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Taxonomy and conservation status of Moroccan stapeliads (Apocynaceae-Asclepiadoideae-Ceropegieae-Stapeliinae)

Keith BENSUSAN

Gibraltar Ornithological & Natural History Society (GONHS) & Gibraltar Botanic Gardens
PO Box 843, Gibraltar. email: kbensusan@gibraltargardens.gi

Abstract. The Kingdom of Morocco hosts at least five species of stapeliad (Stapeliinae), including three apparently endemic taxa. The status of the asclepiads (Asclepiadoideae) as a subfamily, of which the stapeliads form a clade, has been revised recently. Moreover, the stapeliads themselves have undergone numerous nomenclatural revisions and the taxonomy of a number of groups remains disputed. Here, the latest understanding of the taxonomy of Moroccan stapeliads is reviewed. In addition, the conservation status of these species in Morocco is discussed. The current representation of stapeliads in the herbarium of the Institut Scientifique, Université Mohammed V-Agdal at Rabat is also commented upon. A key to stapeliad taxa that have been confirmed from Morocco is provided.

Keywords: Stapeliinae, Morocco, taxonomy, conservation, stapeliads, Asclepiadoideae, Apocynaceae.

Taxonomie et état de conservation des Stapeliinae du Maroc (Apocynaceae-Asclepiadaceae-Ceropegieae-Stapeliinae).

Résumé. Le Royaume du Maroc abrite au moins 5 espèces de Stapeliinae dont 3 apparemment endémiques. L'état des Asclepiadoideae comme sous-famille, à l'intérieur de laquelle les Stapeliinae constituent un clade a été révisé récemment. Par ailleurs, les Stapeliinae eux-mêmes ont fait l'objet de nombreuses révisions nomenclaturales et la taxonomie d'un certain nombre de groupes reste controversée. Dans cet article, les dernières connaissances sur la taxonomie des Stapeliinae marocaines sont révisées ; de même, l'état de conservation de ces espèces est discuté. La représentativité actuelle des Stapeliinae dans l'herbier de l'Institut Scientifique (Université Mohammed V - Agdal, Rabat) est commentée. Une clé de détermination des taxa dont la présence est confirmée au Maroc est fournie.

Mots clés: Stapeliinae, Maroc, taxonomie, conservation, Stapeliinae., Asclepiadoideae, Apocynaceae.

[*traduit par la rédaction*]

INTRODUCTION

The stapeliads comprise a group of succulent plants that includes around 400 species (Albers & Meve 2002), although estimates of the number of species vary between authors; for example, Bruyns (2005) gives 328 whereas Plowes (*pers. comm.*) estimates some 480. Many have large and attractive flowers with complex structures. Most species are pollinated exclusively by Diptera, for which these plants exhibit remarkable adaptations including sapromyophilous habits (Meve & Liede 1994, Jonkers 2002, Jürgens *et al.* 2006). Stapeliads are distributed from Dakar (Senegal) in the west to the Ayeyarwady River (Myanmar) to the east, and from southeast Spain in the north to the South African Cape in the south (Bruyns 2002a, 2005). The Kingdom of Morocco in northwest Africa lies close to the northern and western limits of the range of these plants. Eight species of stapeliad are given in the literature for Morocco, five of which have been confirmed. Fennane & Ibn Tattou (2005) list seven, whereas Audissou (2005) and Fennane *et al.* (2007) both list five confirmed and one unconfirmed species. These include three taxa – a species and two subspecies – that are apparently endemic to the country. This article summarises current understanding of the taxonomy of Moroccan stapeliads. It also discusses the conservation status of these interesting and vulnerable species in Morocco, as well as briefly reviewing the status of these plants in the Herbarium of the Institut Scientifique, Université Mohammed V-Agdal, Rabat.

TAXONOMY

The subtribe Stapeliinae G. Don. belongs to the tribe Ceropegieae Decne ex Orb. of the subfamily Asclepiadoideae R. Br. ex Burnett (Endress & Bruyns 2000, Meve & Liede 2004). This subfamily has traditionally been treated as a family (Asclepiadaceae) but molecular evidence has demonstrated that the group, monophyletic though it is, is nested within the Apocynaceae Juss. (Angiosperm Phylogeny Group 2003). Much has changed regarding stapeliad taxonomy since White & Sloane's (1937) encyclopaedic work on these plants and, more than many groups, the stapeliads have been subjected to turbulent changes in classification. In recent years, molecular revisions have provided a clearer picture of phylogeny within the Stapeliinae (e.g., Meve & Liede 2002, 2004, Meve & Heneidak 2005), but precise relationships and validity of species are still disputed.

Until relatively recently, all Moroccan species of the Stapeliinae were placed within the genus *Caralluma* N. E. Br. In spite of various genera being proposed for smaller sections within *Caralluma* s.l. since the 1800s, the treatment of all species within this group became so standard that even some recent publications have persisted in placing most or all North African species in *Caralluma* (e.g., Audissou 2005, Fennane *et al.* 2007). Although disagreement still exists among a few workers on the taxonomy of species in *Caralluma* s.l., there has been a general consensus that they were in need of revision and division into smaller genera (e.g., Plowes 1995, Bruyns 2002a). Not least, this is due to paraphyly and the existence of smaller and recognisable monophyletic groups within *Caralluma* s.l. (Meve & Liede 2002). The taxonomy of the eight species of stapeliad listed for Morocco is summarised, with synonyms listed after currently accepted names, which are in **bold** (adapted from Meve & Liede 2002, de Kock & Meve 2007 and Jonkers 2008). Genera listed are those

recognised by molecular phylogenies (Meve & Liede 2002, Endress *et al.* 2007). The principle of monophyly is upheld throughout this work, but it is important to note that arguments for the retention of paraphyletic taxa merit attention (see, e.g., Sosef 1997, Brummitt 2002, or Plowes 2003, 2008a in reference to stapeliads). *Apteranthes europaea* (Guss.) Plowes is listed at the species level with no reference to the complicated history of its infraspecific taxonomy, which is discussed separately (for more on this matter see Meve & Heneidak 2005). An asterisk (*) indicates that the presence of a taxon in the Kingdom of Morocco requires confirmation. An (†) highlights the name used for this species in Fennane *et al.* (2007), for ease of reference. The classification of every taxon is discussed. A key to taxa confirmed from Morocco is given in Appendix .

