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***Mucinaea (Hyacinthaceae-Urgineoideae), a Remarkable  
New Genus from Namaqualand  
(Northern Cape Province, South Africa)***

By

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With 4 Figures

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Summary

PINTER M., CRESPO M. B., ILG I., LUIDOLD A. K., MARTÍNEZ-AZORÍN M., MÜLLER-DOBLIES U., MÜLLER-DOBLIES D., PFOSSER M. & WETSCHNIG W. 2013. *Mucinaea (Hyacinthaceae-Urgineoideae)*, a remarkable new genus from Namaqualand (Northern Cape Province, South Africa). – *Phyton (Horn, Austria)* 53(2): 289–304, with 4 figures. – English with German summary.

We here describe a new genus from Namaqualand, which is based on *Tenicroa nana* SNIJMAN. *Mucinaea* M. PINTER, MART.-AZORÍN, U. MÜLL.-DOBLIES, D. MÜLL.-DOBLIES, PFOSSER & WETSCHNIG gen. nov. shows several character-states different from all other known species of *Tenicroa* and a few even do not occur in any other genus of *Hyacinthaceae*. *Mucinaea* M. PINTER & al. is easily distinguishable by its purplish-pink tepals bearing a double-eyed green floral marking at their base, surrounded by a white margin, unique within *Hyacinthaceae*. It also differs by the single sheathing cataphyll without raised transverse ribs, different from the other species of *Tenicroa*, and by the second sheath consisting of a compound of the bases of about ten foliage leaves, surrounding about ten further free foliage leaves, what is a unique structure in the bulbous world. *Mucinaea* with *Mucinaea nana* (SNIJMAN) M. PINTER & al. comb. nova is a monotypic genus, only known from three quarter -

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degree squares in the Northern Cape Province of South Africa. Data on morphology, ecology and distribution are given. Additionally, this separation leads to the monophyly of the genus *Tenicroa*.

#### Zusammenfassung

PINTER M., CRESPO M. B., ILG I., LUIDOLD A. K., MARTÍNEZ-AZORÍN M., MÜLLER-DOBLIES U., MÜLLER-DOBLIES D., PFOSSER M. & WETSCHNIG W. 2013. *Mucinaea* (*Hyacinthaceae-Urgineoideae*), a remarkable new genus from Namaqualand (Northern Cape Province, South Africa). [*Mucinaea* (*Hyacinthaceae-Urgineoideae*), eine bemerkenswerte neue Gattung aus dem Namaqualand (Nördliche Kapprovinz, Südafrika)]. – *Phyton* (Horn, Austria) 53(2): 289–304, mit 4 Abbildungen. – Englisch mit deutscher Zusammenfassung.

Wir beschreiben hier eine neue Gattung aus dem Namaqualand, welche auf *Tenicroa nana* SNIJMAN basiert. *Mucinaea* M. PINTER & al. gen. nov. weist Merkmale auf, welche sie von allen anderen bekannten Arten der Gattung *Tenicroa* und sogar von allen anderen Gattungen der *Hyacinthaceae* unterscheidet. *Mucinaea* ist durch ihre violett-rosafarbenen Tepalen, welche ein grün-weißes Blütenmal an ihrer Basis aufweisen, was einzigartig innerhalb der *Hyacinthaceae* ist, leicht zu erkennen. Weiters unterscheidet sie sich von allen anderen Arten der Gattung *Tenicroa* durch ein einzelnes stängelumfassendes Niederblatt ohne erhabene Querleisten und durch eine zweite Scheide, welche aus den Basen von ca. zehn Laubblättern zusammengesetzt ist und weitere ca. 10 freie Laubblätter umgibt, was eine einzigartige Struktur innerhalb der Welt der Zwiebelpflanzen darstellt. *Mucinaea* mit *Mucinaea nana* (SNIJMAN) M. PINTER & al. comb. nova ist eine monotypische Gattung, die nur aus drei Gradquadranten der Nördlichen Kapprovinz Südafrikas bekannt ist. Daten zur Morphologie, Ökologie und Verbreitung werden präsentiert. Desweiteren führt diese Abtrennung zur Monophylie der Gattung *Tenicroa*.

#### 1. Introduction

*Hyacinthaceae* includes about 700–900 species, mainly distributed in Africa, Europe and Asia. Only a single small genus – *Oziroë* RAF. 1837: 53 – is native to South America (SPETA 1998a, b, APG 2002). The family can be subdivided into four monophyletic clades, which correspond to the subfamilies *Hyacinthoideae*, *Ornithogaloideae*, *Oziroëoideae* and *Urgineoideae* (SPETA 1998a, PFOSSER & SPETA 1999, MANNING & al. 2004).

That family is alternatively treated as subfamily *Scilloideae* of the *Asparagaceae*, and subsequently the former subfamilies are treated as tribes *Hyacintheae*, *Ornithogaleae*, *Oziroëeae* and *Urgineeae* (APG 2009, CHASE & al. 2009). The authors of the present paper, however, mostly based on morphology, favour the traditional treatment as *Hyacinthaceae*, in accordance with the DAHLGREN family concept (DAHLGREN & al. 1985).

