescence. Briquest (1897) subdivided sect. Paniculatae Benth. into group A (interrupted verticils) and group B (continuous verticils) and Sect. Racemosae Benth. into Group I glabriuscula with non-hairy filaments and group II Barbata, with hairy filament. In the genus *Pogostemon* all the species from Bangladesh have hairy filaments therefore Briquest (1897) division of Sect. Racemosae Benth., cannot be recognized. Moreover, the demonstration between interrupted and continuous verticils is not possible, hence the sub-division of Sect. Paniculatae is not recognized. Press (1982) while studying the tribe Pogostemoneae has also rejected the further division of Bentham's section. The results of this cladistic analysis agrees with Bentham's classification.

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**APPENDIX I**

Showing the data matrix of *Pogostemon* species (OTU) used for numerical analysis

aa-	0	0	0	0	0	1	0	0	2	0	1	0	1	2	0	0	1	0	0	1	0	1	1	1	0	0	1	0	0	0	0	0	1	
bb-	0	1	1	0	3	0	2	1	1	2	0	0	3	0	0	1	0	1	0	1	1	0	1	1	1	0	0	9	9	9	9	9	9	
cc-	0	0	0	0	0	0	1	0	0	2	0	1	0	1	2	0	0	1	0	0	1	0	1	1	1	0	0	1	0	0	0	0	1	
dd-	0	1	1	0	2	1	2	1	0	1	1	1	2	0	0	2	0	1	0	1	1	0	1	1	1	0	1	1	0	0	1	1	0	0
ee-	0	0	0	0	0	0	1	0	0	1	1	1	0	1	2	0	0	1	0	1	1	0	1	1	0	0	0	1	0	0	0	0	0	0
ff-	0	1	1	0	3	1	0	1	1	0	0	1	3	0	2	3	0	1	0	0	0	0	1	1	1	0	1	1	1	0	0	1	0	0
gg-	0	1	0	0	1	2	0	1	3	0	0	3	1	0	1	0	0	1	1	1	2	1	0	0	1	1	1	1	0	0	1	0	1	1
hh-	0	1	1	0	1	2	0	1	3	0	0	3	1	0	1	0	0	1	1	1	2	1	0	0	1	1	1	1	0	0	0	0	1	1
ii-	0	1	1	0	1	2	0	0	2	0	0	2	1	0	1	0	0	0	1	1	2	1	0	0	1	1	1	0	0	0	0	0	0	0
jj-	0	1	0	1	1	2	0	0	2	0	0	3	1	0	3	0	1	1	1	1	2	1	0	0	1	1	1	9	9	9	9	9	9	9
kk-	1	1	1	0	1	2	0	1	2	0	0	2	1	0	1	0	0	1	1	1	2	1	0	0	0	1	2	1	1	1	0	1	0	1
ll-	1	1	1	0	2	2	0	1	2	3	0	1	2	0	1	2	0	1	1	1	2	1	0	0	1	1	1	9	9	9	9	9	9	9
mm-	0	1	1	0	3	1	0	1	1	3	1	1	3	0	0	3	0	0	0	1	2	2	1	1	1	0	1	1	1	0	0	0	0	0

aa = *P. crassicaulis*, bb = *P. cruciata*, cc = *P. pumilus*, dd = *P. quadrifolius*, ee = *P. stellatus*, ff = *P. auricularius*, gg = *P. suavis*, hh = *P. hispidus*, ii = *P. paniculatus*, jj = *P. parviflorus*, kk = *P. plectranthoides*, ll = *P. villosus*, mm = *P. strigosus*. 9 = missing data.

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