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Euphorbia evolution and taxonomy

Wei, N., Pérez-Escobar, O.A., Musili, P.M., Huang, W.-C., Yang, J.-B., Hu, A.-Q.,Hu, G.-W., Grace, O.M. & Wang, Q.-F. Plastome evolution in the hyperdiverse genus *Euphorbia* (Euphorbiaceae) using phylogenomic and comparative analyses: large-scale expansion and contraction of the inverted repeat region. *Frontiers in Plant Science*, 12: 712064, Aug. 2021.doi: 10.3389/fpls.2021.712064

Wei, N., Mutie, F.M., Mwachala, G., Grace, O.M., Hu, G.-W. & Wang, Q.-F. *Euphorbia mbuinzauensis*, a new succulent species in Kenya from the *Synadenium* group in *Euphorbia* sect. *Monadenium* (Euphorbiaceae). *PhytoKeys*, 183: 21–35, 2021 doi: 10.3897/phytokeys.183.70285

Euphorbia is the largest genus of succulents with around 800 of its c. 2,000 species being of interest to us here. Recent molecular studies have provided evidence that *Euphorbia* is a very diverse but unified genus because a number of other smaller genera actually belong within it. The first study reviewed here provides the strongest supporting evidence to date confirming *Euphorbia* as a single hyperdiverse genus.

The molecular biology techniques used to provide this evidence are state of the art and are merely summarised here. As far as I am aware these techniques have been applied to study succulents for the very first time, so this work is at the forefront of the new direction in which succulent plant taxonomy is moving.

Fig. 1 *Euphorbia splendens* growing bedded out at Duthie Park, Aberdeen (Photo: Colin C Walker)

DNA, the genetic material of all plants, is contained within cells in three discrete compartments:

- The nuclear genome in the cell nucleus which includes the vast majority of the DNA and is mainly packaged as genes in chromosomes.
- Mitochondria, organelles which generate the energy molecule ATP at night (and nearly all animal cells also have these).
- The chloroplast, the organelle that carries out photosynthesis which captures light energy used to drive the conversion of carbon dioxide into all other organic molecules that make up a plant. Only plants have chloroplasts so their genes are generally used in comparative studies because these are smaller in number and hence generally more easily sequenced than those of the significantly larger nuclear genome. A relatively new term is now applied to the chloroplast genome: the plastome.

The first paper under review concerns whole plastome sequencing in a selection of *Euphorbia* species. What makes this ground-breaking is that the total DNA of these plastomes has been compared for the very first time. To put this into context, these techniques are now used routinely in the taxonomy of bacteria which are similar in structure to chloroplasts. Bacterial taxonomists can now define species with 100% certainty because **all** the DNA is being compared in their studies and not merely samples of it, as has been the previous practice.

The headline conclusion of this study is that the genus *Euphorbia* is monophyletic, meaning that all its component species have a unique common evolutionary origin. This statement, however, is based on other recent work in which the following smaller segregate genera were merged with *Euphorbia*: *Chamaesyce*, *Cubanthus*, *Elaeophorbia*, *Endadenium*, *Monadenium*, *Pedilanthus*, *Poinsettia* and *Synadenium*, five of which contained only succulents. These genera are now shown to be very deeply nested within *Euphorbia*. The four subgenera of *Euphorbia*, subg. *Athymalus*, *Chamaesyce*, *Esula* and *Euphorbia*, are also shown to be monophyletic; all of these include succulents.

The second paper reviewed here provides additional support for this expanded, unified concept of a hyperdiverse genus *Euphorbia* but focuses on a very small group of just 14 species. These were previously separated in the former genus *Synadenium* confined to east and southern tropical Africa. They are shrubs or trees up to 18m tall, characterised by the unique ring-shaped glands in the cyathium (the condensed, specialised inflorescence of Euphorbiaceae). New plant material came to light which did not match any of the known species. A molecular biological study was undertaken which compared 10 taxa. One outcome was that this new material was identified as a new species, *Euphorbia mbuinzauensis* N. Wei, Mwachala, G.W. Hu & Q.F. Wang, a shrub up to 4m tall, known only from a single locality in southern Kenya. Most significantly, this study confirmed

that *Synadenium* is an integral component of *Euphorbia* subg. *Euphorbia* sect. *Monadenium* and hence there is no justification for its recognition as a separate genus.

