

Application of Numerical Taxonomy to Lip Morphology in the Genus *Polystachya* Hook (*Orchidaceae*) in Nigeria

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Abstract

SCLA, a numerical taxonomic method was applied to lip morphology in the genus *Polystachya* Hook. (*Orchidaceae*) in Nigeria. The basic data matrix was prepared by coding for the presence or absence of the attributes of characters involved. The data were standardized so that the values of a particular character were transformed into values ranging from zero to one. The SCLA showed that reproductive characters are much better than the vegetative characters earlier used in the distribution of *Polystachya* species into their sections. In the case of reproductive characters, more clusters were reported; this may be an indication of more sections in *Polystachya* than those earlier reported.

Keywords: *Polystachya* species, cluster analysis, reproductive character, vegetative character, sections

Introduction

Polystachya is a genus of about 200 species, mostly African but also occurring in Madagascar, Central and South America and Asia (Cribb and Rasmussen, 2004). Epiphytic, occasionally lithophytic or terrestrial perennial herbs (Croix, 1997). Hutchinson and Dalziel (1968) listed fifty seven species for West Tropical Africa, with Nigeria having 24 species. New species from Tropical West and South-Central Africa were described by Cribb and Croix (1996) among which is *P. anthoceros* from Nigeria. Segerback (1983) described 104 species of orchids for Nigeria, but Jayeola (1991) otherwise encountered over 400 species for Nigeria.

The greatest challenge for the utilization of orchids in Nigeria for both scientific and aesthetic purposes is the absence of simple identification keys devoid of the usual highly technical details of taxonomy (Jayeola and Folorunso, 2002). The existing keys are too technical to be used by non-taxonomists such as foresters and horticulturists. Orchids are good flagship species and possible good environmental indicators (Cribb and Croix, 1996). They contribute immensely to the national economy of Hawaii, Malaysia, Singapore and Thailand, whereas in Nigeria there is little information about orchids. There is a great deal of variation in the floral structure of *Polystachya* to the extent that most species can be recognized on its basis (Jayeola and Folorunso, 2002). The flowers are known to vary with respect to colour, size and shape. Previous literature on the use of lip show that they are of different sizes and shape (Victoria, 1994; Luer, 1995; Catling, 1997). The lip otherwise known as the labellum is the relatively morphologically complex median inner perianth segment (petal) that, in most orchids, is the primary attractant and landing

stage for pollinators, most commonly insects (Dafni, 1992; Nilsson, 1992; van der Cingel, 1995; Rudall and Bateman, 2002).

Numerical taxonomy makes use of quantitative methods for the classification of organisms into groups (Sokal and Sneath, 1963). Most of the techniques used in numerical taxonomy to measure overall similarity between taxa, as well as classifying them into groups are described by Sokal and Sneath (1963). Morphometric techniques have long been established as valuable tools for exploring the development, population differentiation and systematics of plants (Bookstein *et al.*, 1985; Wiens, 2000; Forey and MacLeod, 2002; Jensen, 2003; Bateman and Rudall, 2006). These morphometric studies have typically employed between 20 and 50 quantified characters, generally consisting of a heterogeneous mixture of metric (continuous), meristic, scalar and presence / absence characters (Bateman and Rudall, 2006). Earnest study of the species of *Polystachya* has become imperative, as some species are being threatened by habitat loss, as for example *Polystachya cooperi* (Pollard and Darbyshire, 2004). The purpose of the present study is to describe the results of the use of single linkage cluster analysis on the lip of the genus *Polystachya* in Nigeria and to delimit the species into their traditional sections.

Materials and methods

Orchid flowers were obtained from two sources: fresh flowers were obtained from the orchidarium, in situ, while dried flowers were collected, ex situ, from the Botany Herbarium (IFE), Obafemi Awolowo University, Ile-Ife (Tab. 1). Fresh flowers were dissected to expose the floral segments and dorsal petals or lips were excised. Preparations of dried herbarium specimens for study required boiling

the flowers in ammonium chloride (NH_4Cl) solution for thirty minutes to revive the tissues of the lips for detailed study under the microscope. The lips were then left to cool for two to three hours after which they were dissected in the laboratory for examination. All data were scored from a minimum of ten accessions for each species. The mean values of these data were then coded (Tab. 2). A total of twenty six characters were recorded for each OTU. The basic data matrix of 26 x 32 was prepared by coding for the presence or absence of the attributes of characters involved. Data were standardized, so that the values of a particular character were transformed into values ranging from zero to one, using the method of Sokal and Sneath (1963). Single linkage cluster analysis (SCLA) was performed to study the phylogenetic relationships of members of the genus.

