Eco. Env. & Cons. 26 (4) : 2020; pp. (1775-1778)
Copyright@ EM International
ISSN 0971–765X

Numerical intraspecific morphometric study of *Actinodaphne Hookeri* Meisn. (Magnoliopsida: Laurales: Lauraceae) from Mahabaleshwar, Maharashtra, India

Snehangshu Das[1] and Minakshi C. Mahajan[2]*

[1] Plant Ecology Laboratory, Department of Botany, Shivaji University, Kolhapur 416 004
[2] Department of Botany, Fergusson College, Pune 411 004, M.S., India
Fergusson College and Biodiversity Park, Mahabaleshwar, Satara, M.S., India

(Received 25 February, 2020; accepted 17 April, 2020)

ABSTRACT

The morphological parameters of seven trees of *Actinodaphne hookeri* Meisn. (Hindi: 'Pisa') were subjected to quantitative analysis in the present study by the means of eight observable morphological characters viz. length of leaf, width of leaf's base, width of leaf's middle part, width of leaf's apex, length of petiole, number of lateral veins present in a leaf, length of the branch and number of leaves present on each branch. The cluster analysis obtained the formation of six nodes with the least Sokal's coefficient of taxonomic distance being found between trees termed as F and G with formation of three prominent groups. The factor loadings of Principal Component Analysis (PCA) and PCA scatter plot was achieved with the aid of Eigen values which establish that first two axes are helping in the grouping of the similar trees and delimiting the group of quantitatively similar trees from dissimilar trees. The current study is found to have a relatively low variation in Sokal's coefficient of taxonomic distance ranging from 0.02375 to 0.2425 which helps in grouping and segregating the trees accordingly. It shows the importance of leaf biological scaling by considering heterogeneity for determining intraspecific morphological variations, providing and documenting effectiveness of Sokal's coefficient of taxonomic distance for the first time in the realm of botanical taxonomy.

Key words : *Actinodaphne hookeri, Numerical Intraspecific Plant Taxonomy, Leaf scaling*

Introduction

Actinodaphne hookeri Meisn., from family Lauraceae, locally known as 'Pisa' (Hindi: to ground), is a medium sized tree which is an endemic tree species (Zunjarrao *et al*., 2015) in the Western Ghats. In the world of ever-changing methods to study taxonomy among the plant groups, numerical taxonomy is proving to be a best alternative to examine differences and similarities through statistical methods (Sonibare, 2004; Mulumba and Kakudidi, 2010). This branch of statistical taxonomy deals with grouping by numerical methods of taxonomic units into taxa on the basis of their character state (Sneath and Sokal, 1973). Current study furnishes a tiered presentation of taxa supported by the Sokal's coefficient of taxonomic distance which accounts for Euclidean distance divided by number of characters or variables (Rohlf and Fisher, 1968; Colwell and Grigorova, 1987).

Materials and Methods

The plants were identified by using flora (Cooke, 1967). It was conducted for a year from April 2017 to April 2018. The seven trees of *Actinodaphne hookeri* Meisn. are assigned alphabets according to their coordinates of occurring in their natural habitat as A, B, C, D, E, F and G. The measurements of morphological characters were done with the help of a line ruler and thread. Characters like number of lateral veins and number of leaves present on each branch was counted and recorded carefully. The coordinates (Figure 1 and Table 1) where measured with the help of device named as Garmin GPS Etrex-20X Receiver and then the coordinates were plotted on to Google Earth Pro to actually locate them on the map (Figure 2d).

The average temperature recorded during the study period was 27.7 ºC with an average wind velocity and rainfall of 11 mph and 480.08 mm respectively (Gelaro *et al.,* 2017). An average respective intensities of light falling on them have been measured with the help of HTC LX-101A Lux meter and calculated for a year (Figure 1 and Table 1) each measurements of light intensity were taken weekly throughout the period of investigation to lessen occurrences of human or technical errors. Cluster analysis was performed on the basis of Farthest Neighbour as the clustering method with Sokal's coefficient of taxonomic distance as the distance matrix typeand a dendrogram was also built (Sneath and Sokal, 1973). All the statistical evaluations were conducted in the software named as Multivariate Statistical Package v3.2 (Kovach 1999) and STASTICA v7.1 (StatSoft Inc. 2005)

Results

The dendrogram (Fig. 2a) shows the formation of six nodes within which the closeness of the species can be seen. The mean and standard deviation values of the tree species have been elucidated in Figure 1 (Table 2) which were considered for statistical analysis. The F and G forms the first group which shows the least value of Sokal's coefficient of taxonomic distance with each other. The next was be-

Trees	Latitude	Longitude	L.I
A	17°54'55"N	73°43'48"E	67,875
B	17°54'57"N	73°43'51"E	28,786
C	17°54'56"N	73°43'52"E	18,772
D	17°54'56"N	73°43'51"E	19,610
E	17°54'54"N	73°43'48"E	55,435
F	17°54'54"N	73°43'44"E	1,16,567
G	17°54'55"N	73°43'45"E	1,16,543

Table 1: Coordinates and exposure to light intensities of the studied trees

Key: L.I: Exposure to light intensity measured in lux.