APTERANTHES J. C. Mikan, *Nov. Act. Nat. Cur.* 17:594 (1835)
= *BOREALLUMA* Plowes, *Haseltonia* 3: 63 (1995)

The resurrection of the genus *Apteranthes* J. C. Mikan by Plowes (1995) accords well with molecular evidence (Meve & Liede 2002). Plowes placed three of the four Moroccan *Apteranthes* species in this genus. In addition, he placed *Apteranthes munbyana* (Decne.) Meve & Liede in the genus *Borealluma* Plowes. However, Meve & Liede (2002) rejected this classification, placing this species in *Apteranthes* due to shared characteristics with this genus (inflorescence morphology in particular) and to the paraphyly of *Borealluma*; *Apteranthes tuberculata* (N. E. Br.) Meve & Liede, which was included in *Borealluma* by Plowes (1995), appears to be more closely related to *Apteranthes europaea* than to *A. munbyana* according to their molecular analyses. Plowes himself (*pers. comm.*) believes that the genus *Borealluma* may require amending.

Apteranthes burchardii (N. E. Br.) Plowes, *Haseltonia* 3: 61 (1995). Basionym: *Caralluma burchardii* N. E. Br., *Bull. Misc. Inf. (Kew)* 1913: 121 (1913)

subsp. *maura* (Maire) Meve & Liede, *Pl. Syst. Evol.* 234: 198 (2002). Basionym: *Caralluma burchardii* var. *maura* Maire, *Bull. Soc. Hist. Nat. Afr. Nord* 14: 156 (1923) ≡ *Caralluma burchardii* subsp. *maura* (Maire) Meve & F. Albers, *Nordic J. Bot.* 15: 465 (1995)†

Apteranthes burchardii s.s. is endemic to the eastern Canary Islands, having been described from the island of Fuerteventura (White & Sloane 1937, Bruyns 1987, Meve & Liede 2002). The subspecies *maura*, which is found in Morocco, is endemic to this country. This taxon differs from the nominate subspecies in that its flowers are smaller and on pedicels, as well as having duller and more slender stems and smaller rudimentary leaves (Meve 1995, Audissou 2005). All varieties of the Moroccan taxon were subsumed under *A. burchardii* subsp. *maura* by Meve & Liede (2002). *A. burchardii* subsp. *maura* has a hexaploid genome (2n = 66 chromosomes), as is also the case with *Apteranthes joannis* (Maire) Plowes (Meve 1995; Albers & Meve 2001). Meve (1995) highlights that the allopatric distribution of the two subspecies of *A. burchardii*, together with their different karyologies and vegetative and floral morphologies, show that the two have lost the capacity for interbreeding. He notes that although the two taxa might thus be considered distinct species, their still far-reaching morphological similarity suggests that division at the subspecific level is the most satisfactory solution for these two taxa.

Apteranthes europaea (Guss.) Plowes, *Haseltonia* 3: 59 (1995)**.** Basionym: *Stapelia europaea* Guss., *Fl. Sicul. Prodr. Suppl.* 1: 65 (1832) ≡ *Boucerosia europaea* (Guss.) Caruel, *Parl., Fl. Ital.* 6: 725 (1886) ≡ *Desmidorchis europaea* Kuntze, *Rev. Gen*: 418 (1891) ≡ *Caralluma europaea* (Guss.) N. E. Br., *Gard. Chron.* 12: 369 (1892)†

This is the type species of the genus *Apteranthes*. A number of infraspecific taxa have been described within *A. europaea*, many for plants originating from Morocco. These include the following taxa: var. *schmuckiana* (Gattef. & Maire) Plowes, subsp. *gussoneana* (J. C. Mikan) Plowes and subsp. *maroccana* (Hook. f.) Plowes, itself with a number of infra subspecific taxa (see Meve & Liede 2002 and de Kock & Meve 2007). Fennane *et al.* (2007) distinguish between *Caralluma europaea* subsp. *europaea* (Guss.) N. E. Br. and subsp. *maroccana* (Hook.f.) Maire. Separate classification of two broad morphotypes of the taxa found in Morocco would appear logical (see below). However, Meve & Heneidak's (2005) molecular study of *A. europaea* found little evidence to support such a classification, preferring instead to designate two varieties, an eastern *A. europaea* var. *judaica* (Zohary) Plowes and western *A. europaea* var. *europaea* (Guss.) Plowes of what is an extremely polymorphic species. The variability of flower colour and size in Morocco, even within single populations, attests to this polymorphism. The Moroccan populations belong to the variety *europaea* according to this classification. However, the number of characters that distinguish these two taxa suggest a considerable degree of separation and the two are possibly allopatric (Meve & Liede 2002). Based on this, Crespo Villalba (2006) proposes that these two taxa should be raised to subspecific level. *A. europaea* has been left in its *sensu lato* until the precise infraspecific status of Moroccan populations is satisfactorily resolved.

Interestingly, flowers of plants in Morocco seem to differ somewhat according to habitat: those on limestone have typical flowers whereas those on granite have browner, slightly campanulate flowers (Jonkers & Walker 1993, Meve & Liede 2002). These two forms could be considered two distinct Moroccan ecotypes (Meve & Liede 2002) but further research is required to confirm this, including a systematic approach to gathering field data (Jonkers & Walker 1993).

