Challenges and progress in Petalidium Nees (Acanthaceae) 2014

Research · March 2016

Challenges and Progress

Petalidium Nees (Acanthaceae)

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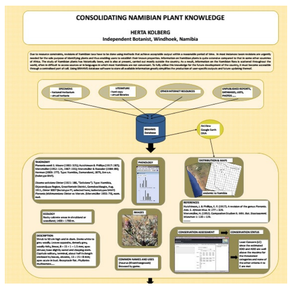
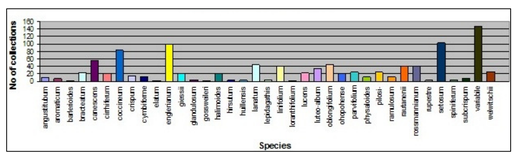
Petalidium Nees (Acanthaceae) is a genus of about 40 species. All species have 2 large bracteoles, small 4 or 5-fid calyx, 4 stamens in 2 pairs, ovary with 2 ovules in each cell, mature placentas elastic and seeds covered with hygroscopic hairs. The genus *Pseudobarleria* T.Anderson which only contained species with a 4-fid calyx was placed in synonymy.
The centre of diversity is the north western part of Namibia and south western Angola, with a subcentre in the Huns-Orange area of southern Namibia. A single species occurs on the Indo-Pakistan subcontinent. Such a disjunct distribution is not uncommon in taxa from arid south western Africa and known in other Acanthaceae genera like *Blepharis, Monechma, Phaulopsis* and *Rhinacanthus*.
The *Petalidium* genus was described by Nees in *Plantae Asiaticae rariores* in 1832 with *Petalidium barlerioides* the type of the genus. The first specimens of what are today known as *Petalidium* species, were identified as *Ruellia barlerioides* Roth described in 1821 in India. The earliest collection in this study is from Angola from 1838. Many type specimens were collected by Welwitsch in Angola in the 1860s at the same time as the first specimens were recorded for Namibia by Marloth and Schinz.

Methods

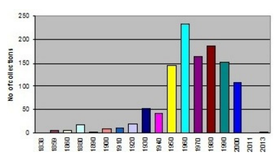
Database:
Petalidium collections and species information were consolidated into BRAHMS, and the data used as described on the poster by Herta Kolberg.



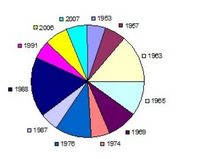
Collections:
- Over 1200 collections were documented
- Geographical names updated and georeferenced
- Targeted fieldwork was carried out in southern Africa and Angola
- Specimens in herbaria in Europe and southern Africa were examined, in particular M, WIND, PRE, Z & ZT, SAM, K, BM, NBG, BOL



Number of collections per *Petalidium* species



No of *Petalidium* collections per decade



Collections per exceptional rainfall years

Phylogenetic analysis
Morphological characters were selected following an extensive review of characters. They were derived from specimens and the species fields in the BRAHMS database. Only limited data is available for some species, mainly from Angola and the evaluation is ongoing for this reason. Many characters are highly variable and difficult to delimit. Many micromorphological features used in previous keys and studies were excluded for now.

01	**plant forms:** 0- DS 1- SS (suffrutex, subshrub) 2- perennial
02	**plant height:** 0- erect 1- prostrate/procumbent/decumbent 2- straggling
03	**plant stem branching:** 0- 1-
04	**plant indumentum:** 0- glandular 1- glabrous 2- hairy 3- white tomentose
05	**plant roots:** 0- 1-
06	**plant internodes:** 0- no 1- y 2- nodes swollen
07	**plant cortex:** 0- not white 1- white 2- white with age
08	**plant aromatic:** 0- no 1- y
09	**data gregarious:** 0- no 1- y
10	**data habitat:** 0- water courses 1- plains 2- rocky slopes
11	**plant duration:** 0- long lived 1- short lived
12	**inflorescence sterile branches:** 0- no 1- y but not spines 2- spines
13	**leaf position/arrangement:** 0- grouped towards branch tips 1- dispersed along branch
14	**leaf size length:** 0- 1- 2-
15	**leaf types on same plant:** 0- 1 1- 2
16	**leaf colour:** 0- green 1- grey-green 2- silver 3- varies
17	**leaf margins:** 0- entire 1- undulate
18	**leaf nerve action:** 0- not obvious 1- obvious

Some of the character states

sp 1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
angustilobum	1	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
aromaticum	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0
barkeoides	0	2	0	1	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0
brevifolium	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
calvum	1	0	0	2	1	0	0	0	0	0	0	1	2	1	1	0	0	0	1
coccineum	0	0	0	2	1	0	0	1	2	0	0	2	1	0					4
crispum	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	
cyanotheme	0	0	1	0	0	0	0	1	0	2	0	0	2	1					0
englerianum	0	0	0	2	0	0	0	0	0	1	0	0	0	1					2
giessii	1	0	1	0	0	0	1	1	0	2	0	0	3	1	1				1
glandulosum	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
glutinosum	0	0	0	0	1	0	0	0	0	0	0	1	2	1	1	0	0	0	0
grossheideri	1	1	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0
hallii minutes	0	1	0	2	1	0	0	0	0	0	0	1	2	1	1	0	0	0	2
hirsutum	0	0	0	0	0	0	0	1	1	0	0	0	#	1	1	0	0	0	3
hirsutissimum	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0

Part of the provisional data matrix

Phenology
Phenolgy data gathered from specimens on BRAHMS can be automatically calculated and analysed using the Phenological Predictability Index and results shown on charts.