Results and discussion

The phylogenetic relationships of the species of *Polystachya* is as shown in Fig. 1. Six main clusters are observable at 0.5 similarity level. Cluster A, which is the largest

cluster encompasses many species of *Polystachya* covering sections like *Cultriformes*, *Affines*, *Grandiflorae*, *Calluniflorae*, *Isochiloidae* and *Dendrobiantae*. The species are *P. dolichophylla*, *P. affinis*, *P. elegans*, *P. mukandaensis*, *P. cooperi*, *P. galeata*, *P. odorata* var. *orosun*, *P. adansoniae*, *P. orosun* var. *novum*, *P. polychaete*, *P. tessellata*, *P. modesta*, *P. fusiformis*, *P. saccata*, *P. bifida*, *P. calluniflora*, *P. golugensis*, *P. coriscensis*, *P. camaridiodes*, *P. rhodoptera*, *P. alpina*, *P. ramulosa*, *P. laxiflora*, *P. stricta*. Cluster B, comprised of *P. albescens* and *P. subulata*, included in the section *Caulescent*. Clusters C and D belong to *Polystachya* section and thus include two varieties of *P. paniculata* in addition to *P. odorata* var. *odorata* and *P. odorata* var. *trilepidis*.

The characters used for the cluster analysis are representatives of both vegetative and reproductive characters of the species *Polystachya*. The species of *Polystachya* here listed are those reported for Nigeria (Hutchinson and Dalziel, 1968) and the 8 species representing entirely new records for the orchid flora of Nigeria (Jayeola and Folorunso, 2002).

The result of the cluster analysis revealed a lot of intraspecific relationships among the species of *Polystachya*