Madagascan euphorbias

Haevermans,T. & Hetterscheid,W.L.A. Novelties in Malagasy *Euphorbia* (Euphorbiaceae). *Phytotaxa*, 488 (1): 1–63, 2021. **https://doi.org/10.11646/phytotaxa.488.1.1**.

Haevermans,T. & Hetterscheid,W.L.A. Taxonomic changes and new species in Malagasy *Euphorbia* (Euphorbiaceae). *Phytotaxa*, 492 (1): 1–61, 2021. **https://doi.org/10.11646/phytotaxa.492.1.1**

Madagascar is home to over 200 taxa of *Euphorbia* and hence exhibits wide diversity, accounting for 10% of the species total in this hyperdiverse genus. These papers reassess the taxonomy and nomenclature of a range of succulent species. A particular feature of this revised taxonomy is that only species rank is utilised, so a number of infraspecific taxa are elevated to species status. A spin-off from this approach is that it will "simplify the work of conservationists by defining clear concepts". In total these two papers assess 48 species of Malagasy *Euphorbia* and hence together they represent a significant revision of this group of species.

A major focus of the first study is that the taxonomy of the famous 'crown of thorns' *Euphorbia milii* Des Moulins is reassessed. The precise identity of *E. milii* has remained a mystery since its original publication in 1826 with this name being applied in the horticultural trade to a widely variable swarm of cultivars. Here the name *E. milii* is restricted to plants with truncate leaves. The most familiar plant in cultivation with elliptical leaves and red or yellow cyathophylls (coloured bracts) has the restored name of *Euphorbia splendens* Bojer ex Hooker (Fig.1). Other species in this complex include: *Euphorbia betrokana* Castillon & Castillon (= *E. milii* var. *longifolia*), *E. bevilaniensis* (= *E. splendens* var. *bevilaniensis*), *E. hislopii* Brown (= *E. splendens* var. *hislopii*), *E. imperatae* (Leandri ex Castillon & Castillon) Haev. & Hett. (= *E. milii* var. *imperatae*) (Fig. 2), *E. neobosseri* Rauh (= *E. milii* var. *bosseri*), *E. roseana* (Marn.-Lap. ex Demoly) Castillon & Castillon (= *E. milii* var. *roseana*), *E. tananarivae* (Leandri ex J.-P. Castillon & J.-B. Castillon) Haev. & Hett. (= *E. splendens* var. *tananarivae*) and *E. tenuispina* (Rauh & Razaf.) Castillon & Castillon (= *E. milii* var. *tenuispina*).

The taxonomy of *Euphorbia bosseri* Leandri is revised and the commonly-grown *E. platyclada* becomes a synonym of the older species. *Euphorbia platyclada* var. *hardyi* is elevated to species status as *E. hardyi* (Rauh) Haev. & Hett. *Euphorbia cylindroclada* Haev. & Hett. is a newly described species in this complex.

The taxonomy of a selection of other spiny shrubby species is also revised: *Euphorbia begardii* (Cremers) Haev. & Hett. (= *E. primulifolia* var. *begardii*), *E. berevoensis* Lawant & Buddensiek (incl. *E. nicaisei*), *E. crassicaulis* (Rauh) Haev. & Hett. (= *E. francoisii* var. *crassicaulis*), *E. delphinensis* Ursch & Leandri, *E. fanjahiraensis* Haev. & Hett. (incl. *E. isalensis*), *E. guillemetii* Ursch & Leandri (incl. *E. beharensis*), *E. leandriana* Boiteau (incl. *E. horombensis*),

Fig. 2 *Euphorbia imperatae* in habitat (Photo: Al Laius)

E. mangokyensis Denis (incl. *E. razafindratsirae*), *E. pachyspina* Haev. & Hett., *E. paulianii* Ursch & Leandri (= *E. perrieri* var. *elongata*), *E. perrieri* Drake, *E. psammiticolia* Haev. & Hett. and *E. werneri* Haev. & Hett.