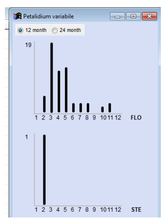
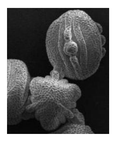
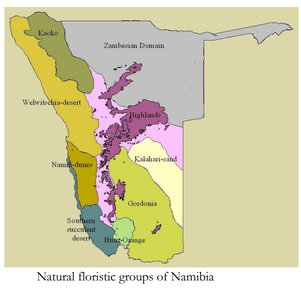


Chart of phenology patterns of *Petalidium variabile*



Pollen
Pollen studies were carried out at the University of Stellenbosch with Leanne Dreyer. The first *Petalidium* pollen illustrated was by Lindau in 1894. A few other images have been published since in discussions of the family and these have been incorporated into the study

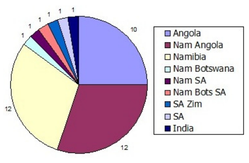
GIS
Georeferenced collections were mapped with various overlays like topography, climatic features. Collections were also mapped for variations that may be caused by certain events, e.g. exceptional rainfall years (see graph), and features identified on Brahms. The ranges of species found in Southern Africa were overlaid onto the map of Natural Floristic groups recognised by Craven 2009 for Namibia and neighbouring countries..



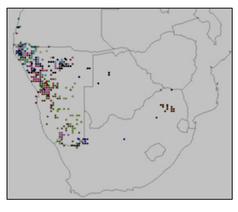
Natural floristic groups of Namibia

Distribution

Petalidium barlerioides, the Nail Dye plant, is the only representative of the genus outside Southern Africa.



Number of *Petalidium* species per country in Africa



Distribution of *Petalidium* species in Southern Africa

Progress

Species
- There are 39 accepted species of *Petalidium* and 42 synonyms, 21 of which are *Pseudobarleria*
- At least 3 new species will be described
- Consolidation of regional accounts and increased collecting in Angola has resulted in new combinations
- Varieties and forms are not recognised as they appear to be associated with episodic climatic events
- Pollen studies have confirmed the status of a number of growth form variations and forms
- Two hybrids are recognised
- *Petalidium currori* Benth. ex S.Moore is a synonym of *P. hirsutum* (T.Anderson) P.G.Mey. In 1880 Moore was unaware of T. Anderson having designated the same specimen as the type of *Pseudobarlereia hirsutum* in 1864
- Material of both *Petalidium glandulosum* S.Moore and *Petalidium hirsutum* is very poor and limited, but they may be the same species
- *Petalidium loranthifolium* S.Moore is not a synonym of *Petalidium halimoides* (Nees) S.Moore as in FTA 1899. It is an accepted species
- *Petalidium ovatum* (Schinz) C.B.Clarke is not a synonym of *P. engleranum* (Schinz) C.B.Clarke but an accepted species
- *Pseudobarleria glandulifera* Lindau is a synonym of *Petalidium rautanenii* Schinz. Lindau was unaware of Schinz's description (1900) when he used the same specimens as types in 1920.

Collections:
Many of the problems associated with the genus have been sorted out due to increased collecting, particularly in Angola. Intermediate forms have been found and the changes in features in space detected. Detailed analysis of the collections in good rainy seasons, i.e. early 1930s, early 1960, 1970s and late 1990s compared to dry periods has shown the differences in growth form and features in wet and dry periods to be considerable. The number of collections in dry period are limited, but provided sufficient data for understanding adaptations to the arid environment like obligate evergreen forms of *Petalidium* leaves.
BRAHMS graphs of collecting patterns provide information for evaluating variations of growth form.

Characteristics
The aim of the phylogenetic study is to complement work on systematic diversity via nucleotides of genes and pollen studies, that are not implicated in growth form development. However, selection and evaluation of morphological characters was complicated by the extreme variations in growth forms found in the desert and semi-desert environments were most *Petalidium* species occur. Not only do individuals change with habitat, range and seasonal climatic conditions, but also with age. During the duration of a plant's life, hairiness, flower colour, leaf type, etc. may differ. Flowering periods may be prolonged during good rain cycles with resulting changes to the appearance of the inflorescences. Knowing and understanding the variations in other unrelated genera, with similar distribution ranges, like *Commiphora, Sesamothamnus* and *Cordia* contributed to better understanding the diversity in *Petalidium* species. The large specimen data set as well as using GIS contributed to this evaluation, which is ongoing.