The current taxonomy and systematics of subfamily *Urgineoideae* is very unsatisfying from genus to species level. There are two opposed tenden-

cies in the generic circumscription within the subfamily, which evolved during the last decades – the splitting and the lumping one. On the one hand SPETA and collaborators mostly support a narrow generic concept (SPETA 1998a, b, PFOSSER & SPETA 2001), in which the subfamily comprises some 20 genera (excluding *Igidia* SPETA 1998a: 70, according to WETSCHNIG & al. 2007). On the other hand, extremely contrary to this concept, GOLDBLATT & al. 2000 and MANNING & al. 2002, 2004 have reduced the subfamily gradually to only two genera, the nearly monotypic *Bowiea* HARV. ex HOOK.f. 1867: t. 5619 and the extremely heterogenous *Drimia* JACQ. 1796: 38, the latter including a number of clades with very different morphology.

Following the most recent phylogenetic analyses in *Urgineoideae* (PFOSSER & SPETA 2001, 2004, MANNING & al. 2004, PFOSSER & al. 2012) it is clear that some of these genera are monophyletic, whereas some others are still para- or polyphyletic. A similar controversy regarding generic circumscriptions has been shown in subfamily *Ornithogaloideae* (MANNING & al. 2004, 2009, MARTÍNEZ-AZORÍN & al. 2011). However, the study presented by MARTÍNEZ-AZORÍN & al. 2011 for *Ornithogaloideae* evidenced that when sufficient plastid and nuclear DNA regions are included, clades that are well supported by phylogenetic analyses are also based on clear syndromes of morphological characters. Similar results are expected for *Urgineoideae* when sufficient phylogenetic and biogeographic data are reached, which is in the focus of our current research.

*Tenicroa* RAF. 1837: 52 is a small genus distributed in South Africa and southern Namibia (OBERMEYER 1980, SPETA 1998a, b), with a very turbulent history. Unlike many other genera, species of *Tenicroa* have been placed by time in 8 different genera: *Anthericum* L. 1753: 310, *Albuca* L. 1762: 438, *Drimia*, *Ornithogalum* L. 1753: 306, *Phalangium* MILL. 1754: 248, *Pilasia* RAF. 1837: 53, *Sypharissa* SALISB. 1866: 37 and *Urginea* STEINH. 1834: 322.

Currently five species are accepted within this genus: *T. exuviata* (JACQ. 1796: 89) SPETA 1980: 195, *T. filifolia* (JACQ. 1796: 93) OBERM. 1981: 577, *T. fragrans* (JACQ. 1797: 45) RAF. 1837:53, *T. multifolia* (G. J. LEWIS 1952: 9) OBERM. 1981: 577 and *T. nana* SNIJMAN 1985: 284 (SPETA 1998a, b).

Due to its intricate history, most of these species have an extensive synonymy (revision in prep. by PINTER & al.). Four of these species fit well into the recent concept of the genus, whereas *T. nana* considerably differs in flower (Fig. 1 A, B) and seed morphological characters (Fig. 2) and above all in bulb characters (Fig. 1 C – H). Furthermore, phylogenetic analyses (Fig. 4) clearly separate *T. nana* from the other species in the genus (MANNING & al. 2004, GASPERL 2009, PFOSSER & al. 2012).

*Tenicroa nana* differs strongly in seed morphology (Fig. 2) from all other species of *Tenicroa*, as noted by LUIDOLD 2010 and ILG 2010. The seeds show moderate resemblance to the seed morphology of the *Rhadamanthus platyphyllus* group. The relationship of *T. nana* and the *R. platyphyllus* group is well supported by our phylogeny (Fig. 4).

Due to the clear differences of *T. nana* with regards to morphological characters, as well as phylogenetic results (Fig. 4), we here describe a new genus to accommodate this remarkable South African species.

## 2. Material and Methods

The species and specimens examined in the phylogenetic study are listed in Tab. 1. Furthermore, living plants from the collections of U. & D. MÜLLER-DOBLIES and E. G. OLIVER (see 3.2.) were used for the morphological investigations. Herbarium specimens of *Mucinaea nana* are listed at the end of section 3.2.

The quarter – degree squares are used as detailed in LEISTNER & MORRIS 1976.

Hand-sections of the bulbs were made and stained with toluidine.

Examination of seed morphology was conducted on fully developed, dry seeds. Weight and size (arithmetic means) were taken from at least 20 seeds. Dried seeds were mounted on aluminium stubs and coated with gold in an Agar sputter coater. Electron micrographs were obtained with a Philips XL 30 ESEM scanning electron microscope (SEM) operating at 20 kV. Seeds were oriented with the micropylar pole pointing left. Lateral views were oriented with the raphe facing upwards. Specimens from the following herbaria have been examined: GZU, NBG, PRE (acronyms according to THIERS 2013). Authornames of the cited taxa follow IPNI 2013.