In the second paper, 14 new species of Malagasy *Euphorbia* are described and compared to related species; identification keys for morphologically close relatives and distribution maps are provided: *Euphorbia agatheae* Haev. & Hett., *E. atimovatae* Haev. & Hett., *E. fuscoclada* Haev. & Hett., *E. graciliramulosa* Haev. & Hett., *E. kalambatitrensis* Haev., Hett. & Spannring, *E. linguiformis* Haev., Hett. & Spannring, *E. mahaboana* Haev. & Hett., *E. makayensis* Haev. & Hett., *E. multibrachiata* Haev. & Hett., *E. parvimedusae* Haev. & Hett., *E. perrierioides* Haev., Hett. & Spannring, *E. rigidispina* Haev. & Hett., *E. spannringii* Haev. & Hett, and *E. tsihombensis* Haev. & Hett.

Fig. 3 *Euphorbia croizatii* in habitat (Photo: Al Laius)

In the informal *Euphorbia rubrostriata* group the new combination is proposed: *Euphorbia itampolensis* (Rauh) Haev. &. Hett. (= *E. neobosseri* var. *Itampolensis*), whilst the following are reassessed: *E. mahafalensis* Denis, *E. rubrostriata* Drake (incl. *E. mainiana* Poisson) and *E. xanthadenia* Denis (incl. *E. croizatii* (Fig. 3), *E. ebeloensis* and *E. emiliennae*).

In addition, new synonyms, new combinations or new statuses are proposed: *Euphorbia antsingiensis* (Cremers) Haev. & Hett. (= *E. moratii* var. *antsingiensis*), *Euphorbia crassa* (Cremers) Haev. & Hett. (= *E. enterophora* subsp. *crassa*), *E. rangovalensis* Leandri (incl. *E. castilloni* Lavranos) and *E. xylophylloides* Brongn. ex Lemaire (incl. *E. enterophora*).

Euphorbia susannae is endangered in the wild

Jabar, L., Siebert, S.J., Pfab, M.F. & Cilliers, D.P. Population biology and ecology of the endangered *Euphorbia susannnae* Marloth, an endemic to the Little Karoo, South Africa. *Biodiversitas*, 22: 4583–4596, 2021.

Euphorbia susannae is a charismatic, well-known species and hence justifiably popular with collectors because it is a relatively small-growing clumping species that performs well in cultivation. However, it is currently listed as Endangered in the wild and is included in the Red List of South African plants because it has a very limited area of occurrence and is known from only four locations. The current study aimed to assess its population biology and ecology.

Euphorbia susannae grows on the edges of quartz patches along a section of the northern slopes of the Langeberg Mountains. The population structure, regeneration potential and stability of each subpopulation were assessed. The measured EOO (Extent of Occurrence) was determined to be only 170km^2 and the species is confined to eight subpopulations that vary considerably in size. This study found that only 1845 individuals remain in the wild. The main threat to the species seems to be habitat degradation,

Fig. 4 *Euphorbia susannae* growing at Springfontein, Western Cape Province, South Africa under the shade of a nurse plant shrub (Photo: Alice Vanden Bon)

although only parts of the distribution range were affected. Habitat preferences of the species were considered in detail and linked to a species distribution model for conservation purposes. It was shown that the species preferred nurse plants (Fig. 4). Annual recruitment levels (new seedlings added to the populations) were found to be healthy, suggesting good pollination, seed set and germination conditions, all of which is positive for the future survival in the wild of this iconic species.

Colin C Walker

Conservation update – Karrasberge Protected Area

In 2020, the BCSS and the Mesemb Study Group (MSG) provided funds to assist in creating much needed infrastructure for the Karrasberge Protected Area in South Africa. This Protected Area, which was designated that year, is situated to the east of the Northern Cape town of Springbok and consists of the Areb, Karas, Marietjie van

