



# Synopsis of the genus *Drosera* (Droseraceae) in Angola and the Democratic Republic of the Congo

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## Key words

Angola  
Democratic Republic of the Congo  
distribution  
*Drosera*  
identification key  
taxonomy

**Abstract** While some African Floras were continuously revised and several are now almost completed, the Flora of Angola's 'Conspectus Florae Angolensis' still remains incomplete. This applies also for *Droseraceae* and the genus *Drosera*. Our study aims to provide an identification key for *Drosera* of Angola and the Democratic Republic of the Congo, including all morphological characters of the different Angolan and Congolese taxa. Loans from different herbaria were studied. A list of important morphological characters was combined with data obtained by observations and measurements. Beside the identification key, nine species descriptions with drawings of the main characteristics, distribution maps and SEM-pictures of pollen and seed morphology are provided. The possibility of hybridisation is discussed. Despite difficulties such as varying morphology or hybridisation in some species, the identification key enables researchers to identify specimens by morphological characters.

**Citation:** Rjosk A, Neinhuis C, Monizi M, et al. 2022. Synopsis of the genus *Drosera* (Droseraceae) in Angola and the Democratic Republic of the Congo. *Blumea* 67 (1): 1–14. <https://doi.org/10.3767/blumea.2022.67.01.03>.  
Effectively published online: 10 January 2022.

## INTRODUCTION

Until a few years ago, the diversity of vascular plants in Angola had only been estimated (Figueiredo & Smith 2008). Whereas most African Floras are actively being worked upon to take them to completion if not already complete (e.g., the Flora of Central Africa), the Flora of Angola treated in the 'Conspectus Florae Angolensis' remains far from complete (Exell & Mendonça 1937, Figueiredo & Smith 2008). In the 19th and 20th century, several important collectors contributed to the botanical exploration of Angola: e.g., Friedrich Weltwitsch (1806–1872), Hugo Baum (1867–1950) and John Gossweiler (1873–1952) (Figueiredo et al. 2020). From the following years there are no bigger collections known due to the war of independence and the civil war in Angola (Kuder & Möhlig 1994, Figueiredo & Smith 2008). Nowadays most of the Angolan collections are kept in European herbaria, especially in Portugal, the former colonial power in Angola, but also in Great Britain, Germany, France and other countries (Figueiredo & Smith 2008). 'Plants of Angola', the first checklist for Angola, records over 6500 indigenous species. This can now be used as a basis for further research of plant diversity in Angola (Figueiredo & Smith 2008, Goyder & Gonçalves 2019). Currently there are botanical surveys in process in several areas in the provinces of Cabinda, Uíge, Lunda-Norte, Malanje, Cuanza-Sul, Huambo, Namibe, Huíla and Cuando Cubango (Goyder & Gonçalves 2019).

The Flora of the Democratic Republic of the Congo (DRC) is currently being completed. The botanical exploration of the DRC began in the 19th century with the Norwegian botanist Christen Smith (Tuckey & Smith 1818). A checklist summarizing the early exploration of botanical diversity of the Congo was published

in 1909 by Théophile Durand (1855–1912) and his daughter (Durand & Durand 1909, Sosef 2016). With Walter Robyns (1901–1986) and the INEAC (Institut National pour l'Étude Agronomique du Congo) the production of the Flore du Congo Belge et du Ruanda-Urundi started in 1942 and in the following years many volumes were published (Sosef 2016). After closure of the INEAC, the responsibility of the Flora was transferred to the Botanic Garden Meise (former National Botanic Garden of Belgium). Since the decision of the Botanic Garden Meise in 2010 to revitalize the Flora of Central Africa, which includes the DRC, all volumes published were made available online and families not treated so far are being added to the Flora (Sosef 2016).