DNA was extracted from leaf tissue using either the DNeasy Plant Mini Kit (Qiagen, Valencia, California, USA) or the CTAB method (DOYLE & DOYLE 1987) with modifications (PFOSSER & al. 2006). The plastidal *trnC<sup>GCA</sup>-ycf6* intergenic region was sequenced for this study. Primers used for amplification were *trnC<sup>GCA</sup>F* (CCA GTT CRA ATC YGG GTG) (modified from DEMESURE & al. 1995) and *ycf6R* (GCC CAA GCR AGA CTT ACT ATA TCC AT) (SHAW & al. 2005) using standard thermal cycling conditions (95°C, 5 min; 35 cycles of 94°C, 20 sec; 50°C, 30 sec; 72°C, 1 min; final extension at 72°C, 10 min). PCR was performed using Hybaid thermal cyclers in 20 µL volumes with the following reaction components: 2 µL template DNA (10–100 ng), 2X DreamTaq ReadyMix PCR reaction mix (Fermentas) and 0.1 µmol/L each primer. Amplified doublestranded DNA fragments were purified with Exonuclease I and Shrimp alkaline phosphatase (Fermentas) following the protocol of the manufacturer to remove unincorporated nucleotides and excess primers prior to sequencing. Dideoxy sequencing was performed using purified PCR fragments following the DYEnamicET cycle sequencing protocol (General Healthcare, USA). Both strands were sequenced using the same primers as for amplification. Separation of fragments and base calling was performed on a MegaBace 500 automated sequencer (General Healthcare, USA). On average, less than 1% of data matrix cells were scored as missing data.

Indels in the data matrix were coded as additional characters, and tree searches were performed using the nucleotide data together with the indel data. Phylogenetic analysis using the maximum parsimony (MP) method were performed with PAUP\* version 4.0b10 (SWOFFORD 2000). MP analyses were performed either without or with successive character weighting (rescaled consistency index) until tree lengths remained the same in two successive rounds. Most parsimonious trees were obtained by 1000 replicates of random sequence addition using tree bisection-reconnection (TBR) branch swapping under the Fitch criterion (FITCH 1971). Ten thou-

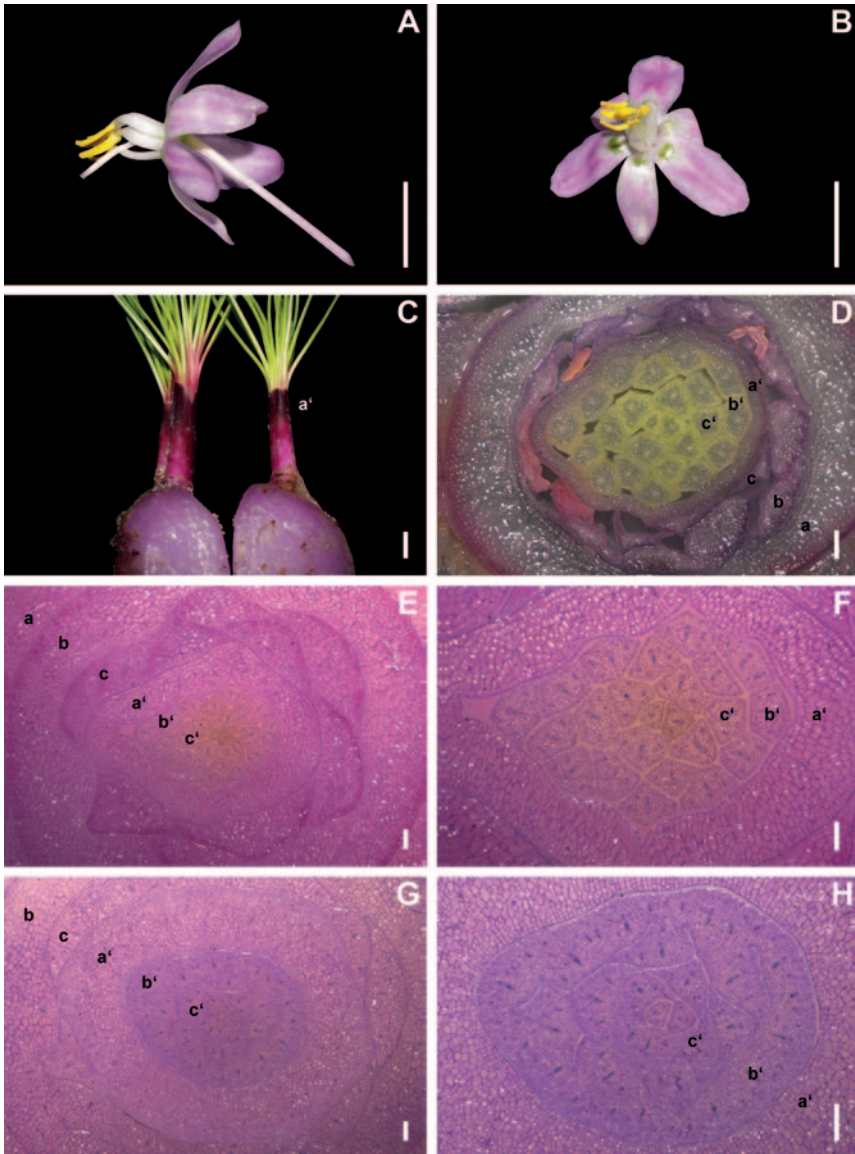


Fig. 1. Flower and non-flowering bulb of *Mucinaea nana* (SNIJMAN) M. PINTER & al. – A Flower lateral view showing the nearly always strongly reflexed, purplish-pink tepals. – B Flower frontal view showing the distinctive basal floral markings. – C. Bulb with the amplexicaulous sheathing cataphyll (a'). – D – H Cross-sections of the bulb: D uppermost part general view. – E central part general view. – F central part detailed view. – G basal part general view. – H basal part detailed view. a & a'. Amplexicaulous sheathing cataphyll. b & b'. Gamophyllous second sheath compound of about ten foliage leaves. c & c'. about ten free foliage leaves. a – c previous season. a' – c' present season. – C, D natural colour – E, F, G, H stained with toluidine – Scale bars A – C = 0.5 cm, D – H = 0.5 mm.



sand fast bootstrap replicates (FELSENSTEIN 1985) were used to assess confidence limits for the resulting tree topologies.