Apteranthes joannis (Maire) Plowes, *Haseltonia* 3: 61 (1995). Basionym: *Caralluma joannis* Maire, *Bull. Soc. Hist. Nat. Afr. Nord* 31: 27 (1940)†

This monotypic species, which is rare and endemic to Morocco, was described within the genus *Caralluma* N. E. Br. It was placed in *Apteranthes* J. C. Mikan by

Plowes (1995) and this was accepted by Meve & Liede (2002). The species has a hexaploid genome, a feature shared by *A. burchardii* subsp. *maura* (Meve 1995, Albers & Meve 2001).

Apteranthes munbyana (Decne.) Meve & Liede, *Pl. Syst. Evol.* 234: 199 (2002). Basionym: *Boucerosia munbyana* Decne. ex Munby, *F. Alger.*: 25 (1847) ≡ *Caralluma munbyana* (Decne.) N. E. Br., *Gard. Chron. Ser.* 3 12: 278 (1892)† ≡ *Borealluma munbyana* (Decne.) Plowes, *Haseltonia* 3: 63 (1995)

According to most sources this is a monotypic species (e.g., de Kock & Meve 2007). However, the Spanish populations are sometimes attributed to a separate subspecies, *Apteranthes munbyana* subsp. *hispanica* (Coincy) M. B. Crespo & Mateo (2006), based on morphological differences between plants from Spanish and North African populations (Crespo Villalba 2006). If the species is polytypic, the Moroccan plants would presumably belong to the nominate subspecies, which was described from neighbouring Oran (Crespo Villalba 2006). The genus *Boucerosia* Wight & Arn., in which *A. munbyana* was originally described, is currently understood to have a southern Asian distribution (Plowes 1995, Meve & Liede 2004). This species is known from Algeria, Morocco and Southeast Spain.

CARALLUMA R.Br., *Asclepiadaceae*: 14 (1810)*
= *SAUROLLUMA* Plowes, *Haseltonia* 3: 54 (1995)
= *SOMALLUMA* Plowes, *Haseltonia* 3: 57 (1995)
= *SPATHULOPETALUM* Chiov., *Ann. Bot. (Rome)* 10: 392 (1912)

The type species of the genus *Caralluma* is *Caralluma adscendens* (Roxb.) Haw., a species originally described from India (Meve & Liede 2002, de Kock & Meve 2007). Following the breakdown of *Caralluma* s.l. into smaller genera, the species forming a clade with *C. adscendens* were retained in *Caralluma* s.s. (Plowes 1995, Meve & Liede 2002). Meve & Liede (2002) give Plowes' (1995) *Saurolluma* and *Somalluma* as synonyms of *Caralluma*. Although this treatment is followed here, it must be stressed that the species included within these genera by Plowes were not included in Meve & Liede's analyses.

Caralluma subulata Forssk. ex Decne., *Ann. Sc. Nat.* 9: 267 (1838)*. Basionym: *Stapelia subulata* Forssk., *Fl. Aegypt.-Arab.*: CVIII (1775).
= *Caralluma dalzielii* N. E. Br., *Bull. Misc. Inform. (Kew)* 1912: 280 (1912)

C. subulata is listed in Fennane & Ibn Tattou (1998, 2005) as *C. dalzielii*, a junior synonym of this species according to Meve & Liede (2002). *C. subulata* is known from Saudi Arabia and Yemen, with '*C. dalzielli*' referring to plants from West Africa and Sudan (de Kock & Meve 2007). In Africa, the species is distributed across the Sahel, including Senegal (Plowes 2008b). There are no confirmed records from Morocco.

CAUDANTHERA Plowes, *Haseltonia* 3: 58-59 (1995)*
= *CRYPTOLLUMA* Plowes, *Haseltonia* 3: 57 (1995)
= *SPIRALLUMA* Plowes, *Haseltonia* 3: 53 (1995)

Species included within the genus *Caudanthera* by Meve & Liede (2002), following their molecular revision, are the *Caralluma* s.l. species that were included in the genera *Caudanthera*, *Cryptolluma* and *Spiralluma* by Plowes (1995), the last two of which they considered unnecessary. *Cryptolluma* at least appears to form a well-supported clade with *Caudanthera* based on molecular evidence, but taxa placed in *Spiralluma* by Plowes (1995), because of unique spirally coiled inner corona lobes and very different pollinia, were not included in Meve & Liede's analysis. Plowes (*pers. comm.*) disagrees with this view and continues to uphold these genera.

Caudanthera edulis (Edgew.) Meve & Liede, *Pl. Syst. Evol.* 234: 201 (2002)*. Basionym: *Boucerosia edulis* Edgew., *J. Linn. Soc.* 6: 205 (1862) ≡ *Caralluma edulis* (Edgew.) Benth. ex Hook.f., *Gen. Pl.* 2: 782 (1883) ≡ *Cryptolluma edulis* (Edgew.) Plowes, Haseltonia 3:57 (1995)
= *Boucerosia stocksiana* Boiss., *Fl. Orient.* 4: 63 (1879) ≡ *Desmidorchis stocksiana* (Boiss.) Kuntze, *Rev. Gen.:* 418 (1891)
= *Caralluma longidens* N. E. Br., *Gard. Chron.* 2: 369 (1892) ≡ *Spiralluma longidens* (N. E. Br.) Plowes, *Haseltonia* 3: 53 (1995)
= *Caralluma vittata* N. E. Br., Th.-Dyer, *Fl. Trop. Afr.* 4(1): 483 (1904)
= *Caralluma mouretii* A. Chev., *Rev. Bot. Appl.* 14 : 272 (1934) ≡ *Spiralluma mouretii* (A. Chev.) Plowes, *Haseltonia* 3: 54 (1995)