The genus *Drosera* L. consists of c. 250 species and is part of the family *Droseraceae*, which is composed of three carnivorous genera: *Drosera*, *Dionaea* J.Ellis and *Aldrovanda* L. (Kubitzki & Bayer 2003, Ellison & Adamec 2018). These carnivorous herbs show an almost worldwide distribution, with diversity hot spots in Australia, South America and South Africa (Laundon 1978, Kubitzki & Bayer 2003, Spichiger et al. 2004, Ellison & Adamec 2018). On the African continent over 30 *Drosera* species can be found with about half of them occurring in South Africa and only a few species in northern tropical Africa (Rivadavia et al. 2003). According to the checklist (Figueiredo & Smith 2008) Angola has 7 native species: *Drosera affinis* Welw. ex Oliv., *D. bequaertii* Taton, *D. burkeana* Planch., *D. elongata* Exell & J.R.Laundon, *D. indica* L., *D. madagascariensis* DC. and *D. pilosa* Exell & J.R.Laundon. In the Democratic Republic of the Congo 8 species can be found according to the Flore du Congo Belge et du Ruanda-Urundi (Gilbert 1951): *D. bequaertii*, *D. burkeana*, *D. congolana* Taton, *D. flexicaulis* Welw. ex Oliv., *D. indica*, *D. insolita* Taton, *D. katangensis* Taton and *D. madagascariensis*.

The family *Droseraceae* is part of the *Caryophyllales* and its monophyly is well supported by molecular data as well as mor-

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phological synapomorphies and phytochemistry (Cuénoud et al. 2002, Rivadavia et al. 2003, Ellison & Adamec 2018). Within the family the genus *Drosera*, with its active adhesive traps, is placed basal to the other genera *Dionaea* and *Aldrovanda*, both using snap-traps as the trapping mechanism, which likely have evolved from adhesive traps (Rivadavia et al. 2003, Barthlott et al. 2004, Ellison & Adamec 2018). The monophyletic genus *Drosera* comprises four subgenera (*Drosera* L., *Ergaleium* (DC.) Diels, *Arcturia* (Planch.) Schlauer and *Regiae* Seine & Barthlott), which are divided into several sections (Seine & Barthlott 1994, Rivadavia et al. 2003, Ellison & Adamec 2018). The South African species *D. regia* Stephens, as the only species of subg. *Regiae*, shares several characteristics with *Dionaea* and *Aldrovanda* and is placed basal in the phylogenetic tree of the genus. The subg. *Ergaleium*, containing almost only Australian *Drosera* species, is sister to subg. *Drosera* in which Australian, Eurasian, American and African species are placed. The African *Drosera* species with the exception of *D. regia* (subg. *Regiae*) are part of the sections *Arachnopus* Planch. (one species) and *Ptycnostigma* Planch. (38 species) (Rivadavia et al. 2003, Ellison & Adamec 2018).

*Drosera* grows anchored in the substrate with stem, leaves and reproductive organs emergent, in swamps as well as in sandy, seasonally wet and low-nutrient habitats (Fig. 1b–c; Obermeyer 1970, Barthlott et al. 2004, Spichiger et al. 2004). The herbaceous plants show diverse growth habits including annual and perennial as well as tuber producing species (no tropical African species), and those producing dormant rosettes (no tropical African species) (Ellison & Adamec 2018). The