### 3. Results and Discussion

#### 3.1. Differences between *Tenicroa nana* and other *Tenicroa* species

*Tenicroa nana* is easily distinguishable from all other *Tenicroa*-species by the bright purplish-pink tepals (Fig. 1A, B) and by the presence of an amplexicaulous sheathing cataphyll without raised transverse ribs, enclosing the leaf bases (Fig. 1C). The basal green tepal marking surrounded by a white ring (Fig. 1B) is unique within all other members of the *Urgineoideae* and even within all *Hyacinthaceae*.

The protologue emphasizes another character: "*Tenicroa nana* also has strongly reflexed tepals, in contrast to the spreading tepals of the other *Tenicroa* species." (SNIJMAN 1985: 286). At least in some species of *Tenicroa* the tepals can also be strongly reflexed (perhaps depending on the age of the flower or on the temperature) and on the other hand the tepals of *T. nana* can also be just spreading, at least in the greenhouse on the northern hemisphere. Thus, SNIJMAN's sentence needs to be modified: "*Tenicroa nana* has nearly always strongly reflexed tepals, in contrast to the spreading to slightly reflexed, only occasionally strongly reflexed tepals of the other *Tenicroa* species." Thus, there remains little of this distinguishing character and we better do not emphasize it. Strongly reflexed tepals may only help as a first hint, but in any case they are useless as a generic character.

Inside the amplexicaulous cataphyll (Fig 1C, Da', Ea', Fa', Ga', Ha') there is a gamophyllous second sheath, consisting of the bases of about 10 non-amplexicaulous foliage leaves, a structure which is unique in *Hyacinthaceae* and not known from any other bulb (Fig. 1Gb', Hb'). SPETA also dissected bulbs of *T. nana* (SPETA 1998a: 78–80), described the structure correctly and he recognized its outstanding character; apparently he has not seen bulbs of any other *Tenicroa* species.

In the protologue the leaves of *T. nana* are described as "hysteranthous or present at flowering" or "hysterantha vel synantha" respectively in the Latin description (SNIJMAN 1985: 284–285), whereas the respective character state of the leaves in the other *Tenicroa* species is not even mentioned. Also other authors scarcely paid attention to the time correlation of leaves and flowers in the other *Tenicroa* species, e. g. in Flora Capensis the leaves of *Urginea fragrans* are called "contemporary with the flowers" (BAKER 1897: 465), but this character state is omitted in the two following species *U. filifolia* and *U. exuviata*. In fact, however, leaves contemporary with the flowers are a valid character state for all other *Tenicroa* species, and are a difference with a lot of genera in *Urgineoideae*. Thus, we can state, that there is a further difference between *T. nana* and the other *Tenicroa* species: leaves hysteranthous or present at flowering time in *T. nana* versus leaves present at flower-



Table 1. List of taxa examined in the phylogenetic study, with voucher and locality information. All vouchers are deposited at LI (Herbarium Biocenter of the Upper Austrian Museums). Abbreviations: WW = Wolfgang WETSCHNIG, ZAF = South Africa

| Taxon   | Voucher | Locality              |
|---|---------|-----------------------|
| <i>Mucinaea nana</i> (SNIJMAN) M.PINTER & al.   | WW02608 | ZAF: Rooiberg         |
|   | WW02609 | ZAF: Rooiberg         |
| <i>Tenicroa exuviata</i> (JACQ.) SPETA          | WW03917 | ZAF: Hantam B.G.      |
| <i>Tenicroa filifolia</i> (JACQ.) OBERM.        | WW03916 | ZAF: SW of Bredasdorp |
| <i>Tenicroa fragrans</i> RAF.                   | WW03911 | ZAF: Namaqua N.P.     |
|   | WW03913 | ZAF: NW of Darling    |
|   | WW03914 | ZAF: SE of Darling    |
|   | WW03915 | ZAF: Jonkershoek      |
| <i>Tenicroa multifolia</i> (G. J. LEWIS) OBERM. | WW03920 | ZAF: Koring           |
| <i>Tenicroa</i> spec.                           | WW03918 | ZAF: Potberg          |
|   | WW03922 | ZAF: Koring           |

ing time in all other *Tenicroa* species. Behind this rather tiny difference, however, a rather important difference is hidden: In all other *Tenicroa* species the leaves present at flowering belong to the flowering shoot generation, whereas in *T. nana* they belong to the following shoot generation. In other words: In all other *Tenicroa* species the inflorescence is concordant with its preceding leaves, whereas in *T. nana* the leaves of the flowering shoot generation are already long ago withered before the inflorescence starts to emerge and the leaves which appear after the inflorescence or even already with it belong to the following shoot generation = the innovation shoot.

As a result we have to distinguish two characters from SNIJMAN's wording for *T. nana*: "Leaves hysteranthous or present at flowering"

1° Leaves contemporary with the flowers or not and 2° Inflorescence cataleptic as compared with all other *Tenicroa* species 1° Leaves contemporary with the flowers and 2° Inflorescence concordant (with the leaves).