This species includes two synonyms, *Caralluma longidens* and *C. mouretti*, which are considered good species by some (e.g., Plowes 1995). The subsumption of these under *C. edulis* is remarkable given that Plowes (1995) ascribed these two taxa to another genus: *Spiralluma*. Plowes (1995) created *Spiralluma* based on the spiralled staminal or inner corona lobes, an obtriangular pollinium (in *S. longidens*) a short anther extension and a shrubby, freely branching habit in *S. mouretii* (that of *S. longidens* was not recorded and it has not been collected since its original description). Meve & Liede (2002) argue that the length of anther appendages might follow a clinal distribution pattern, with rudimentary anther appendages in south-Saharan representatives and none at all in Arabian and Asian plants (although this seems to be based on little evidence). They therefore treat all three taxa as a single species, following Bruyns (1989) and Gilbert (1990) who examined the type material of these three taxa (Meve & Liede 2002), but had apparently overlooked N. E. Brown's drawing of the unique pollinia of *S. longidens* on the Kew type sheet (Plowes 1995). It should be stressed that *mouretii* and *longidens* have not been seen again since they were originally collected in Mauritania and Sudan respectively (Plowes 1995). Extremely little is known about them and acceptance of the two within *C. edulis* must be regarded as tentative only and pending examination of

further material. The exact status of these species can only be assessed by the collection of additional material in the wild for morphological and molecular analyses, but this may prove impossible as the two have not been relocated despite searches and may be extinct (D. C. H. Plowes, *pers. comm.*).

The unconfirmed report of this species from Morocco is given as *Caralluma mouretii = C. edulis* (Audissou 2005), and it would indeed be '*mouretii*' which we would expect from Morocco since this taxon was described from Mauritania (White & Sloane 1937). The expanded concept of *C. edulis* (if correct) represents a very widespread species, distributed from Mauritania in the west to India in the east (Meve & Liede 2002, de Kock & Meve 2007). The type specimen of *C. edulis* was collected in India (White & Sloane 1937).

DESMIDORCHIS Ehrenb., *Linnaea* 4: 94-97 (1829)*
= *SARCOCODON* N. E. Br., *J. Linn. Soc.* 17: 169 (1878)
= *CRENULLUMA* Plowes, *Haseltonia* 3: 66-67 (1995)

Species within the genus *Desmidorchis* were included in *Caralluma* s.l. for most of the 20th Century, until Plowes' (1995) revision of the group. Although Plowes' designations were not widely accepted at the time of publication, some of the genera that he proposed or resurrected find support in molecular data (Meve & Liede 2002). This is the case for *Desmidorchis* for example, in which Plowes (1995) included the species that has been cited for Morocco. Contrary to its treatment in numerous publications, the gender of *Desmidorchis* is in fact feminine (Jonkers 1997, 2003). The genus *Crenulluma* was created by Plowes (1995) for those Arabian species that have crenulate or undulate stem edges, but Meve & Liede's (2002) molecular analyses indicate that these species belong within *Desmidorchis*.

Desmidorchis retrospiciens Ehrenb., *Abhandl. Königl. Akad. Wiss. Berlin* 15: 31, tab. 2, fig. 8 (1832)* ≡ *Caralluma retrospiciens* Ehrenb., *Abh. Acad. Berlin*: 33 (1831) (*nom. nud., nom. illegit.*) ≡ *Caralluma retrospiciens* Ehrenb. ex N. E. Br., *Th. Dyer, Fl. Trop. Afr.* 4(1): 480 (1904)

= *Desmidorchis acutangula* Decne., *Ann. Sc. Nat. Ser.* 2 (9): 265 (1838) ≡ *Boucerosia acutangula* (Decne.) Decne., *Ann. Sc. Nat.* 9 (1844) ≡ *Caralluma acutangula* (Decne.) N. E. Br., *Gard. Chron. ser.* 3, 12: 369 (1892) (*nom. nud.*)† ≡ *Caralluma restrospiciens* subsp. *tombuktuensis* (A.Chev.) A. Chev. var. *acutangula* (Decne.) A. Chev., *Rev. Bot. Appl.*: 266 (1934) ≡ *Caralluma retrospiciens* var. *acutangula* (Decne.) A. C. White & B. Sloane, *Stap.*, 2nd ed., 1: 242 (1937)

= *Boucerosia tombuktuensis* A. Chev., *Cong. Int. Bot. Paris*: 271 (1900) ≡ *Caralluma tombuktuensis* (A. Chev.) N. E. Br., *Gard. Chron.* 12: 369 (1892) ≡ *Caralluma restrospiciens* subsp. *tombuktuensis* (A. Chev.) A. Chev., *Rev. Bot. Appl.* 266 (1934) ≡ *Caralluma restrospiciens* var. *tombukctuensis* (A. Chev.) A. C. White & B. Sloane, *Stap.*, 2nd ed., 1: 242 (1937)

= *Boucerosia russelliana* Courb. ex Brongn., *Bull. Soc. Bot. Fr.* 7: 900 (1860) ≡ *Caralluma ruselliana* (Brongn.) Cufod., *Enum. Pl. Aeth.* 30 (1969)
= *Caralluma hirtiflora* N. E. Br., *Bull. Misc. Inf. (Kew)* 1895: 264 (1895) ≡ *Caralluma retrospiciens* var. *hirtiflora* (N. E. Br.) Berger, *Stap. Klein* 71 (1910)
= *Caralluma retrospiciens* var. *glabra* N. E. Br., *Th. Dyer, Fl. Trop. Afr.* 4(1): 481 (1904)
= *Caralluma retrospiciens* var. *laxiflora* Maire, *Bull. Soc. Nat. Hist. Afr. Nord* 30 : 357 (1939)