leaves of *Drosera* are covered with different types of long- and short-stalked glands (tentacles) as well as sessile glands on the leaf surface, which function as insect traps (Fig. 1a1–3). The stalked glands secrete an adhesive fluid attracting and trapping small insects, immobilising and digesting them (Kubitzki & Bayer 2003, Barthlott et al. 2004, Ellison & Adamec 2018). The tentacles around the trapped insect and/or the whole leaf bend towards the prey to increase the contact to the leaf. The glands on the leaf surface, as well as the stalked glands, are involved in the digestion of the insect by secreting enzymes like esterases, peroxidases and proteases to break down the insect into elements that can be absorbed by the plant (e.g., nitrogen, sodium, calcium, phosphorus, iron and magnesium; Barthlott et al. 2004). The leaves can be arranged in a rosette (acaulescent taxa) and/or alternately to spirally along the elongated stem (caulescent taxa; Fig. 1a5). The leaves vary in shape and size (e.g., linear, spatulate, oval; Fig. 1a1–3) but in the majority of the taxa the leaves are petiolate and bear stipules at the base of the leaf (Barthlott et al. 2004, Ellison & Adamec 2018). Leaves, stems and inflorescences are often covered with different types of hairs. The inflorescences of *Drosera* are mainly cymose, while some species form multiple cymes or reduced single-flowered inflorescences. The bisexual and pentamerous (in some taxa tetramerous) flowers are composed of 5 connate sepals, 5 petals, 5 stamens and the gynoecium composed of 2–5 fused carpels with 2–5 styles (Fig. 1a4). The pollen of *Drosera* is produced in tetrads, and the fruit is a capsule, containing numerous, small seeds (Laundon 1978, Kubitzki & Bayer 2003, Ellison & Adamec 2018).



**Fig. 1** Morphology (a) and habitat (b, c) of *Drosera* L. a. Leaf shapes, flower and growth habit of *Drosera* (modified from Gilbert 1951, Laundon 1978). The leaf shapes show a great diversity (1. *D. indica*, 2. *D. bequaertii*, 3. *D. burkeana*). The flower (4) is usually pentamerous. The genus shows caulescent and acaulescent taxa (5. growth habit of *D. madagascariensis*); b–c. example of the habitat of *Drosera* in Angola. *Drosera* grows in swamps and seasonally wet habitats. — Photos by T. Lautenschläger.



In this work, the genus *Drosera* will be studied focusing on the taxonomy with the following objectives:

- taxonomic analysis and identification of herbarium specimens collected in Angola and the Democratic Republic of the Congo;
- assembly of all morphological characters of the different Angolan and Congolese taxa into species descriptions;
- creation of distribution maps of the different Angolan and Congolese taxa;
- creation of an identification key for the Angolan and Congolese species.

## MATERIALS AND METHODS

### Herbarium specimens

Herbarium specimens collected in Angola and DRC were loaned from the following herbaria: B, BR, COI, DR, FR, HBG, P and ZT (for abbreviations see Thiers continuously updated). Approximately 100 herbarium specimens were studied. In addition type specimens were located by using JSTOR Global Plants database (<http://plants.jstor.org/>) and GBIF (Global Diversity Information Facility, <https://www.gbif.org/>) and used for comparison of typical characteristics.

### Floras

To re-determine the borrowed herbarium specimens and to assemble a list of important morphological characters plus character states of the Angolan and Congolese species of *Drosera* identification keys and species entries were selected from the following Floras: Conspectus Florae Angolensis (Laundon 1970), Flora of Southern Africa (Obermeyer 1970), Flora of Tropical Africa (Oliver 1871), Flora of Tropical East Africa (Laundon 1959), Flora of West Tropical Africa (Keay 1954), Flora Zambesiaca (Laundon 1978), Flore Analytique du Bénin (Akoègninou et al. 2006), Flore du Congo Belge et du Ruanda-Urundi / Flore d'Afrique Centrale (Gilbert 1951), Flore du Rwanda (Troupin 1978), Upland Kenya Wild Flowers (Agnew & Agnew 1994).

### Taxonomy

For the revision of each taxon, descriptions of the above mentioned Floras were combined with observations and measurements of the herbarium specimens following standard herbarium techniques (De Vogel 1987). Measurements were performed on dry herbarium material. First species descriptions of the different Floras were assembled into one description per species containing all information of the Floras. Synonyms and accepted/unresolved taxa were retrieved from the following websites and literature: Tropicos.org, WCSP (World Checklist of Selected Plant Families) and Klopffer et al. (2006).