As a final statement SNIJMAN furthermore noted: "The addition of this new species to the genus does not alter the apparent naturalness of the grouping." This is a surprising statement in comparison with the characters mentioned above, and furthermore it is clearly not supported by our current molecular results (Fig. 4) and those published by other authors (MANNING & al. 2004, GASPERL 2009, PFOSSER & al. 2012). *T. nana* forms a well supported (bootstrap-value 100) monophyletic branch in our phylogenetic tree (see chapter 3.3). All these facts suggest that this species merits recognition as a new genus.

3.2. Taxonomic Treatment

*Mucinaea* M. PINTER, MART.-AZORÍN, U. MÜLL.-DOBLIES, D. MÜLL.-DOBLIES, PFOSSER & WETSCHNIG, genus novum (Fig. 1, 2)

Diagnosis: *Mucinaea* ab omnibus ceteris Hyacinthaceis praesentia vaginulae secundae singularis quasi pseudocataphylli distincte differt. Hoc pseudocataphyllum structura gamophylla a circa 10 foliorum basibus composita est.

Insuper *Mucinaea* ab omnibus ceteris Tenicroidis (quarum folia adulta semper non-amplexicaulia) praesentia cataphylli amplexicaulis laevisque (i.e. haud costis transversalibus instructis) recedit et demum tepalis fere semper valde reflexis, purpurascensibus et basaliter signis viridibus albisque ornatis et filamentis applanatis (non filiformibus) differt. Genus monotypicum pro specie *Mucinaea nana* (Fig. 1, 2).

Typus generis: *Mucinaea nana* (SNIJMAN) M. PINTER, MART.-AZORÍN, U. MÜLL.-DOBLIES, D. MÜLL.-DOBLIES, PFOSSER & WETSCHNIG comb. nova

Basionym: *Tenicroa nana* SNIJMAN in South African Journal of Botany 51: 284 (1985). — Type: SOUTH AFRICA. Northern Cape Province, 3018 AC: South slopes of ridge below north slopes of Rooiberg, Kamiesberg, D. A. SNIJMAN 292 (holotype NBG photo!, isotypes PRE photo!, K).

= *Drimia nana* (SNIJMAN) J. C. MANNING & GOLDBLATT in Bothalia 33: 111 (2003).

Eponymy: The name *Mucinaea* honours Prof. Ladislav MUCINA, a renowned botanist, who was born 28 May 1956 in Piešťany (Slovakia, formerly Czechoslovakia) for his valuable investigations on the flora and vegetation of South Africa.

Descriptio generico-specifica: Bulbus globosus. Folia numerosa, a basi carnosa, filiformia, glabra, suberecta, hysterantha. Cataphyllum amplexicaule partes basales foliorum includens. In cataphyllo amplexicauli pseudocataphyllum gamophyllum a circa 10 foliorum basibus composita inclusum est. Scapus porphyreus, simplex, erectus. Bracteeae 1.0–1.5 mm longae, ovato-triangularae, acutae, brevicaratae. Bracteolae nullae. Perigonium siccum in fructu pillei modo instructum. Tepala 6, libera, reflexa, purpureo-rosea, in parte basali signis nitentibus viridibus et albidis. Filamenta albida, stria vinacea transversali ornata, applanata, ovarium cingentia, supra ovarium simul deflexa et ad antheras convergentia vel fasciculata. Antherae, flavae, basifixae, rimis longitudinalibus ab apice dehiscentes. Ovarium ovoid-eum, pallide viride. Stylus albus, semper infra antheras declinatus, e fasciculo filamentorum lateraliter protrudens. Capsula ovoidea, trilocularis, loculicida. Semina parva, ellipsoidea ad ovata, aureo-brunnea, reticulata.

Description: Bulb gregarious, globose to laterally compressed, inner leaf bases of each shoot generation narrow, semiterete, with a purplish bulb flesh. Sheathing cataphyll forming a short cylindrical neck, 12–50 mm long, white, brown at the upper part, as far as it is exposed to the sun. The about