Phenology
Presence of flowers and seeds have been documented. Charts for individual species were grouped according to species distributions and although no specific conclusions have been made, patterns are emerging. The full range of information that can be stored and is available on specimens, e.g. new leaves, buds, will be included so as to identify flowering periods and strategies, like one during the rainy season or during the dry season. *Petalidium* seeds are parasitized very quickly and non viable seed will be noted.

Pollen
Studies in *Petalidium* have shown results but the evaluation is not complete. Integrating this knowledge with other morphological characters has shown the need for more pollen to be investigated. Results to date show that widely differing growth forms in *Petalidium canescens* and *P. setosum* have the same pollen grains.
Dupont (2006) mentions a continuous record of *Petalidium* (Acanthaceae) starting at 2.20 Ma and which would indicate the earliest known occurrence of this genus in Namibia. This is unlikely considering that the age of the centre of diversity of *Petalidium* species in northwestern Namibia/Angola is at least 20 Ma and the second area of diversity is around 11 Ma.

Phytogeography
One species occurs in each of the following regions: Centre of Namibia and Botswana; India, Nepal and Pakistan; Limpopo Province and Mpumalanga; Limpopo, RSA and southern Zimbabwe
The ranges of the remaining species coincide with the phytogeographical patterns on the floristic groups recognised by Craven (2009) for Namibia and neighbouring countries. The majority of these and their life forms shows a certain degree of uniformity with unrelated taxa in the centres.
The majority of *Petalidium* species (about 17) grow in the Welwitschia Desert group and about 4 are confined to the Kaoko group. 6 are in both. 3 species are found in the Gordonia groups and 1 the Hunsberg Orange River group, with another one in both. Two species are associated with higher lying areas (Highland group)
The main reasons for the species diversity are the numerous and various "tracks" that have contributed taxa since early times. Other factors include environmental diversity, different rainfall regimes, and recurrent climate fluctuations in the past.
Some species are range restricted endemics and some may dominate the habitat.

Uses
Petalidium species are fodder plants for domestic stock while game and even rhino have been seen to eat them. Some species have been shown to be promising as garden plants because of their colourful flowers and bracts, however viable seed is scarce as seed predation is very high. Medicinal uses include for nausea and leg pain.

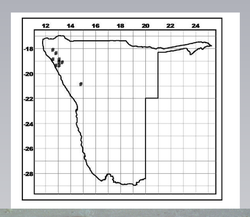
Conservation
During a survey of Namibian plants for inclusion in the Red Data Lists, using the 1994 IUCN Red Data List Categories and criteria, a number of *Petalidium* species were listed as LR-lc (lower risk, least concern) because of their limited area of occurrence. Some were considered data deficient (DD). Because of changes in the more recent versions of the IUCN categories, *Petalidium* species are no longer listed.

Looking ahead
- Complete input of data onto BRAHMS and add images.
- Use BRAHMS to evaluation various traits, the collections, phenology, and carry out diversity calculations
- Prepare taxonomic outputs for each species and describe new species
- Put updates online regularly
- Create an accurate and straightforward identification key for the genus

Challenges

Macro-morphological features of many *Petalidium* species are probably best described as pseudo cognate, as we have a fair idea of what they are, but defining them is not easy.
The enormous variation in growth form over their growth period, over time and in different areas is the main challenge faced in the revision of *Petalidium*. *Differentiating* between life forms that are insensitive to environmental changes and growth forms that are the plants response to different habitats and conditions (like drought-deciduous leaves) are not easy.
One reason for the variation is the idiosyncrasies of the rainfall in the arid western parts, which affects a number of other unrelated taxa in the same way.

Petalidium cymbiforme



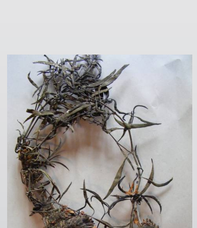
Petalidium angustilobum

Petalidium crispum

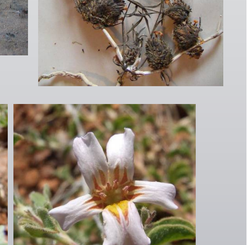
Petalidium obopobense

Petalidium giessii

Petalidium luteo-album



Petalidium lepidagathis



Petaldium variabile

Petalidium lanatum

Petalidium welwitschii

Petalidium setosum

Petaldium variabile

Petalidium lanatum

References: see http://herbaria.plants.ox.ac.uk/bol/petalidium and http://herbaria.plants.ox.ac.uk/bol/namibia

Craven, P. 2009. Phytogeographic study of the Kaokoveld Centre of Endemism. Unpublished PhD thesis, University of Stellenbosch, Stellenbosch.

Dupont, L. M. 2006. Late Pliocene vegetation and climate in Namibia (southern Africa) derived from palynology of ODP Site 1082. *Geochemistry, Geophysics, Geosystems*., 7: 1—15.

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