To assemble an identification key for the genus the species descriptions were scanned for usable diagnostic character states. Drawings were made based on herbarium specimens for each species.

### Distribution maps

Distribution maps were created using the software GIMP (GNU Image Manipulation Program, v. 2.8, <http://www.gimp.org/>). For the distribution of the different species in Africa, data of the above-mentioned Floras and borrowed herbarium specimens was combined with information of the following databases: GBIF, IPNI (International Plant Names Index, <https://www.ipni.org/>); Plants of the World online (POWO 2021) (<http://www.plantsoftheworldonline.org/>); WCSP (World Checklist of

Selected Plant Families, <https://wcsp.science.kew.org/>); African Plant Database (v. 3.4.0, <https://www.ville-ge.ch/musinfo/bd/cjb/africa/recherche.php>).

Furthermore, province maps of Angola and the DRC were created for each species containing the collection location of all examined herbarium specimens. Additional geographical information was retrieved from GeoNames (Wick & Boutreux 2019).

### Scanning electron microscopy

Pollen and seed morphology of *Drosera* were studied by scanning electron microscopy (SEM). One stamen was removed from one specimen per species and fixed on the sample holder followed by the removal of pollen from the pollen sacs using a pair of tweezers. The samples were sputter-coated with gold (Emitech K 550, Quorum Technologies Ltd., Laughton, United Kingdom) and examined using the Supra 40 CP-31-79 scanning electron microscope and corresponding Smart SEM software (Carl Zeiss, Oberkochen, Germany).

## RESULTS / TAXONOMIC PART

### *Drosera* L. — Fig. 2

*Drosera* L. (1753) 281; Keay (1954) 120; Oberm. (1970) 189; J.R.Laundon (1978) 64; Kubitzki & C.Bayer (2003) 201; A.M.Ellison & Adamec (2018) 50. — Type: *D. rotundifolia* L.

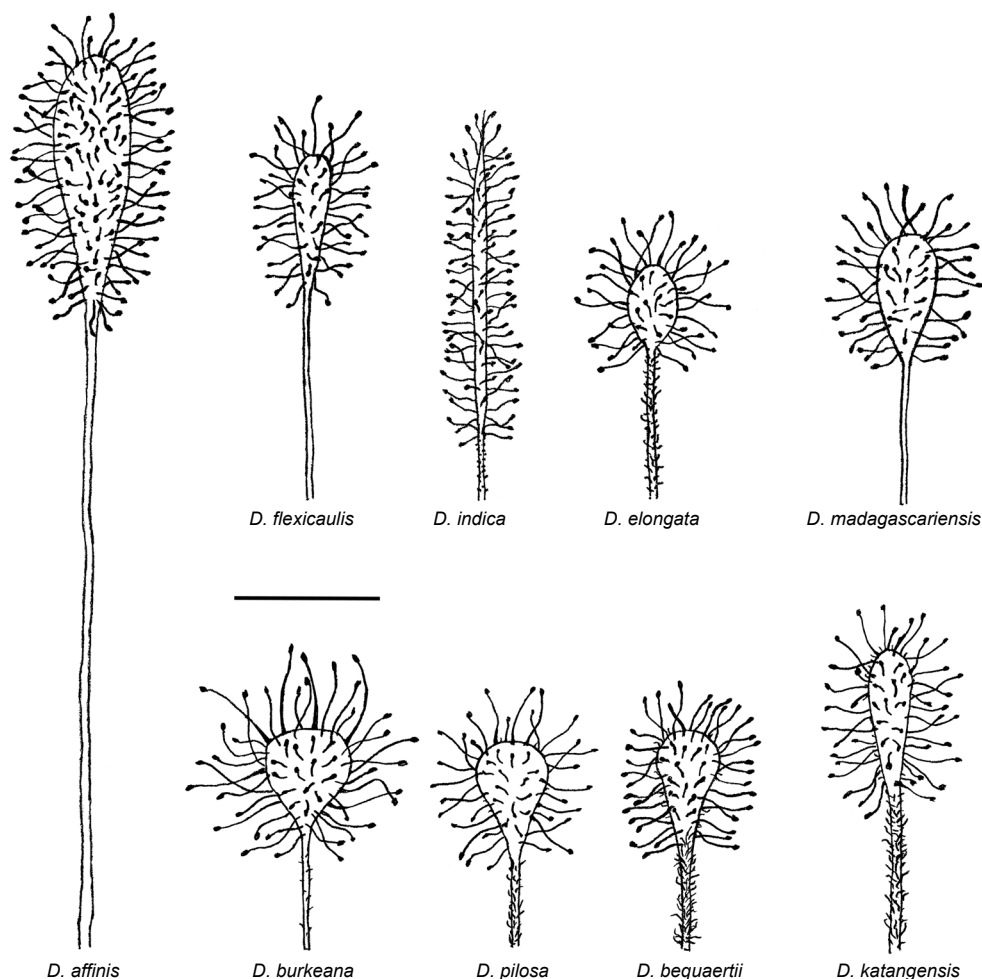
Carnivorous, annual or perennial herbs. *Stems* caulescent or acaulescent. *Leaves* simple, in a basal rosette or alternate to spirally arranged along the stem; stipules present or absent, membranous, often lacerated; petiole present or confluent with lamina; lamina variously shaped (Fig. 2), adaxial surface covered with short- and long-stalked glands (tentacles) and digestive glands that trap and digest insects. *Inflorescences* 1–many-flowered cymes, axillary or terminal, flowers bisexual. *Sepals* 5 (rarely 4–8); ± connate at the base. *Petals* 5 (rarely 4–8); free. *Stamens* 5 (rarely 4–8); free. *Pollen* in tetrads. *Pistil*: ovary (2–)3–5 carpels; styles (2–)3–5. *Fruit* a loculocidal capsule. *Seeds* small, numerous.

