Namibia: Phytogeographic and floristic affinities

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NAMIBIA

Phytogeographic and floristic affinities

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The principle phytogeographic elements of the Namibian flora have been summarized.

Affinities of all species confined to an area showed particular tracks. This indicates that a fuller understanding of the areas and floras showing previous contact with the Namibia flora is required.

The aim of this poster is to highlight the intriguing evolutionary history of Namibian plants and recommend investigating the taxa and using Namibian material in future studies.

Sir Joseph Dalton Hooker: "of all the branches of botany there is none whose elucidation demands so much preparatory study or so extensive an acquaintance with plants and their affinities, as that of their phytogeographic distributions"

Introduction

Namibia is the most arid country in sub-Saharan Africa and covers a total surface area of 824 295 km2. The southern border, with the Republic of South Africa, is the Orange River and the northern border, with Angola, is the Kunene River over 2000 km away. Botswana lies in the east and the Atlantic Ocean in the west.
The Namib Desert, along the west coast, varies from sand dunes to gravel plains and ends at the foothills of the escarpment. The contention that it is the oldest desert in the world causes heated debates. The Kalahari Desert lies in the east.
Most of the land in Namibia is used for agriculture, but a sizable portion has had restricted access due to mining and conservation. Most of the farming is based on natural grazing for stock, both small and large, with game farming increasing in importance.

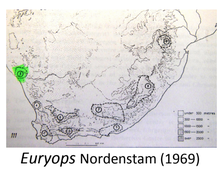
Background

Volk (1964, 1966) was the first to use species distributions to verify and comment on the phytogeographical subdivision of Namibia. He outlined the Karoo-Namib Region, and divided the tropical floristic elements. He recognized four endemic regions: the Luderitz Centre, from the Orange River to Maltahöhe; the Namib Centre; the Kaokoveld Centre from Swakopmund to Angola and the Gordonia Centre which includes the sandy parts of the southwest Kalahari. Volk mapped mainly distributions of tree and some grass species.

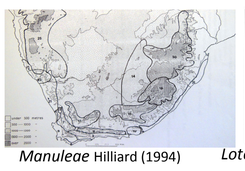
Acacia haematoxylon distribution (Volk 1966)

Sesamothamnus guerichii distribution (Volk 1966)

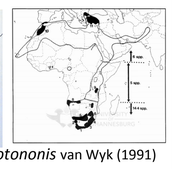
Species-concentrations and endemism recorded by Nordenstam (1969), Hillard (1994) and Van Wyk (1991) involved Namibian species as seen in the maps below. *Lotononis* has a similar geographic distribution to *Androcymbium* (Caujape-Castells *et al.* 2001) and *Lessertia* Nkonki (2013)



Euryops Nordenstam (1969)



Manuleae Hilliard (1994)



Lotononis van Wyk (1991)

Method used by Craven (2009)

- A very high number of the 4000 species in Namibia were assigned a range or distribution
- Distribution patterns of taxa and areas were compared with one another
- Reasons sought for factors that may be responsible for these distribution patterns
- Patterns mapped and Natural floristic groups of Namibia produced
- Floristic elements listed

Ongoing analysis

Data has been transferred to a BRAHMS database, Plants of Namibia, which is partly online at http://herbaria.plants.ox.ac.uk/bol/namibia

Updating the database is a dynamic process and the following recent revisions have been included, species mapped and their distributions analysed.
Anticharis (Norderstam 2013)
Lessertia (Nkonki 2013)
Pteronia (Kolberg 2013)
Aptosimum (Kolberg ongoing)
Petalidium (Craven ongoing)

Many, if not most of the ranges of these species coincide with Natural Floristic Groups of Namibia (Craven 2009).

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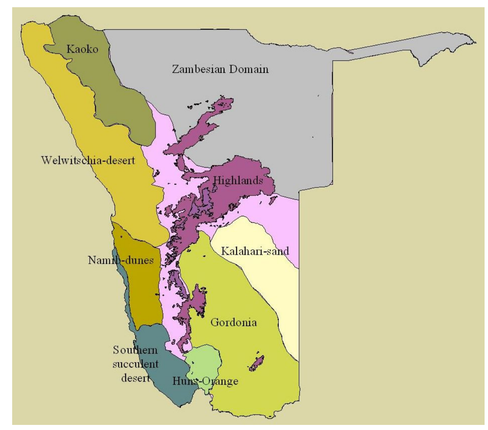
http://herbaria.plants.ox.ac.uk/bol/namibia

Natural floristic groups of Namibia

The nine phytogeographic groups outlined in the map on the right are based exclusively on distribution patterns of plant species. Such ranges should not be confused with those of Jürgens (1991) who included habitat information and life form, and the numerical analysis of Born, et al. (2007). Some names, like Gariep have been used for various concepts, but based on different criteria and should not be compared.

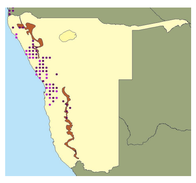
Age of the flora:
Evidence suggest that the Huns-Orange Group contains the oldest flora of Namibia (over 20 Ma) followed by the Welwitschia desert group (17 Ma).