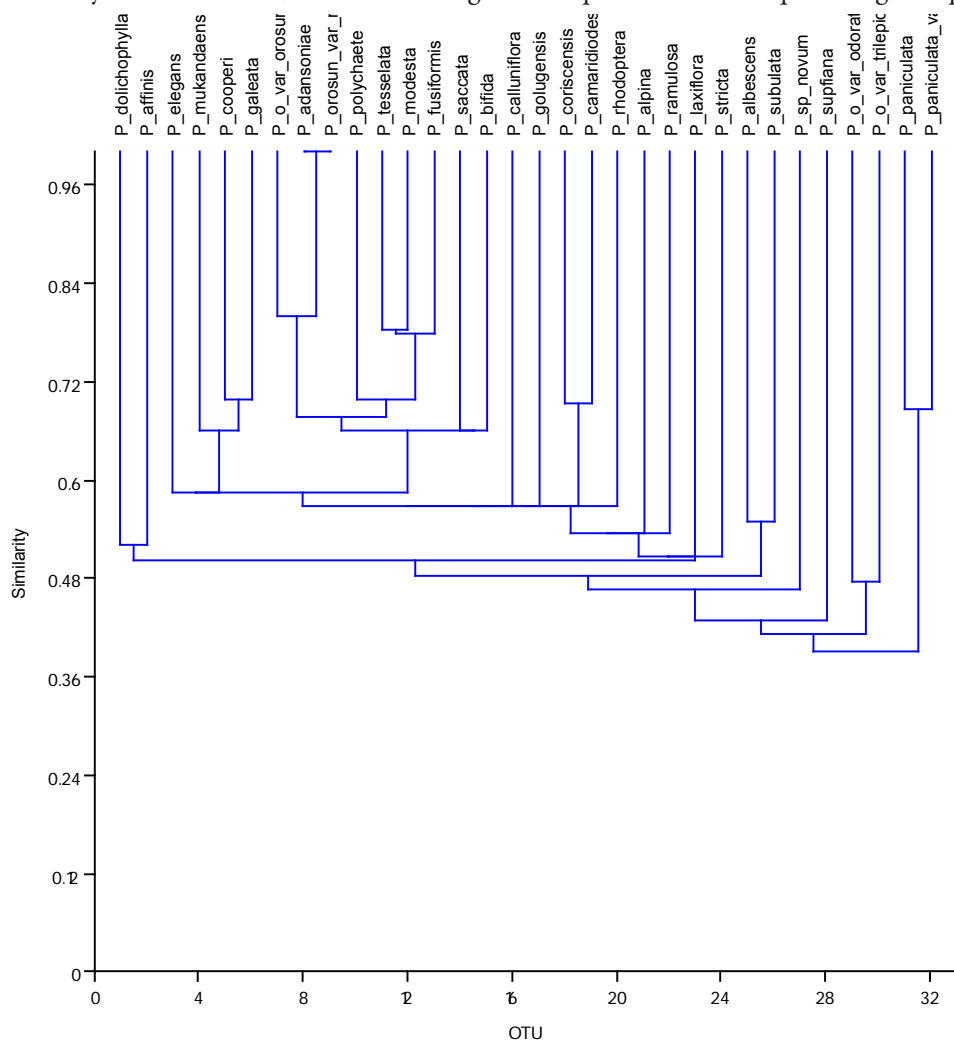


Fig. 1. Phylogenetic relationships of the species of *Polystachya* studied

studied. Cluster A, which is the biggest of the clusters is a conglomerate of five sub-clusters. For instance *P. dolichophylla* and *P. affinis* which have yellow flowers and whose mid lobes are short, form the first sub – cluster comprised of *P. elegans*, *P. mukandaensis*, *P. cooperi* and *P. galeata*. All these species have green flowers with the apex of their lateral lobes acute. The third sub-cluster includes *P. odorata* var. *orosun*, *P. andansoniae*, *P. orosun* var. *orosun*, *P. polychaete*, *P. tessellata*, *P. modesta*, *P. fusiformis*, *P. saccata* and *P. bifida*. These are the species with white flowers together with purple markings. The fourth sub-cluster includes species like *P. calluniflora*, *P. golugensis*, *P. coriscensis*, *P. camaridiodes* and *P. rhodoptera* with pale green flowers. The fifth sub-cluster comprises of *P. alpina*, *P. ramulosa*, *P. laxiflora*, *P. stricta* and they are largely white with yellow colour that is tinged with pink. Cluster B comprises *P. albescens* and *P. subulata*.

They have greenish white flowers and belong to the Caulescent section. The species in cluster C are with whitish yellow flowers tinged with rose. Those in cluster D have orange flowers with red markings.

Conclusions

This work has shown that reproductive characters are much better than the vegetative characters earlier used by Kraenzlin (1926) in the distribution of *Polystachya* species into their sections. With the use of reproductive characters more clusters have been reported which also indicate the occurrence of many more sections in *Polystachya* than those earlier reported.

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48 .OTU coded values of the species of <i>Polystachya</i>	Lip-celled	Lip-pubes-cent	Lip-apex-acute	Lip-apex-depre-ssed	Lip-margin-entire	Apex-midlobe-acute	Margin-incurved-below	Venation-network	Lip-large	Lip-small	Lip-moderate	Lip-fleshy	Lip-withoutcallus
P_galeata	0	0	0	1	0	1	0	0	1	0	0	0	0
P_stricta	0	0	0	1	0	1	0	0	1	0	0	0	0
P_elegans	0	0	0	1	0	1	0	0	0	0	1	0	1
P_golugensis	0	0	0	0	0	1	0	0	0	1	0	0	0
P_o_var_odorata	0	0	0	0	1	0	0	0	0	0	1	0	0
P_o_var_orosun	0	0	0	0	0	1	0	0	0	0	1	0	0
P_o_var_trilepidis	0	0	0	0	1	0	0	0	0	0	0	0	0
P_mukandaensis	0	0	0	0	0	1	0	0	1	0	0	0	0
P_adansoniae	0	0	0	0	0	1	0	0	0	0	1	0	0
P_orosun_var_novum	0	0	0	0	0	1	0	0	0	0	1	0	0
P_alpina	0	0	0	1	0	1	0	1	1	0	0	0	0
P_paniculata	1	0	0	1	0	1	0	1	0	1	1	0	1
P_calluniflora	0	0	0	1	0	1	0	1	0	0	0	0	1
P_dolichophylla	0	0	1	0	0	0	0	1	0	0	0	0	0
P_polychaete	0	0	0	0	0	1	0	1	0	0	0	0	0
P_coriscensis	0	0	0	1	0	1	0	1	0	0	0	0	0
P_camaridiodes	0	0	0	1	0	1	1	1	0	0	0	0	0
P_albescens	1	0	0	1	0	1	0	1	0	0	1	1	0
P_paniculata_var_novum	1	0	1	1	0	1	0	1	0	1	0	0	0
P_cooperi	1	0	0	1	0	1	0	1	1	0	0	0	0
P_supfiana	0	0	0	0	0	1	0	1	0	0	0	0	1
P_sp_novum	0	1	1	0	1	0	0	1	0	1	0	0	1
P_saccata	0	0	0	0	0	0	0	1	0	0	1	0	0
P_bifida	0	0	1	0	0	1	0	1	0	0	1	0	1
P_rhodoptera	0	0	0	0	0	1	0	1	0	0	1	0	0
P_affinis	0	1	1	0	0	1	0	1	0	0	1	0	0
P_tesselata	0	0	0	0	0	1	0	1	0	0	1	0	0
P_laxiflora	0	1	1	0	0	1	0	1	0	0	1	0	0
P_subulata	1	0	0	1	0	1	0	1	0	0	1	1	1
P_fusiformis	0	0	0	0	0	1	0	1	0	0	1	0	0
P_modesta	0	0	0	0	0	0	0	1	0	0	1	0	0
P_ramulosa	0	0	0	1	0	1	1	1	0	1	1	0	1