Distribution — Over 240 species, almost worldwide.

Habitat & Ecology — Swamps, sandy, seasonally and perennially wet and low-nutrient habitats.

### KEY TO THE ANGOLAN AND CONGOLESE *DROSERA* SPECIES

1. Stipules absent, lamina linear . . . . . 6. *D. indica*
1. Stipules present, lamina lanceolate, spathulate, obovate, ovate, elliptic, suborbicular or orbicular . . . . . 2
2. Acaulescent, leaves in a basal rosette, leaves horizontal . 3
2. Caulescent, including short stems (one to several cm long, rarely appearing acaulescent), young leaves erect, older leaves variable (erect, perpendicular to stem, reflexed) . . 5
3. Seeds fusiform, seed testa reticulate, peduncle strongly curved at the base, peduncle, pedicels and sepals glabrous, glandular or pilose, petals pink or purple. — Usually caulescent, rarely dwarf forms with suppressed stems . . . . . 8. *D. madagascariensis*
3. Seeds ovoid, seed testa smooth or reticulate, peduncle curved at the base, peduncle, pedicels and sepals glandular or pilose, petals pink to purple or white . . . . . 4
4. Petiole narrow, abruptly broadening into the suborbicular to spathulate lamina, peduncle, pedicels and sepals glandular, petals white or purple, seed testa reticulate . 3. *D. burkeana*
4. Petiole gradually broadening into the elliptic to obovate lamina, peduncle, pedicels and sepals usually pilose, petals pink to purple, seed testa smooth . . . . . 9. *D. pilosa*



**Fig. 2** Leaf shapes of Angolan and Congolese *Drosera* L. species. The leaf shapes of *Drosera* vary in lamina form, lamina size, petiole length and petiole hairiness. — Scale bar = 1 cm.