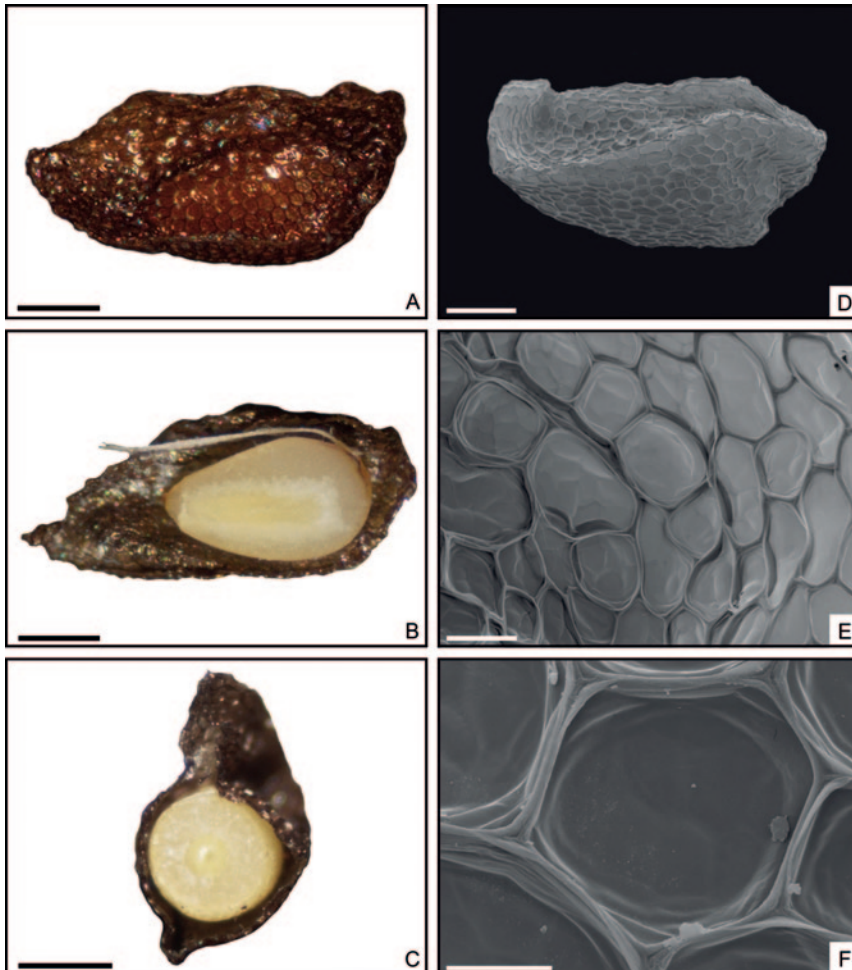


Fig. 2. Photographs and scanning electron micrographs of seeds of *Mucinaea nana* (SNIJMAN) M. PINTER & al. – A, D lateral views, B longitudinal section. – C cross section. – E cell aggregate. – F single cell. – Scale bars: A – D = 500  $\mu\text{m}$ , E = 100  $\mu\text{m}$ , F = 50  $\mu\text{m}$ .

10 outer leaf bases form a second gamophyllous sheath, a unique structure in *Hyacinthaceae*. Leaves numerous, about 20, suberect to spreading, filiform, 50–100 mm long, glabrous, hysteranthous. Scape brownish-red, simple, erect. Bracts short-spurred, ovate-triangular, acute. Bracteoles lacking. Perianth persistent in fruit on top of the capsule. Tepals 6, free, (6–)7.5–8.0(–11)  $\times$  2.0–3.5 mm, usually strongly reflexed, occ. scarcely so, purplish-pink, with basal green, shiny tepal markings surrounded by a white ring. Filaments stout, flattened, declinate, rather suddenly contracted to a terete

upper part, white occ. with a purplish transverse band in the middle of the flattened part, deflexed downwards above the ovary, convergent to fasciculate towards the anthers. Anthers in a fascicle, yellow, basifixed, dehiscent by longitudinal slits starting from the apex. Ovary ovoid, pale-green. *Style* white, declinate, protruding laterally from the fascicle of filaments below the anthers (enantiostyly). Capsule ovoid, trilobulate, loculicidal. Perianth persistent in fruit on top of the capsule. Seeds small,  $2.41 \times 1.11$  mm, ellipsoid to reniform, dark golden-brown, surface reticulate.

*Mucinaea* differs from *Tenicroa* by the purplish-pink tepals, with green and white basal markings, the flattened (for most of their length not terete) filaments, mainly by a rather unique leaf sequence in *Hyacinthaceae*, with two different sheaths surrounding the foliage leaves, namely an amplexicaulous sheathing cataphyll without the raised transverse ribs so characteristic of *Tenicroa* cataphylls, and a second amplexicaulous gamophyllous sheath compound of about ten foliage leaves, preceding the about ten following free foliage leaves, as well as by the separated position within the molecular phylogeny. One species, *Mucinaea nana*. (Fig. 1, 2).

**Distribution:** To date *M. nana* is only known from three quarter - degree squares in the Northern Cape Province of South Africa – from the Rooiberg in the Kamiesberg Range and the Kourkammaberg (Fig. 3).

**Ecology and biogeography:** It grows in seasonally moist sandy patches in the lee of granite domes and boulders, and on shady mossy ledges. It falls within the Fynbos Biome, namely in the Kamiesberg Granite Fynbos (MUCINA & RUTHERFORD 2006), in the winter rainfall area with an annual precipitation of 240–450 mm.

**Seed morphology:** Seed morphological data have been evaluated for *Mucinaea nana* (Fig. 2 A-F) in this study.

**Weight:** 0.0004 g. **Length/width/height:** 2.41/1.11/1.12 mm. Seeds of *M. nana* are oblong-lanceolate in shape in lateral view (Fig. 2 A), and circular with two wings in cross-section (Fig. 2 C), partially matching the shape of the endosperm. The area in lateral view is  $2.06 \text{ mm}^2$  whereas in cross section is  $0.67 \text{ mm}^2$ . The testa is loose, brownish and the surface is shining. The raphe and hilum are isochromatic than the testa. The endosperm is ovoid in longitudinal section (Fig. 2 B), and circular in cross section (Fig. 2 C). It is 1.25 mm long, 0.64 mm wide and 0.75 mm in height. The area in longitudinal section is  $0.69 \text{ mm}^2$ , and in cross section  $0.31 \text{ mm}^2$ . The proportion between the height of the endosperm and its width is 0.98, the proportion between the area of cross section of the endosperm and the area of cross section of the seed is 0.46. The embryo (Fig. 2 B, C) is straight, and is 0.85 mm long, 0.64 mm wide and 0.17 mm in height. The area in longitudinal section is  $0.13 \text{ mm}^2$ , in cross section it is  $0.04 \text{ mm}^2$ . The proportion between the height of the embryo and its width is 0.68, the proportion between the area of longitudinal section of the embryo and the area of longitudinal section of the endosperm is 0.19 and the proportion between cross section of embryo- and endosperm is 0.13.