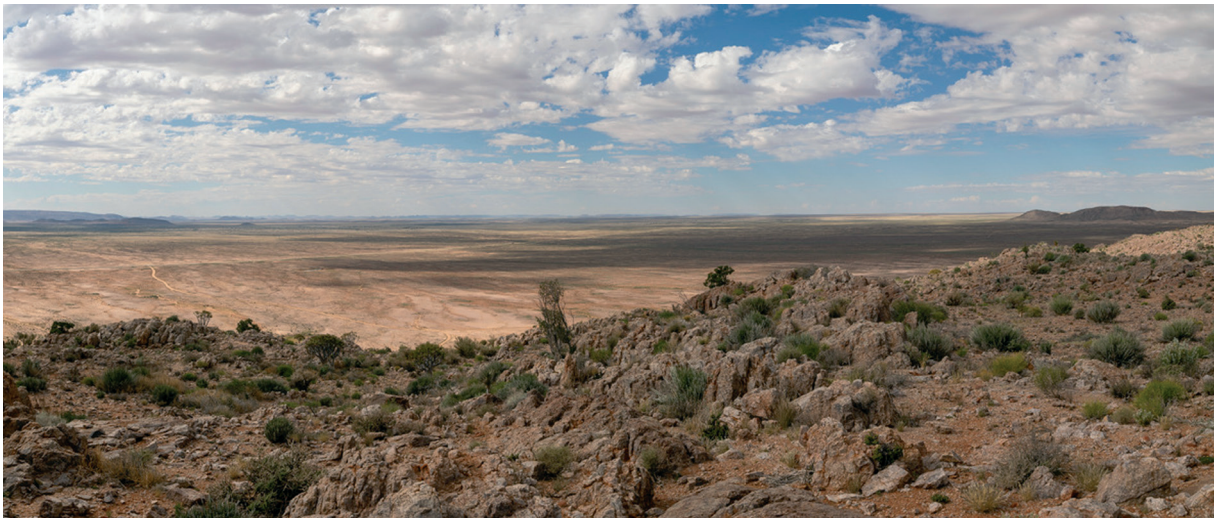

Fig. 5 Panoramic view of the Karrasberge (Photo: Andrew J Young)

Niekerk and Smorgenskadu Nature Reserves. These adjoin each other and together represent approximately 5,000 hectares of two previously unprotected vegetation types, namely Bushmanland Inselberg Shrubland and Aggeneys Gravel Vygieveld. Crucially, the area contains several quartz-rich inselbergs which are home to a range of dwarf succulents including several species that are endemic to the reserve.

The ten *Conophytum* taxa present within the boundaries of the Protected Area are all threatened and have this year been assessed to be Critically Endangered (5 taxa), Endangered (4) or Vulnerable (1). The donations from the BCSS and MSG have greatly assisted with the completion of the fence on the Marietjie van Niekerk Nature Reserve (Kangnas section) and contributed towards the overall conservation goals. In total, around 10 kilometres of new fencing have been constructed, while 23 kilometres of old internal fencing have been removed, opening the system between the inselbergs on the reserve and countering the impacts of grazing edge effects along the lower slopes of the inselbergs.

A team of four was appointed from the local community of Kamassies for the duration of the project. Living in an area with high rates of unemployment, and almost exclusively off social grants, the employment opportunities created for this team by the project were also of great benefit to the local community.

I was able to visit the Nature Reserve in April this year and see for myself the work on the fencing and talk to those from the Wilderness Foundation Africa who led the work on the ground as well as the farmers. The funding provided from the MSG and BCSS has clearly made a difference.

Andrew J Young

Melocactus paucispinus update

In the last issue (*CactusWorld* **40**(3):227–228) I reported on the extraordinary rapid growth rate of my *Melocactus paucispinus* in cultivation in my garden in Brazil. The cephalium had appeared in just 23 days back in June 2022 and now the plant is flowering well, as can be seen in this photo (Fig. 6) taken in late August. Hummingbirds are regular visitors and pollinators.

Some more interesting details follow. The plant of *M. paucispinus* has started to produce fruits three months after it first flowered. I have harvested the first five fruits and counted the seeds: 73 seeds from five equals an average of 14.6 per fruit. The average number of flowers per day is about three, so multiplied by 365 days it makes roughly 1000 flowers per year. If each flower produces a fruit, which they will as they are self-pollinating, the simple maths suggests around 14,600 seeds per year.

There are days when for lack of sun and/or warmth the plant does not flower, but while there is water available it grows and flowers all year around. In nature the rate of flowering and seed production will likely be lower due to long dry periods, though we have observed melocacti flowering even after long periods without water. Fruiting is likely to be more seasonal as the fruits are rather juicy and must use more water than flower production.

Nigel Taylor

Fig. 6 *Melocactus paucispinus* in flower (Photo: Nigel Taylor)