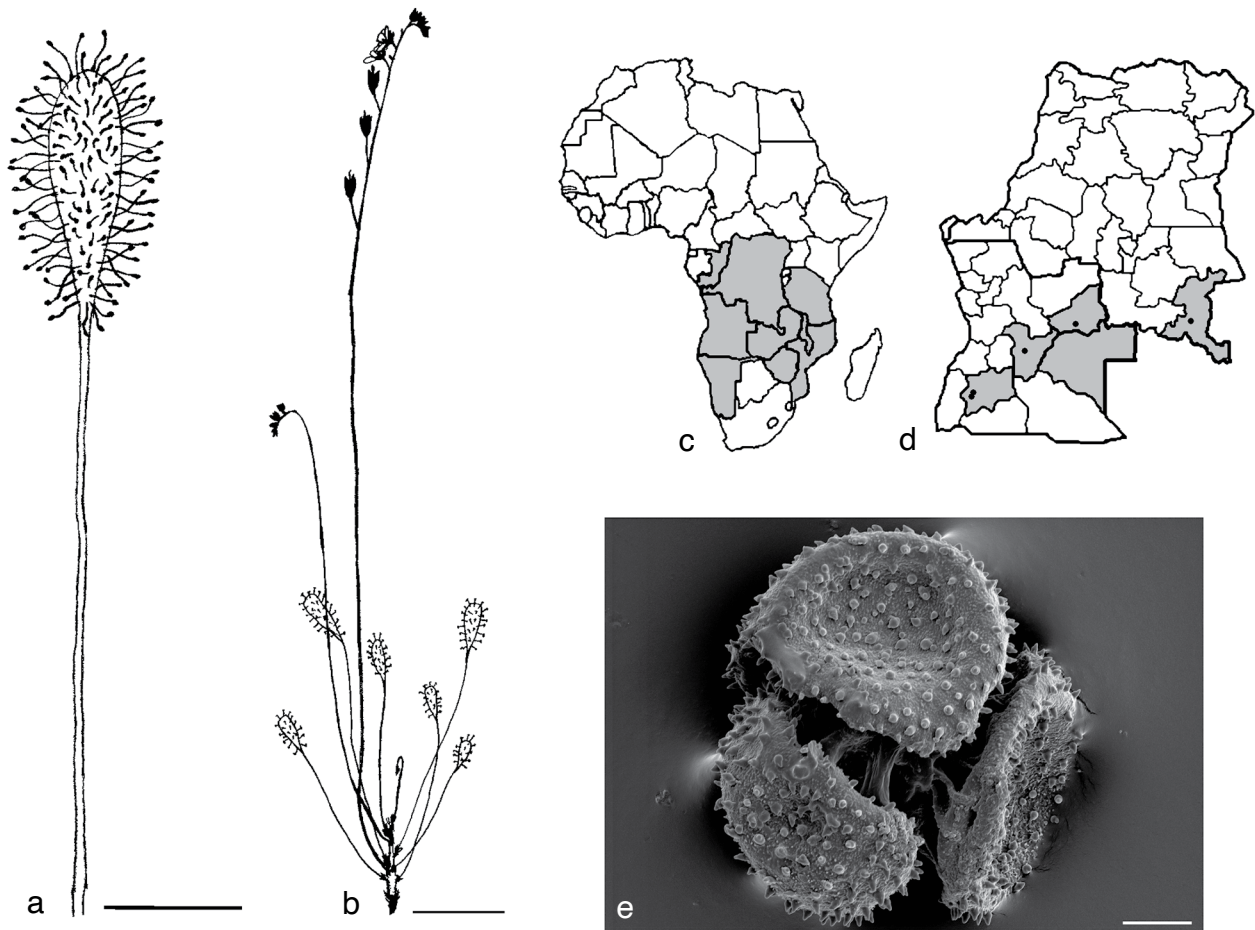
5. Peduncle arising apically, erect throughout its whole length, stem very short (c. 4 cm long), densely pilose, seeds sub-orbicular to ovoid . . . . . 2. *D. bequaertii*
5. Peduncle arising laterally, curved or erect at the base, then ascending, stem short to very long (up to 90 cm), glabrous, glandular or pilose, seeds fusiform . . . . . 6
6. Older (but still green) leaves reflexed towards the stem, old parts of the stem enclosed with old reflexed leaves, peduncle strongly curved at the base . . . . . 8. *D. madagascariensis*
6. Older (but still green) leaves held erect or  $\pm$  perpendicular to the stem (rarely reflexed), peduncle  $\pm$  curved at the base . . . . . 7
7. Stem up to 90 cm long, older (but still green) leaves perpendicular to stem, lamina obovate to elliptic, peduncle and petioles pilose or glandular-pilose . . . . . 4. *D. elongata*
7. Stem shorter (max. 25 cm long, sometimes longer), older (but still green) leaves  $\pm$  erect, lamina  $\pm$  spathulate, peduncles and petioles glabrous/sparsely pilose or densely pilose . . . . . 8
8. Peduncle and petioles densely pilose/hirsute, stem up to 15 cm long, densely glandular, lamina oblong-spathulate. — Only known from Katanga, DRC . . . . . 7. *D. katangensis*
8. Peduncle and petioles glabrous or sparsely pilose, stem short (up to 10 cm) or elongated (up to 25 cm), glabrous, lamina narrowly spathulate, spathulate or obovate . . . . . 9
9. Stem short (up to 10 cm), leaves closely arranged, petioles very slender and 3–7 cm long . . . . . 1. *D. affinis*
9. Stem elongated (up to 25 cm, sometimes longer), alternating between segments with evenly spaced leaves and segments with rosette-like clustered leaves, petioles max. 3.2 cm long . . . . . 5. *D. flexicaulis*