Although the specific name *acutangula* was given priority in most modern classifications of this taxon, this species was described as *Desmidorchis retrospiciens* by Ehrenberg seven years before it was described as *Caralluma acutangula* by Decaisne. Not having seen Ehrenberg's original plate, Gilbert & Raynal (1980) considered that *Desmidorchis retrospiciens* was a *nom nud*. and reduced it to a synonym under *D. acutangula*. However, Plowes (1995, 1996a) discovered Ehrenberg's plate t.vii in *Symbolae Physicae*, which provided the identity of *D. retrospiciens* and proved that it is the same species as *D. acutangula* (de Kock & Meve 2007). Meve & Liede (2002) continued to consider *D. retrospiciens* a *nom. nud., nom illegit.*, apparently as an oversight of Plowes' find (U. Meve, *pers. comm.*), and persisted with *D. acutangula* (as masculine), placing *D. retrospiciens* as a synonym. However, *D. retrospiciens* is the correct name for the taxon. This species occurs from Mauritania east to Saudi Arabia, and southwards to Kenya (White & Sloane 1937).

ORBEA Haw., *Syn. Pl. Succ.*: 37 (1812)
= *ORBEOPSIS* L. C. Leach, *Excelsa Taxonomic Series* 1: 61 (1978)
= *ORBEANTHUS* L. C. Leach, *Excelsa Taxonomic Series* 1: 71-72 (1978)
= *PACHYCYMBIUM* L. C. Leach, *Excelsa Taxonomic Series* 1: 69 (1978)
= *ANGOLLUMA* Munster, *Cact. Succ. J. New South Wales* 17: 63-65 (1990); L. E. Newton, *Cact. Succ. J. (U.S.)* 65: 196-199 (1993)

A number of genera have recently been synonymised with *Orbea* (Bruyns 2001, 2002b). Cladistic and molecular studies have demonstrated that *Caralluma* s.l. species in the so-called *ango*-group are in fact more closely related to the genus *Orbea* than to other *Caralluma* s.l. species, and have thus been placed within that genus (Bruyns 2001, 2002b, Meve & Liede 2002). Plowes (1994, 1995, 2008a-c) prefers to retain the genus *Angolluma*. Other than the principle of monophyly that many taxonomists prefer for phylogenetic reasons, there are no set rules to determine what constitutes a genus, but it has been argued that part of the aim of establishing a genus is to have a name which should evoke a mental image of the general appearance of constituent members of a group (Plowes 1996b). *Orbea* sensu Bruyns (2001, 2002b) is a large group that includes species with morphologically diverse flowers which do not conform to this aim [compare for example the flowers of

Orbea decaisneana (Lemaire) Bruyns and *Orbea variegata* (L.) Haw.]. However, according to the principle of monophyly, the genus *Angolluma* could only be demonstrated to be valid if its members can be shown to be more closely related to each other than to other *Orbea* species, and if the integrity of *Orbea* as a monophyletic group is not compromised as a result. Preliminary molecular analyses using only two '*Angolluma*' species have shown that although the species within '*Angolluma*' could be monophyletic, they are nested within *Orbea* and their inclusion in this genus is well supported (Meve & Liede 2002). This view is rejected by Plowes (*pers. comm.*), who favours the retention of *Angolluma* on morphological grounds. Retaining *Angolluma* would require the delimitation of Bruyns' *Orbea* into a series of smaller units, but that would prove unnecessary and inconsistent with the principle of monophyly. However, even if paraphyletic taxa were to be accepted (*as per* Sosef 1997, Brummitt 2002), the differentation of *Angolluma* from some species of *Orbea* appears to be less than straightforward (Bruyns 2002b). Thus, although it has been argued that the floral morphology of the *ango*-group precludes them from being accommodated in *Orbea* unless the parameters of that genus are stretched unacceptably widely (Plowes 2008a), it appears that Bruyns (2001, 2002b) currently offers the most parsimonious approach to the problem. Although a mental image is not easily evoked by this concept of *Orbea*, this does not impair identification, as species may still be grouped according to shared characters in identification keys (and these informal groupings need not carry any phylogenetic significance, even if they are given names). As it currently stands, the genus *Orbea* includes a wide range of species that are diverse in flower structure and adapted to a wide range of dipteran pollinators (Bruyns 2003).

Orbea decaisneana (Lemaire) Bruyns, *Aloe* 37: 74 (2000). Basionym: *Boucerosia decaisneana* Lemaire, *Hort. Uni.* 5 : 99 (1844) ≡ *Desmidorchis decaisneana* (Lemaire) Kuntze, *Rev. Gen. Pl.* 418 (1891) ≡ *Caralluma decaisneana* (Lemaire) N. E. Br., *Gard. Chron.* 12 : 369 (1892) ≡ *Stapelia decaisneana* (Lemaire) A. Chev., *Rev. Bot. Appliq.* 14 : 262 (1934) ≡ *Pachycymbuim decaisneanum* (Lemaire) M. G. Gilbert, *Bradleya* 8 : 22 (1990) ≡ *Angolluma decaisneana* (Lemaire) Munster ex L. E. Newton, *Cact. Succ. J. (U.S.)* 65: 198 (1993)

subsp. *hesperidum* (Maire) H. A. Jonkers, *Asklepios* 100: 58 (2008). Basionym: *Caralluma hesperidum* Maire, *Bull. Soc. Hist. Nat. Afr. N.* 13: 17 (1922)[†] ≡ *Caralluma commutata* var. *hesperidum* (Maire) Font-Quer, *It. Maroc.* 354 (1929) ≡ *Caralluma commutata* subsp. *hesperidum* (Maire) Maire ex Jahandiez & Maire, *Cat. Pl. Maroc* 3 : 582 (1934) ≡ *Caralluma decaisneana* subsp. *hesperidum* (Maire) Raynaud, *Bot. Chron.* 10 : 717 (1991) ≡ *Angolluma hesperidum* (Maire) Plowes, *Excelsa* 16: 107 (1994)