.OTU coded values of the species of <i>Polystachya</i>	Lip-clawed	Lip-transparent	Lip-not-well developed	Lip-punctate	Lip-lobed-atmiddle	Lip-lobed-at lower part	Lip-aslong-aswide	Flowers-white	Flowers-red	Flowers-green	Flowers-yellow	Flowers-tinged-pink	Flowers#9 greenish-yellow
P-galeata	0	0	0	0	0	0	0	1	1	1	0	0	0
P-stricta	0	0	0	0	0	0	0	0	0	0	1	1	0
P-elegans	0	0	0	0	0	0	0	1	0	1	1	0	0
P-golugensis	0	0	0	0	0	0	0	0	0	1	1	1	1
P-o-var-odorata	0	1	0	0	1	0	1	1	0	0	1	0	0
P_o_var_orosun	0	0	0	0	0	0	1	0	0	0	0	0	0
P_o_var_trilepidis	0	0	0	0	0	0	0	0	0	0	1	0	0
P_mukandaensis	0	0	0	0	0	0	0	1	0	1	1	0	0
P_adansoniae	0	0	0	0	0	0	0	0	0	0	0	0	0
P_orosun_var_novum	0	0	0	0	0	0	0	0	0	0	0	0	0
P_alpina	1	0	1	1	0	0	0	1	0	0	0	0	0
P_paniculata	1	0	1	0	1	0	0	0	1	0	0	0	0
P_calluniflora	0	0	0	0	0	1	0	1	0	0	0	0	0
P_dolichophylla	0	0	0	1	1	0	0	0	0	0	1	0	0
P_polychaete	0	0	0	0	0	0	0	1	1	1	1	0	1
P_coriscensis	0	0	0	0	1	0	0	0	0	1	1	0	0
P_camaridiodes	0	1	0	1	1	0	0	0	0	1	1	0	1
P_albescens	1	0	0	1	1	1	1	1	1	1	0	0	0
P_paniculata_var_novum	1	0	1	0	1	0	0	0	0	0	0	0	0
P_cooperi	0	0	0	0	0	0	0	1	0	1	0	0	0
P_supfiana	1	0	0	0	0	0	0	0	0	0	1	0	0
P_sp_novum	1	0	0	1	1	0	0	0	0	0	0	0	0
P_saccata	0	0	0	0	0	0	0	1	0	0	0	0	0
P_bifida	0	0	0	0	0	0	0	1	0	0	0	0	0
P_rhodoptera	0	0	0	1	0	1	0	0	0	0	1	0	0
P_affinis	0	0	0	0	1	0	0	0	1	0	1	0	0
P_tesselata	0	0	0	0	0	0	0	0	0	1	1	0	1
P_laxiflora	0	1	0	1	0	0	1	1	0	0	1	0	0
P_subulata	0	1	0	1	0	0	1	1	0	1	0	0	0
P_fusiformis	0	0	0	0	0	0	0	0	0	1	0	0	0
P_modesta	0	0	0	0	0	0	0	1	0	1	1	0	1
P_ramulosa	0	1	0	0	0	0	0	1	0	0	1	1	0

Tab. 1. Representative Specimens of the *Polystachya* species in Nigeria.