### 1. *Drosera affinis* Welw. ex Oliv. — Fig. 3

*Drosera affinis* Welw. ex Oliv. (1871) 402; Diels (1906) 88; J.R.Laundon (1959) 4; (1970) 27; (1978) 66; A.S.Rob. et al. (2017) 1318. — Type: F.M.J. Welwitsch 1183 (holo LISU), Angola, Distr. Huilla, Lopolo, Jan. 1860.

Perennial herb, caulescent. *Stems* mostly short, up to 10 cm high (Fig. 3b). *Leaves* up to 9 cm long (petiole and lamina), alternate to spirally arranged, clustered, densely arranged, mostly erect, old leaves reflexed; stipules 0.3–1 cm long, ferrugineous, apex lacerated; lamina narrowly spathulate or obovate, 1.5–3 by 0.2–0.5 cm, apex obtuse, gradually narrowing from the apex downwards, bearing tentacles adaxially and around the margins, glabrous or sparsely pilose abaxially (Fig. 3a); petiole 3–7 cm long (2–5 times as long as lamina), slender, glabrous or sparsely pilose. *Inflorescences* cymose, with 3–13 flowers; peduncles 1–3 together; 8–35 cm long, arising laterally from the stem, slightly curved at the base or erect, glabrous, canaliculate; bracts linear to elliptic, 3–5 mm long, caducous; pedicels 2–10 mm long, glabrous or sparsely pilose (sometimes glandular). *Sepals* 5, oblong to lanceolate, 3–7 by 1.5–2 mm, connate at the base, sparsely pilose. *Petals* 5, elliptic to obovate, 5–8 mm long, apex obtuse, pale pink to purple. *Stamens* 5, filaments c. 5 mm long and pink. *Pollen* in tetrads, yellow, tetrads c. 35–55  $\mu$ m diam, single grains c. 23–30  $\mu$ m diam, echinate (Fig. 3e), echini  $\pm$  conical, c. 2  $\mu$ m long, medium density of echini, short gemmate to clavate sculptural elements between echini. *Pistil*: ovary subglobose, glabrous; styles 3, c. 2.5 mm long, 2-partite to the base, arms filiform. *Seeds* fusiform, 0.7–0.9 by c. 0.2 mm, testa reticulate.