The Moroccan *Orbea* has a close relative that grows south of the Sahara. *O. decaisneana* in its *sensu stricto* is known from a narrow coastal strip from Dakar to St. Louis in Senegal (Plowes 2008b; Jonkers 2008). The Moroccan taxon was synonymised with this plant by Gilbert (1990), under the genus *Pachycymbium*. This synonymy was maintained by Bruyns (2002b), who examined a Moroccan plant[*]. *O. decaisneana* was described prior to the Moroccan plant so Jonkers (2008), in his argument that the two taxa represent a polytypic species, classified the Moroccan taxon as *Orbea decaisneana* subsp. *hesperidum*. He lists differences between the two taxa to support this designation. One of these is the marked difference in production of nectar and smell between the two, which appears to attract different pollinators: callophorid flies visit the Moroccan taxon (which produces a strong and unpleasant smell) frequently but completely ignore the flowers of the Senegalese plant. Furthermore, Plowes (2008b) includes a photograph of *Angolluma sudanensis* Plowes [a plant originally described from Sudan which Bruyns (2002b) considers synonymous with *O. decaisneana*, and which is reported by Plowes (2008b) from the Senegalese Sahel] being visited by a mosquito, which although unconfirmed, is suspected of being a pollinator of another species of stapeliad (Jonkers 2002). This suggests reproductive segregation within Bruyns' concept of *O. decaisneana*. Pollinator specificity must be considered an important driver of speciation in stapeliads given the complex adaptations for attracting Diptera that these plants exhibit, and the ability of stapeliads to produce hybrids across species and even genera when hand-pollinated (e.g., Walker 2005). In fact, the number of differences between the taxa outlined by Jonkers (2008) satisfy the criteria for the acceptance of species outlined by Bruyns (2005): they appear to differ by at least two good characters and are reproductively segregated by pollinator specificity and geography. The status of the Moroccan taxon as a subspecies of *decaisneana* is only accepted tentatively here.

CONSERVATION STATUS

Stapeliads are distributed throughout most of Morocco, although they are most frequent and diverse in the southwest of the Kingdom. Fennane *et al.* (2007) summarise the distribution of stapeliads in the country, but they do so vaguely. A map of the distribution of stapeliad species in Morocco is given by Jonkers & Walker (1993). Audissou (2005) also discusses the distribution of these.

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[*] The specimen examined by Bruyns (2002b) was collected by Font Quer (*Font Quer 354*) and is given as 'Morocco. 30°30'N, 09°40'W, Agedir (Beni Uriaguel), *Font Quer 354* (G, Z)'. Presumably 'Agedir' refers to Agadir, since the latitude and longitude given lie extremely close to this southwest Moroccan city. However, Beni Uriaguel lies in the Rif, close to Ajdir (35°12'N, 03°55'S). I was able to find an entry for *Font Quer 354* collected on the 08/10/1929, on the Aluka online herbarium (www.aluka.org), at the Herbarium of the Institut Botànic de Barcelona (BC). Here, the locality is given as 'c. Axdir, Beni Uriaguel'. Axdir is an alternative spelling of Ajdir and this shows that Font Quer must have collected his specimen in the eastern Rif, as stated by Audissou (2005). Having said this, the collection altitude is given as '20 meters' and this corresponds approximately to the coordinates given by Bruyns (2005) rather than the Rif mountains. However, a similar discrepancy between coordinates and elevation exists at this herbarium for an entry of a *Silene* species from the Rif (J. Cortes, *pers. comm.*).

Current knowledge on the distribribution of *Apteranthes joannis* is discussed by Bensusan *et al.* (2009). Although stapeliad diversity is not high in Morocco, rate of endemism is (at 60% among the five confirmed taxa). Fennane & Ibn Tattou's (1998) catalogue of rare, threatened and endemic vascular plants in Morocco includes most species of stapeliad.

Orbea decaisneana subsp. *hesperidum* is endemic to Morocco (Jonkers 2008) where it is considered rare (Fennane & Ibn Tattou 1998). It has a fairly extensive distribution in the southwest, occurring from Essaouira to south of Sidi Ifni, and inland along the Souss valley to Aoulouz and the western Anti-Atlas (Jonkers & Walker 1993). In addition, it was recorded from the eastern Rif in 1929 (Audissou 2005). The species is poisonous and is not eaten by livestock (Audissou 2005, Jonkers 2008). Consequently, plants are found growing out in the open and untouched, even in habitats that have been degraded by goats (*pers. obs.*). Due to this and its relatively extensive distribution, this Moroccan endemic is of lower conservation concern.

The stems of some stapeliad genera are harvested and eaten by traditional communities. The shoots of a number of stapeliad species are consumed with zeal in some parts of Arabia (Miller & Morris 1988, Jongbloed 2003), whereas the young stems of *Hoodia* species, reportedly hunger suppressants, are eaten by San people in southern Africa and have found a market in weight-loss programmes (Rowley 2005, Hargreaves 2008). All *Apteranthes* species are edible. In Morocco, mountain tribes are known to eat the young shoots of the endemic *Apteranthes burchardii* subsp. *maura* (Audissou 2005). The succulent stems are equally appreciated by livestock which, unlike traditional communities, can have a significant effect on the ecology and conservation of *Apteranthes* species in Morocco.