Trees	Lt. Br.	Lf. L.	N.LV	N.LvTEB	Mid.	Pet. L	Apx	Base
A	8.8 (8.5±0.65) 10.2	9.0 (8.86±0.78) 10.0	10 (11±2.25) 15	6 (6±0.1) 7	2.4 (3.16±0.45) 3.7	0.3 (1.05±0.38) 1.4	0.3 (0.45±0.10) 0.6	0.7 (0.81±0.13) 1.0
B	9.3 (9.2±0.98) 11.1	11.0 (11.94±1.83) 12.5	12 (15±1.41) 16	4 (5±0.56) 6	3.0 (4.46±1.33) 5.7	0.6 (1.85±0.72) 2.2	0.5 (0.58±0.08) 0.7	0.7 (0.96±0.18) 1.2
C	8.1 (7.3±0.56) 9.2	12.2 (13.26±0.85) 14.0	10 (13±2.22) 17	6 (6±0.2) 8	4.3 (4.9±0.43) 5.3	1.6 (1.86±0.26) 2.3	0.6 (0.7±0.10) 0.9	0.9 (1.04±0.08) 1.1
D	9.3 (8.2±1.22) 10.1	9.1 (12.08±1.16) 14.0	10 (12±1.87) 14	4 (5±0.38) 7	3.6 (4.28±0.56) 5.0	1.4 (1.96±0.31) 2.8	0.5 (0.62±0.0.8) 0.7	0.8 (0.98±0.13) 1.1
E	11.3 (10±0.76) 12.7	8.5 (9.36±0.98) 11.5	8 (9±1.09) 11	6 (6±0.20) 7	2.5 (2.75±0.66) 3.6	0.9 (1.2±0.52) 1.6	0.4 (0.53±0.09) 0.6	0.6 (0.83±0.17) 1.1
F	6.6 (5.4±0.44) 7.4	8.0 (8.13±0.68) 9.7	6 (10±2.06) 12	5 (6±0.33) 7	2.2 (2.78±0.58) 3.5	0.6 (1.28±0.37) 1.9	0.4 (0.58±0.09) 0.7	0.7 (0.93±0.15) 1.1
G	6.0 (5.2±1.78) 7.3	7.9 (8.5±0.85) 10.3	7 (10±1.48) 11	5 (6±0.50) 7	2.1 (2.76±0.64) 3.5	0.7 (1.2±0.35) 1.7	0.4(0.5±0.10) 0.6	0.7 (0.96±0.13) 1.1

Table 2: Measurements of vegetative morphological characters in cm; presented in the form "min(mean±standard deviation)max".

Key: Lt. Br.: Length of branch; Lf. L.: Length of leaf; N.LV.: Number of lateral veins; N.LvTEB: Number of leaves at end of each branch; Mid.: Width of the middle part of the leaf; Pet. L.: Length of petiole; Apx: Width of leaf's apex; Base: Width of the leaf's base.

	A	B	C	D	E	F	G
A	0						
B	0.1685	0					
C	0.174375	0.09175	0				
D	0.128125	0.091875	0.080375	0			
E	0.06775	0.190875	0.218625	0.1725	0		
F	0.100125	0.2425	0.21075	0.19275	0.10575	0	
G	0.093125	0.233	0.201125	0.183125	0.11275	0.02375	0
	A	B	C	D	E	F	G

Table 3: Values of Sokal's coefficient of taxonomic distance of the studied trees.

G.N	Node	Set 1	Set 2	ScTD	TiG
1	1	F	G	0.02375	2
2	2	A	E	0.06775	2
3	3	C	D	0.080375	2
3	4	B	Node 3	0.091875	3
-	5	Node 2	Node 1	0.100125	4
-	6	Node 5	Node 4	0.2425	7

Table 4: Summarisation of values used in building the dendrogram.

Key: G.N: Group number; ScTD: Sokal's coefficient of taxonomic distance; TiG: Trees in group.

Axes	Axis 1	Axis 2
Eigenvalues	5.106	1.639
V%	**63.825**	**20.491**
Cum. V%	63.825	**84.316**

Table 5: Total Variance of the studied characters. Extraction method: Principal component analysis

Key: V%: Variance Percentage; Cum. V%: Cumulative Variance Percentage

	Axis 1	Axis 2
Length of Branch	0.074	-0.718
Length of Leaf	**0.426**	-0.126
Number of Lateral Veins	0.374	-0.178
Number of Leaves at the end of each branch	-0.283	0.359
Width of Middle part of Leaf	**0.426**	-0.126
Length of Petiole	0.389	0.17
Width of Leaf's Apex	**0.419**	-0.107
Width of Leaf's Base	-0.095	**0.443**

Table 6: Axes matrix of the eight studied characters (Principal Component Analysis Factor Loading).