In the electron micrographs (Fig. 2 D-F) the raphe is not perceptible and there are no stomata on the surface. The following character-states are homogenous all over the whole testa. The isodiametric cells have an area of  $12167 \mu\text{m}^2$ , and a perimeter of  $420.2 \mu\text{m}$ . The anticlinal cell walls are straight or curved and the relief of the anticlinal cell borders is heavily raised. No waxes or other tertiary structures were detected.

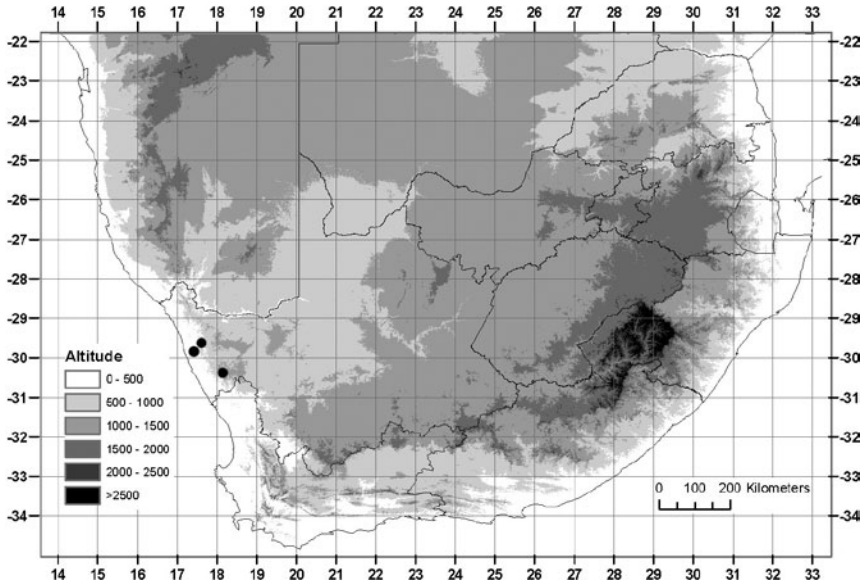


Fig. 3. Distribution map of *Mucinaea nana* (SNIJMAN) M. PINTER & al. in the Northern Cape Province, South Africa.

Compared with other species of *Tenicroa* s. str. the character states of seed morphology are highly different (see ILG 2010, and LUIDOLD 2010). LUIDOLD 2010 noted a potential relationship between *M. nana* and *Rhadamanthus platyphyllus* B. NORD. 1970: 172 based on seed similarities, whereas ILG 2010 stated that *M. nana* is closer to *R. convallarioides* SALISB. 1866: 37. A seed-morphological study including *Mucinaea*, *Rhadamanthus* SALISB. 1866: 37 and *Tenicroa* is in preparation (PINTER & al. in prep.).

Material studied: SOUTH AFRICA. Northern Cape Province:

2917 CD (Springbok): Kourkammaberg, SE slopes, steep, quartzitic derived soil, in partial shade of boulders, very localised, 24.04.2001 veg., fl. ex hort. NBG 15.11.2001, D. A. SNIJMAN 1804 (NBG).

2917 DA (Springbok): Ezels Fontein ca. 14 miles from Springbok on Spektakel road, Namaqualand, flat rocks along river, 10.11.1962, B. NORDENSTAM 1881 (NBG) [grid no 2917 CA on the label, but locality is in 2917 DA]

3018 AC (Kamiesberg): Western slopes of Rusbospoort. On the farm Damsland, foot of the Rooiberg, Kamiesberg, leaves ex hort 03.06.1980, fl. ex hort 21.01.1981, H. HALL 4931 (NBG). – South slopes of ridge below north slopes of Rooiberg, Kamiesberg, Growing on shady mossy ledges, fl. ex hort 26.11.1980, bulbs 10.06.1980, D.A. SNIJMAN 292 (holotype NBG, isotype PRE). – Namaqualand, Kamiesberge, on slopes of the Rooiberg near Garies, 1300 m, s. d., ex cult. E. G. H. OLIVER s. n. (GZU) [grid no 2917 DA on the label, but the locus classicus is in 3018 AC]. – Namaqualand, Kamiesberge, on slopes of the Rooiberg near Garies, 1300 m, 15.12.2007 ex cult. E. G. H. OLIVER s. n. (GZU) [grid no 2917 DA on the label, but the locus classicus is in 3018 AC]. – Farm Welkom, NE of Stalberg, along rocky stream bed with waterfall, ca. 1100 m, 15.12.1990, U. & D. MÜLLER-DOBLIES & E. G. H. OLIVER 90107j, fl. ex cult. BTU 8470 (B, BTU, GRA, K, LD, LI, M, S, UPS). – SE of Rooiberg, W-facing slope of stream SE of Rooiberg, fynbos slope, ca. 1300 m, 15.12.1990 U. & D. MÜLLER-DOBLIES & E. G. H. OLIVER 90110c, fl. ex cult. BTU8484 (B, BTU, GRA, K, LI, M, S, Z). – SE of Rooiberg, stream SE of Rooiberg, stream-bed, ca. 1300 m, 15.12.1990, U. & D. MÜLLER-DOBLIES & E. G. H. OLIVER 90111a, fl. ex cult. BTU8486 (B, BTU, GRA, K, LD, LI, M, S, UPS, Z).