The range of *A. burchardii* subsp. *maura* stretches along the Atlantic coast from north of Cap Ghir to the Oued Assaka (= Oued Noun), which lies some 20 km south of Sidi Ifni. This subspecies is endemic to Morocco and is considered rare (Fennane *et al.* 1998), although it is easily overlooked (Audissou 2005). Primarily a coastal species, *A. burchardii* subsp. *maura* extends inland to the westernmost slopes of the Anti-Atlas (Jonkers & Walker 1993, Audissou 2005). This distribution has been attributed to the species' preference for a relatively high atmospheric humidity (Bruyns 1987, Jonkers & Walker 1993). The range of the species coincides with that of the cactoid *Euphorbia echinus* Hook.f. & Coss. and *Euphorbia officinarum* L. (Euphorbiaceae). *A. burchardii* subsp. *maura* is almost invariably found within the thorny branches of these species and, less frequently, in other succulent shrubs (Jonkers & Walker 1993, Audissou 2005). These plants make access to the stapeliads impossible to livestock. Currently, these species dominate much of the coastal habitat from Cap Ghir south to the Oued Assaka and consequently, the status of *A. burchardii* subsp. *maura* seems secure. However, surveys along the Atlantic coast from Oued Assaka to Cap Ghir in November 2008 revealed that some considerable areas of cactoid *Euphorbia* habitat had been cleared recently (*pers. obs.*). Seeds of *A. burchardii* subsp. *maura* germinating in areas devoid of cactoid *Euphorbia* will no doubt be easily accessible to livestock. Some of these areas were being replanted with *Opuntia ficus-indica* (L.) Mill. (Cactaceae), especially south of Sidi Ifni. It is possible that this cactus could replace *Euphorbia* species in providing refuge for *A. burchardii* subsp. *maura*. Currently, and considering that very large expanses of cactoid *Euphorbia* habitat continue to exist, *A. burchardii* subsp. *maura* must be considered a taxon of lower conservation concern. This status is dependent on the extent of suitable habitat and must be revised if stands of cactoid *Euphorbia* continue to be cleared.

The third stapeliad that is endemic to Morocco is *Apteranthes joannis*. Ever since its initial discovery, *A. joannis* has been known to be very rare, and is classified as such by Fennane & Ibn Tattou (1998). The species was originally found at 'Taberbout' in 1933 (a site that remains unknown to the author, as well as to French and Moroccan colleagues of his; J.-A. Audissou & M. Mouna, *pers. comm.*). The site lay very close to Aoulouz where the plant was also found three years later. However, when visited in 1940, the site at Aoulouz had been largely destroyed during the construction of a bridge over the Oued Souss (Jonkers & Walker 1993). The species was rediscovered by Audissou (1994) on limestone cliffs overlooking the Oued Souss, adjacent to the bridge that lies immediately north of Aoulouz. This site remained the only known locality for this species globally, until Bensusan *et al.* (2009) discovered two more populations in the western Anti-Atlas. Bensusan *et al.* also located the species at the Aoulouz site once again, although they found it at a seemingly lower abundance than the photographs presented by Audissou (1994, 1998, 2005) suggest.

Audissou (2005) predicted that *A. joannis* may once have been more widespread in the Souss valley and may not have been a strict cliff-dweller in times when grazing pressure was less severe. This may well be true, and is corroborated by observations made on the species' ecology by Bensusan *et al.* (2009). Although Bensusan *et al.* found reason to predict that the species could in fact be fairly widespread in the western Anti-Atlas, intense surveys of the region are required to confirm this. So far, the species is known from only three sites globally. The two new populations in the Anti-Atlas, extremely healthy though they are, are well within the reach of grazing and browsing livestock. In addition, a very abundant population of free-growing *A. joannis* on a rocky slope could be threatened by the spread of *Opuntia ficus-indica*, an invasive species from the New World (Bensusan *et al.* 2009). This species should be considered endangered until its exact status in the Anti-Atlas can be verified and its distribution in Morocco can be mapped accurately.

Apteranthes munbyana is known from Mediterranean areas of southeast Spain, Algeria and Morocco (Crespo Villalba 2006). In Spain, where the species is uncommon, quarrying of its limestone habitats and disturbance by livestock are recognised as threats (Serra *et al.* 2003). *A. munbyana* is thought to be very rare in Morocco, where it is known only from two records by Maire (1954), from Oujda and from Bokkoya which is southwest of Melilla (Jonkers & Walker 1993, Fennane & Ibn Tattou 1998, Fennane *et al.* 2007). Extremely little is known about the

Table I. List of specimens of the Stapeliinae at the Herbarium of the Institut Scientifique, Université Mohammed V-Agdal, at Rabat.

Current Combination	Listed as	Site	Elevation	Year
Orbea decaisneana ssp. *hesperidum*	*Caralluma hesperidum*	Limestone, Axdir (Beni Uriaguel)	20 m	
Orbea decaisneana ssp. *hesperidum*	*Caralluma hesperidum*	Massif du Djebel Amsitten, Haha		
Apteranthes munbyana	*Caralluma munbyana*	Oran, Algeria		
Apteranthes europaea	*Caralluma europaea maroccana*	Vallé J'Cleni (Renaia) Grand Atlas	1300 m	
Apteranthes europaea	*Caralluma europaea maroccana*	Bocailles dans la Foret d'Arganias son la de l'Oued go a l'est de Christian		
Apteranthes europaea	*Caralluma europaea maroccana*	Hassi-Berkan (Beni-bu-Yani), limestone outcrops		1933
Apteranthes europaea	*Caralluma europaea maroccana*	Asni		1980

species in Morocco other than these two records. Spanish populations are found chiefly in rocky areas dominated by *Stipa tenacissima* L., frequently growing from the base of this grass, or from rock fissures (Serra *et al.* 2003; Audissou 2005). Habitat data for the species in Morocco is simply given as rocky, limestone slopes (Fennane *et al.* 2007). It is quite possible that the Moroccan populations, if they still exist, inhabit a similar habitat to those in Spain as *Stipa tenacissima* is dominant in much of eastern Morocco (Thévenot *et al.* 2003). This is of considerable concern to the conservation of the species as this grass provides little protection from grazers. Surveys for the species in the east of the country should have two main aims: (i) to establish whether the species is still present in Morocco, and (ii) to establish its precise distribution. *A. munbyana* should be considered a species of conservation concern in Morocco until more information has been gathered on its status.