Extraction method: Principal Component Analysis, 2 axes extracted.

Fig. 1. Summarisation of all the tables derived from the studied data

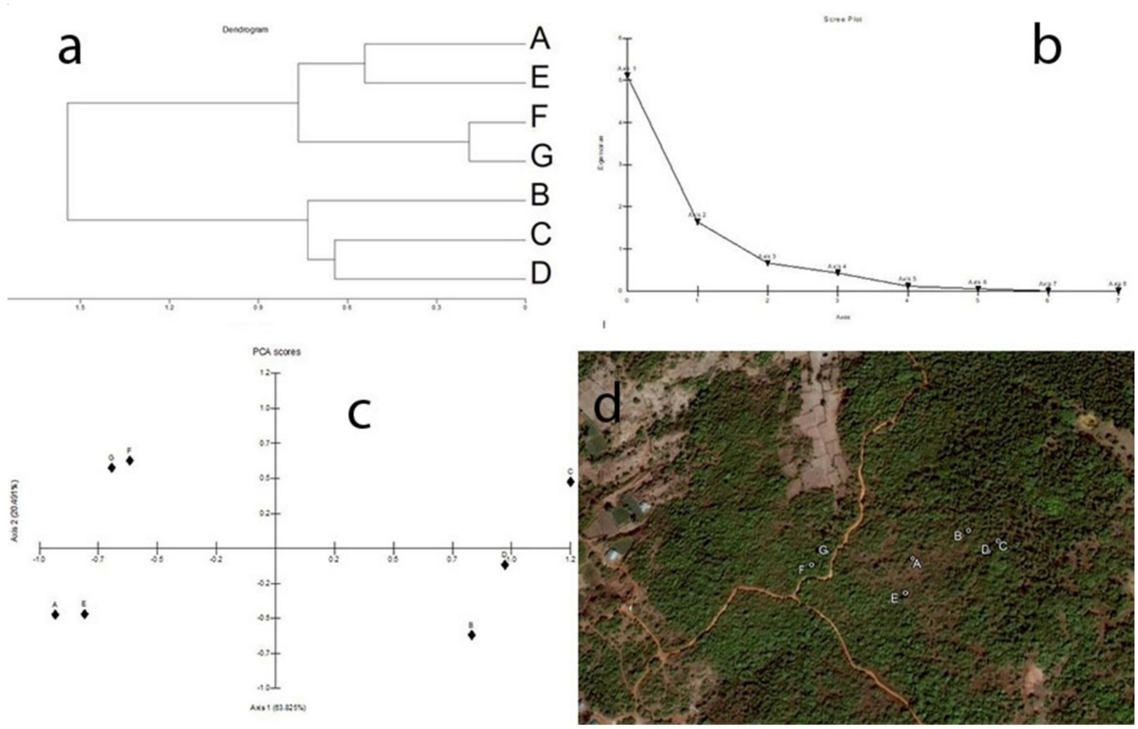

Fig. 2. Summarisation of all the figures (a-c) and depicting the area of study (d)

tween trees A and E forms the next node and the second group. The Principal Components Analysis scatter plot (Fig. 2c) shows grouping among the similar species. The first two axes from the PCA are aptly significant due to the support of scree plot (Figure 2b) which shows that the first two axes have Eigen values more than 1, presenting the positive efficacy of current study.

Discussion

The Principal Components Analysis factor loading (Table 6) of all the morphological characters displays that length of leaf, width of apex, width of middle part of leaf and width of leaf's base has a considerably higher loading in the axes which turns out to be indispensable characters in the separation of the trees studied. This trend in the current study suggest that foliar characters are crucial factors in the study of intraspecific isolation of species. The average light intensities falling on them plays a distinguished role in intra-segregation of species [Figure 1 (Table 3)]. Larger foliar dimensions of A, E, F and G accounts to the fact that availability of sunlight plays a significant role in enlargement of the Specific Leaf Area (SLA). In this study, there was a positive association between length of the petiole and leaf dimensions viz. width of base, width of middle part of leaf and width of apex due to the fact that variations in petiole length was directly proportional to the variations in leaf size. The leaveswith longer petioles will allow the leaf to maximize its curvature for exposing its photosynthetic area to the light (Pickup *et al.*, 2005). The increase in number of leaf veins have a vital insinuations for working of normal leaf physiological activity with usual hydraulic and light-utilization efficiency under low sunlight conditions (Niinemets *et al.*, 2007). However, variations in the leaves may occur due to combinations of genetic mechanisms with biotic as well as non-biotic factors (Gbile, 1976; Nwachukwu and Mbagwu, 2006).