### 3.3. Phylogeny

Although our phylogeny (Fig. 4) is somewhat preliminary, it shows, that all related genera form well supported clades (bootstrap values 80–100). *Mucinaea nana* is retrieved as sister clade to the *Rhadamanthus platyphyllus*-group, which is consistent with their similar seed morphology. In some previously published phylogenies (MANNING & al. 2004, GASPERL 2009, PFOSSER & al. 2012) the separation of *M. nana* is very well perceptible within the trees. MANNING & al. 2004 stated "... *Tenicroa* RAF. is paraphyletic unless *T. nana* SNIJMAN is segregated as a monotypic genus ...", but later reversed themselves, favouring a much broader generic concept. Whereas MANNING & al. 2004 presented a tree for the combined *trnL-F* and *rbcL* matrix, GASPERL 2009 showed two separated trees, using the *trnL-F* and the *ycf6* matrix. Similarly, PFOSSER & al. 2012 also showed trees from the *ycf6* matrix. Nonetheless, all those different phylogenies, which are based on several different DNA regions, demonstrate the separation of *Mucinaea* from the other *Tenicroa*-species.

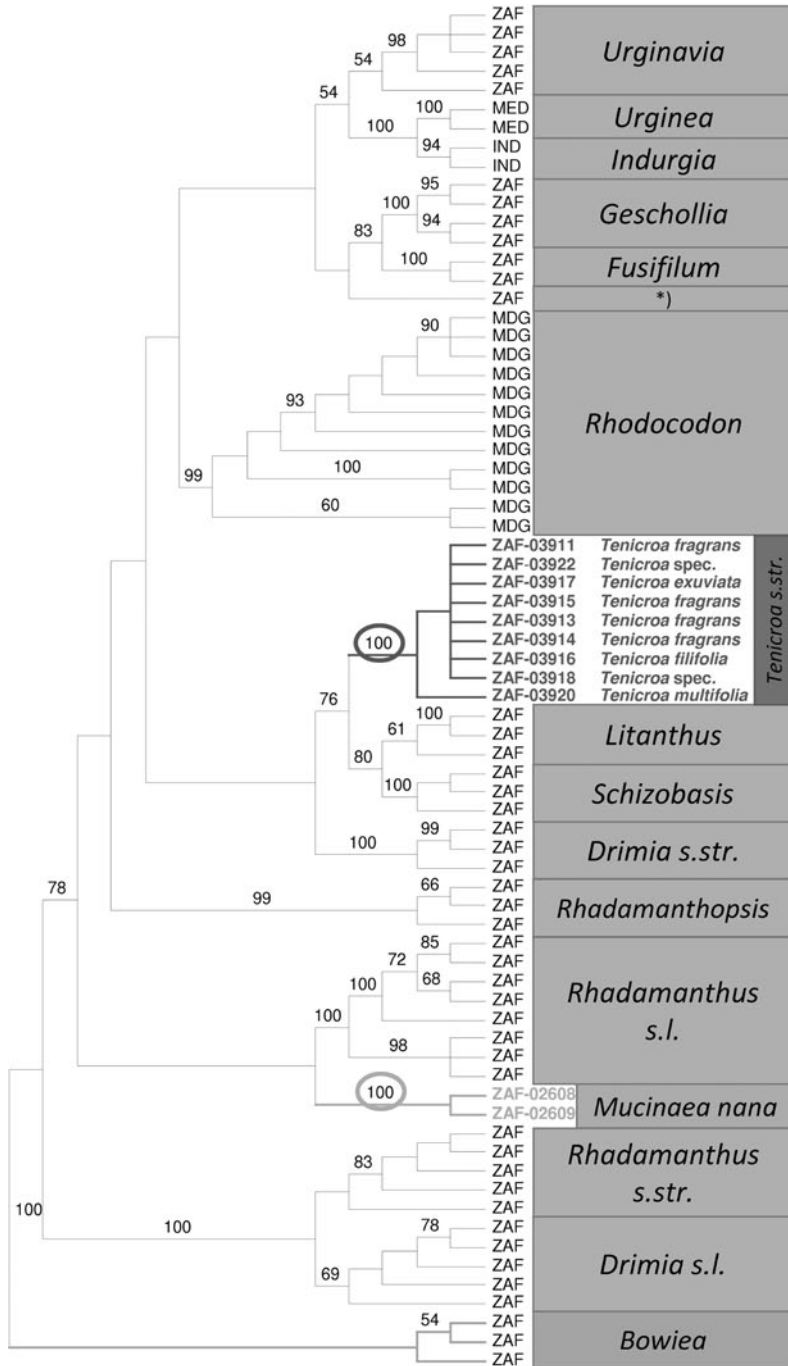
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Fig. 4. A majority-rule phylogenetic consensus tree (maximum parsimony) of members of the subfamily *Urgineoideae* is shown with bootstrap support values > 50 % (indicated above branches); outgroup: *Bowiea*, \*) sample from a sterile specimen, genus currently unknown.







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