Apteranthes europaea is the most widespread species of stapeliad in Morocco, with records for the Atlantic coast from north of Casablanca to Sidi Ifni, the Anti-Atlas, Middle Atlas, the plains of Atlantic Morocco north of the High Atlas, the eastern Rif, the Souss valley and the southeast of the country (Jonkers & Walker 1993). It is the only stapeliad species that is excluded from Fennane & Ibn Tattou's (1998) catalogue. The marked variability between and within Moroccan populations of *A. europaea* suggests that genetic diversity is high. The species has a very widespread distribution across the Mediterranean (Meve & Heneidak 2005). Audissou (2005) observes that although the species has a widespread distribution, it is localised and difficult to find. This is no doubt true throughout most if its range, although it proved abundant and easy to locate on the granites surrounding Tafraout in the Anti-Atlas, which is one of the best-known sites for the species, following exceptional rains during the autumn of 2008 (Lamb *et al.* 2009). In spite of the species being localised, its widespread Moroccan and global distribution should place *A. europaea* as a species of lower conservation concern.

Three species remain unconfirmed in Morocco: *Caudanthera edulis* (= *mourettii*), *Desmidorchis retrospiciens* and *Caralluma subulata*. The first two are known from Mauritania (White & Sloane 1937), whilst the third has been recorded from Senegal (Plowes 2008b). *C. edulis* is mentioned by Audissou (2005) as a possibility for Morocco given its presence in neighbouring Mauritania, whereas *D. retrospiciens* is listed by Fennane *et al.* (2007) as occurring in 'Maroc Saharien oceanique', although they add that verification of the presence of this species in Morocco requires further research. It is likely that if any of these species do exist within the Kingdom of Morocco, they are to be found in the Western Sahara. Locating *C. edulis* in particular would provide a significant find given the possibility that the Mauritanian '*C. mouretii*' could be extinct due to desertification of its habitat. The conservation status of these three species cannot be commented upon until their presence in Morocco is verified.

STAPELIADS AT THE RABAT HERBARIUM

Representation of stapeliads in the Herbarium of the Institut Scientifique at Rabat is poor. Not all species are present and in addition, some of the specimens are lacking flowers, which are essential to the identification of *Apteranthes* species (Audissou 2005, Fennane *et al.* 2007). Specimens present are listed with their data, as recorded by the author on the 9th July 2008 (Table I). A joint expedition to the south of Morocco by the Gibraltar Ornithological & Natural History Society and the Institut Scientifique at Rabat in November 2008 retrieved live material of two species that are not represented in the Rabat Herbarium: *Apteranthes joannis* and *Apteranthes burchardii* subsp. *maura*. In addition, a variety of flower forms of *Apteranthes europaea* were collected. This material is currently being propagated at the Gibraltar Botanic Gardens. Specimens of all of these will be submitted to the herbarium at Rabat as plants grow and flower, together with

their data. These will be submitted as pressed and alcohol specimens, as this last method will allow the diagnostic features of these plants to be preserved better.

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Appendix. Key to Stapeliad taxa that have been confirmed from Morocco

1. stems sub-cylindrical or cylindrical with prominent conical protuberances arranged in four rows; corolla with uniformly coloured, usually dark lobes and a short tube (Fig. 1) .....*Orbea decaisneana hesperidum*

– stems square, with angles more or less wavy; younger stems with small, rudimentary leaves on angles. Corolla without tube. Identification to species level only possible by examining flowers (genus *Apteranthes*).....2

2. inner surface of corolla covered in dense, whitish hairs, giving the corolla a white appearance. Corona uniformly golden yellow (Fig. 2).....*Apteranthes burchardii maura*

– inner surface of corolla more or less glabrous; never completely covered in hairs. Corona not entirely yellow.....3

3. corolla lobes long and narrow, much longer than width at base (length = >2x width); lateral edges almost parallel to apex (Fig. 3).....*Apteranthes munbyana*

– corolla lobes triangular or subtriangular, length similar to width at base.....4

4. inner surface of corolla glabrous, covered with tubercles giving a rough, warty appearance. Centre of corolla paler, becoming darker towards outer edge. Tubercles uniformly dark (Fig. 4).....*Apteranthes joannis*

– inner surface of corolla smooth, without tubercles, sometimes with hairs but never very hairy. Pattern variable but always with helically arranged, yellowish or greenish stripes (Figs. 5, 6 & 7).....*Apteranthes europaea*

Plate I

Figure 1. *Orbea decaisneana* subsp. *hesperidum* KB&BML/2008-70, Oued Noun/Assaka, S. of Sidi Ifni, Morocco (plant in Gibraltar Botanic Gardens collection).

Figure 2. *Apteranthes burchardii* subsp. *maura* KB&BML/2008-114, near Tiznit, Morocco (plant in Gibraltar Botanic Gardens collection).

Figure 3. *Apteranthes munbyana* JAA 224, Hellín, Spain (photo credit: J.-A. Audissou).

Figure 4. *Apteranthes joannis*, western Anti-Atlas, Morocco (photo credit: L. Linares).

Figure 5. *Apteranthes europaea*, Cabo de Gata, Spain (plant in B.M. Lamb collection).

Figure 6. *Apteranthes europaea* KB&BML/2008-96, Tafraoute, Anti-Atlas, Morocco (plant in Gibraltar Botanic Gardens collection).

Figure 7. *Apteranthes europaea*, Tafraoute, Anti-Atlas, Morocco (photo credit: C. Perez).

Fig. 1

Fig. 2

Fig. 6

Fig. 3

Fig. 4

Fig. 5

Fig. 7