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1.	<i>P. dolichophylla</i> Schltr. Keay 39, Nindam F.R. Zaria.	17.	<i>P. golungensis</i> Rchb.f. King 22, Kogin Delli, Zaria Prov.
2.	<i>P. affinis</i> Lindl. Burt B27, Abeokuta to Ijebu Ode FHI 24666 Keay Usenigbe F.R. Sapoba FHE 22714 Keay, Owo, Ondo Prov. Talbot 3776, Ohbe, Degema, Randole Barter 1863, Onitsha	18.	Olokemeji F.R. Keay. FHI 22712 Abeokuta, Akure F.R. Keay 28294 Ondo
3.	<i>P. elegans</i> FHI 25376 Keay Sankwala, Ogoja prov.	19.	<i>P. coriscensis</i> Rchb.f. Sanford WS/185/66, Benin Prov. Sapoba
4.	<i>P. mukandaensis</i> De Willd. FHI 22410 Keay, Olokemeji F.R. Abeokuta a. Thomas 1902 Onika Ohene FHI 6128 Janes, Onitsha Talbot 861, Oban Cooper 80, Obudu Scarp, Ogoja	20.	<i>P. camaridiodes</i> Summerh. Wright 101, Calabar
5.	<i>P. cooperi</i> Summerh. FHI 15190; WS 5458 IFE	21.	<i>P. rhodoptera</i> Rchb.f Talbot 903 Oban, Sapoba Kennedy 1917
6.	<i>P. galeata</i> Brenan 9116, Okomu F.R. Benin a. FHI 227738a Keay Wright 128, Ajagbodudu, Sapele b. Talbot 3725 Degema Cooper 82, Ogoja Plain FHI 25304 Keay Coombe 151 FHI 22429 Keay, Eleyele, Ibadan	22.	<i>P. alpina</i> Lindl. Talbot 835, Oban Niagi
7.	<i>P. odorata</i> var. <i>orosun</i> Sanford 4135, Orosun peak Idanre	23.	<i>P. ramulosa</i> Lindl. Sanford WS/184/66 Benin Prov. Sapoba Talbot 3647, Oban Degema <i>P. laxiflora</i> Summerh. FHI 1366, WS/1521/65 Idanre Hills
8.	<i>P. adansoniae</i> Rchb. F. FHI 40169 Onochie, Niger Prov. Gwari, Bornu a. Sanford WS 216a, 221/66 Boyogbe, 5 Benin Province; FHI 25317 Ejiofor b. Ogoja Province FHI 22438 Keay Okomu F.R., Benin Prov. Talbot 867,927 Kundene Obari	24.	Daramola FHI 29809, Talbot 918 Oban
9.	<i>P. orosun</i> var. <i>novum</i> . Sanford 4123, Orosun Peak, Idanre	25.	<i>P. stricta</i> Rolfe Winbush 611; King 350 Manbia Plateau
10.	<i>P. polychaete</i> Kraenzl. Talbot 927, 928 Oban	26.	<i>P. albescens</i> Ridl. WS 423 IFE
11.	<i>P. tessellata</i> Lindl. King 54, Kushanka, zaria Prov. Elliot 80, FHI 33190 Onochie, Stubbs Creek F.R. Eket FHI 13348 Keay, Calabar	27.	<i>P. subulata</i> Finet FHI 22898 Keay Ribaka F.R. Zaria Prov. FHI 37667 Keay, Mangu F.R. Plateau Prov. Summerhayes 91, Kaliy Zankwa Zaria, Rchb.f.
12.	<i>P. modesta</i> Rchb. F. Cole 13, Zaria king 31, Mongu F.R. Plateau Province FHI 22443 Keay, Sanga River F.R., Zaria, WS/1848765 Agodi Gate, Ibadan.	28.	<i>P. sp. novum</i> WS/443/66 sapoba F.R.
13.	<i>P. fusiformis</i> (Thou.) Lindl. IFE WS/5668	29.	<i>P. supfiana</i> Schltr. Talbot 440, Kwa F. Oban, FHI 3306, Eket; IFE WS/491/66. Sapoba <i>P. odorata</i> var. <i>odorata</i> Barter 1483, Onitsha 0.5cm
14.	<i>P. saccata</i> V.S. Summerh. 90 Kagarko, Zari FHI 37620 Keay and Janes Gimi River F.R. Zaria FHI 37639 Keay and Janes Sanga River F.R. Zaria	30.	Kennedy 1686 Sapoba Richards 3409, Shasha F.R. Ijebu FHI 33176 Onochie Orukini Unyene, Eket FHI 33209 Onochie Lower Enyong F.R. Itu <i>P. odorata</i> var. <i>trilepidis</i> Summerh. FHI 20729b Janes, Mt. Orosun, Idanre, Ondo. FHI 21559 Keay and Onochie FHI 3374 Symington.
15.	<i>P. bifida</i> Summerh. IFE WS/5990, WS/199/66 sapoba F.R. Obudu Plateau Ogoja	31.	<i>P. paniculata</i> (SW.) Rolfe; Keay, FHI 25371, Akure F.R.; Ejiofor FHI 24653 Thomson FHI 1509, Amedzofe; Ngogi, FHI 15341
16.	<i>P. calluniflora</i> Kraenzl. WS/3541 IFE	32.	<i>P. paniculata</i> (SW.) Rolfe subsp. novum