Tracks:
Areas and floras showing previous contact with the Namibia flora, based on the distribution areas of non-endemic taxa, are
•The most northwestern parts of South Africa just south of the Orange River is an extension of the same succulent flora found in the southern Namib.
•Highveld and Afromontane elements of eastern southern Africa, like the Great escarpment.
•NE Africa resulting from the Arid track, which developed after the split of Europe from Africa.
•South American taxa resulting from the Tethys Seaway (Brown & Lomolino 1998)



The three most interesting of the groups in more detail here and pointers to research needed:

The Welwitschia-desert Group



This Group was based on the distribution of *Welwitschia mirabilis, Zygophyllum orbiculatum/stapffii* and *Adenia pechuelii*. The distributions of over 200 species correspond with these three examples. Of these, more than 100 species are endemic to Namibia and an additional 55 only co-occur in Angola. Where the escarpment breaks down in central Namibia, species such as *Welwitschia* in the Welwitschia-desert Group can be found further inland. The southern boundary (24°S) is also the limit of distribution maps of beetle species (Holm 1990), three of which have their closest relatives in East Africa and Somalia like the plants here.

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1. *Welwitschia* is interesting physiologically and morphologically, but very few answers or hypothesis have been put forward regarding it's phylogeny. It is seldom mentioned in discussions on the age of the Namib desert. The link between *Gnetum* and *Welwitschia* maybe the result of persistent dry vegetation that was linked in the Tertiary, from South America, through Central America, Mexico and the Caribbean, along the Tethys Seaway to Africa, Arabia and India.
2. *Adenia pechuelii* is one of the few taxa in the Passifloraceae family in the region. Like *Welwitschia* it is dioecious and very little is know about it.
3. *Indigofera anabibensis* is linked to the arid corridor and is in the second oldest clade in the genus which is estimated to be about 11.7 million years old (Schrire 2009)
4. Genus *Dauresia* has been identified as the most basal taxon in the subtribe Senecioninae (Asteraceae) (Pelser et al. 2007).
5. *Syncolostemon floccosus* is endemic to this group and it may provide clues to a tribe in Lamiaceae that a broad biogeographic analysis suggests has its ancestral area in Africa.

The Huns-Orange Group

This fascinating Group occurs in the area that consists of the Hunsberg Huib highlands [pic 1] and the arid mountains along the Orange River to the east. It is based on the distributions of *Jatropha orangeana*, *Ruellia aspera* and *Bowiea volubilis* subsp. *gariepensis.* Species may extend eastwards into the Northern Cape or disjunct to Eastern Cape. Schrire's (2009) molecular study links *Indigofera* species from here to the Albany area of E Cape. Both the *Dauresia* and *Zygophyllum genera* have links from this area to the Welwitschia Desert group. It is the only area in southern Namibia from where orchids have been recorded. Disjunct distributions to the Brandberg Mountain in the north are known, e.g. *Diospyros acocksii* and *Commiphora namaensis*. Species in the Huns and Aus areas do not occur with the succulent flora further west.

2. *Indigofera nudicaulis* is estimated to be over 20 Ma and may be the only species of *Indigofera* not belonging to one of the four main subclades in the genus (Schrire 2009).

3. *I. merxmuelleri* was the next branching species in this study.

4. *Pachypodium namaquanum* a well-known species in the group.

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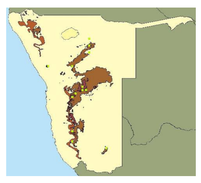
The Highland Group



The distribution pattern of the group is disjointed and irregular, because the Highland Group consists of species confined to upper reaches of mountains or areas higher than 1500 m (up to 1700 m) in altitude. Endemic genera include *Namacodon*, *Manuleopsis*, *Chamaegigas* and *Dintera*. The Group could be split on the basis of altitude and relationships. The Highveld or plateau species are related to eastern SA and the montane parts are more closely related to the Angolan highlands and the great Escarpment, e.g. *Passerine montana* and *Seriphium plumosum.* Studies of fossil pollen indicate a moist and warm phase of climate between c. 7000 and 6000 yr BP near Windhoek. This contrasts to the indications that dry conditions prevailed in the Namib Desert during this same time period. Could this evidence confirm the closer relationship of the flora of the Windhoek highlands with the Highveld of South Africa? Or does the relationship go much further back?

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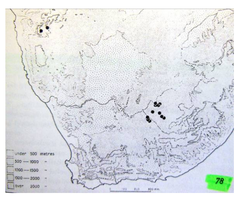

1. The range of the Highland group is exemplified by *Lightfootia dinteri*, an interesting dwarf shrub that could be key in understanding the Highland group and its affinities, but it is in urgent need of taxonomic study. It has been erroneously placed as a synonym in the genus *Wahlenbergia.*
2. Euryops asparagoides is an example of a disjunct from the Highlands in Namibia to the Free State in RSA, 1000 km away. This pattern has been observed in a few taxa and needs to be further investigated. Other species with similar patterns include *Dodonaea viscosa*.

LOOKING AHEAD :

•Establish the specific mapping criteria and approach taken, before comparing different maps and information
•Prepare the data for use in climate change studies so that both historical and ecological phytogeography are taken into account
•Analysis these groups further so as to identify and define centres of outstanding species concentration and endemism
•Understand the patterns by evaluating unusual environmental conditions that could affect the data like the very good rain years (e.g. 1933, 1964, 1975 and 2008) .
•Incorporate data on photosynthetic pathways. Although not well enough known yet to make major deductions, some differences are apparent. Genus *Anticharis* which consists of about 10 species from arid regions of Africa and southwest Asia has the only known example of C4 species in the family Scrophulariaceae (Khoshravesh et al. 2012).

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