Results of our study shows light intensity regulated leaf morphological changes in same species. We need to collate even more data regarding organ morphologicalchanges due to both light and soil heterogeneity from possibly every plant species, only after doing so we can come to a concrete understanding for the debatable light-influenced changes hypothesis. However, with the limitations of numerical taxonomic practices (as in all different kinds of taxonomic practices), an individual must not be directed to presume that "numerical taxonomy is an excursion to futility" as debated by Ross (1964).

Acknowledgement

The authors are thankful to the authorities of Biodiversity Park, Mahabaleshwar for their support. We are also grateful to Dr. R.G. Pardeshi, Principal of Fergusson College, Pune, for his immense support and inspiration.

References

Ashton, D.H. and Turner, J.S. 1979. Studies on the light compensation point of *Eucalyptus regnans* F. Muell. *Aus. J. Bot.* 27(5) : 589-607.

Colwell, R.R. and Grigorova, R. 1987. *Methods In Microbiology: Methods In Classification and Identification of Microorganism*, Vol. 19. A.P., New York.

Cooke, T. 1967. *The Flora of the Presidency of Bombay*Vol. III. Sree Saraswaty Press Ltd.Calcutta, 31pp.

Chukwuma, E.C. and Ayodele, A.E. 2016. Numerical Taxonomy of *Berlinia* species and Their Distribution in Nigeria. *JoTT* 8(2).

Dovciak, M. and Halpern, C.B. 2010. Positive diversity–stability relationships in forest herb populations during four decades of community assembly. *Ecology Letters*. 13 (10): 1300-1309.

Gbile, Z.O. 1976. Taxonomic studies of *Triplochiton scleroxylon* K. Schum. *Proceedings of the Symposium on Variation and Breeding Systems of Triplochiton scleroxylon*, April 21-28. FDFR, Ibadan, Nigeria: 19-27.

Gelaro, R. and McCarty 2017. The modern-era retrospective analysis for research (MERRA-2). *J. Clim.* 30(14): 5419-5454.

Kovach, W.L. 1999. MVSP- Multivariate statistical package for windows, version 3.2. Pentraeth Wales, UK. Kovach computing services.

Mulumba, J.W. and Kakudidi, E. 2010. Numerical taxonomic study of *Acacia senegal*in the cattle corridor of Uganda. *S.A J. Bot.* 76(2) : 72-278.

Niinemets, Ü., Portsmuth, A. and Tobias, M. 2007. Leaf shape and venation pattern alter the support investments. *Func. Eco.* 21 (1) : 28-40.

Nwachukwu, C.U. and Mbagwu, F.N. 2006. Morphological features in some species of *Indigofera* L. *J. Fish. Int.* 1 (2-4): 50-54.

Pickup, M., Westoby, M. and Basden, A. 2005. Dry mass costs of deploying leaf area in relation to leaf size. *Func. Eco.* 19(1) : 88-97.

Rahman, M.Z. and Rahman, M.O. 2012. A morphometric analysis of *Desmodium* in Bangladesh. *Bang. J. Bot.* 41(2) : 143-148.

Rohlf, J.F. and Fisher, D.R. 1968. Tests for Hierarchical Structure in Random Data Sets. *Sys. Bio.* 17(4): 407-412.

Ross, H.H. 1964. Principles of Numerical Taxonomy. *Sys. Zoo.* 13 : 106-108.

Sneath, P.H.A. and Sokal, R.R. 1973. *Numerical taxonomy: the principles and practice of numerical classification*. W.H. Freeman and Company, S.F. 573pp.

Sonibare, M.A., Jayeola, A.A. and Egunyomi, A. 2004. A morphometric analysis of the genus *Ficus* Linn. (Moraceae). *Af. J. of Biotech.* 3(4) : 229-235.

StatSoft, Inc. 2005. STATISTICA (data analysis software system), version 7.1. www.statsoft.com.

Tudhope, D., Taylor, C., Beynon-Davies, P. (1995). *Taxonomic Distance-Classification and Navigation.* In ICHIM and Museums, London. pp. 322-334.

Vernon, K. 1988. The founding of numerical taxonomy. *The British Journal for the History of Science.* 21 (2) : 143-159.

Wright, I.J. and Reich, P.B. 2004. The worldwide leaf economics spectrum. *Nature*. 428: 821–827; https://doi.org/10.1038/nature02403

Zunjarrao, R.S., Barmukh, R.B. and Kindre, A.S. 2015. Digital Herbarium of Angiospermic Tree Species from Western Ghats Regions of Maharashtra, *Gyaanmay*. 12.