*Distribution* — Angola, Congo, DRC, Malawi, Mozambique, Namibia, Tanzania, Zambia, Zimbabwe (Fig. 3c).



**Fig. 3** *Drosera affinis* Welw. ex Oliv. a. Leaf shape showing the very long and slender, glabrous petiole and the narrowly obovate lamina; b. general morphology: short caulescent, spiral leaves and laterally arising, glabrous inflorescences; c. distribution (grey) according to the literature; d. province map of Angola and DRC with localities of examined herbarium specimens; e. pollen in tetrads with echinate, conical sculpture elements in medium density. — Scale bars: a = 1 cm; b = 2 cm; e = 10 µm.

**Habitat & Ecology** — Wet meadows, swamps, perennially wet places in seasonally dry wet-savannahs.

**Additional specimens** (see Fig. 3d for province map). ANGOLA, **Bié**, Camacupa, Cuemba, quedas, alt. 1200 m, 6 Oct. 1965, *Teixeira & Matos* 8995 (BR); **Huíla**, Huíla, Oct. 1898, *E. Dekindt* 466 (BR); Na margem do rio Nene, a montante da ponte, junto da Estrada de Huíla para Jau, 17 Dec. 1955, *E.J. Mendes* 1144 (COI); Sã da Bandeira, na subida para o miradouro da Tundavale, nos lugares encharcados, 13 Oct. 1969, *F. Murta & M. Silva* 799 (COI); **Lunda Sul**, Dala, margem do rio Chiumbe, 1927, *Carrisso & Mendonça* 564 (COI); Dala, rio Chiumbe, lugares húmidos, alt. 1200 m, 23 Apr. 1937, *A.W. Exell & F.A. Mendonça* 1087 (COI); **Moxico**, quedas de Dala, 17 Aug. 1965, *R. Mendes dos Santos* 1658 (COI). — DRC, **Haut-Katanga**, Kaziba, Terr. Manono, Parc national de le Upemba, alt. 1500 m, 16 Feb. 1948, *G.F. de Witte* 3383 (BR).

## 2. *Drosera bequaertii* Taton — Fig. 4

*Drosera bequaertii* Taton (1945a) 308; G.C.C. Gilbert (1951) 553; J.R. Laundon (1970) 27; (1978) 64; A.S. Rob. et al. (2017) 1334. — Type: *J. Bequaert* 476 (holo BR), DRC, 8 June 1912.

*Drosera compacta* Exell & J.R. Laundon (1955a) 44. — Type: *A.W. Exell & F.A. Mendonça* 1030 (holo COI), Angola, Lunda Sul, Rio Luachimo, entre Sila Henrique de Carvalho e Dala, 'Tenga', 24 Apr. 1937.

Perennial herb, shortly caulescent. **Stems** 3–4 (up to 7) cm long, 1–2.5 mm diam, densely pilose (Fig. 4b). **Leaves** alternate, clustered at the apex and erect, basally more widely spaced and more or less reflexed; stipules 2–4.5 mm long, membranous, ferruginous, lacerated at the apex; lamina obovate to spatulate, 4–12 by 3–6 mm, the adaxial surface and margins bearing tentacles, abaxially pilose (Fig. 4a); petiole 5–12 by

0.5–1 mm, flat, densely pilose. **Inflorescence** cymose, with 2–8 flowers; peduncles 1 or 2 together, 10–17 cm long, completely erect, basally glandular and pilose to densely pilose, apically glandular; bracts almost linear, 2–3 mm long, glandular or pilose; pedicels 2–7 mm long, glandular. **Sepals** 5, lanceolate to ovate, 3–4.5 by 1.5–2 mm, connate at the base, occasionally apex serrate, glandular. **Petals** 5, obovate, 5–7 by c. 4 mm, bright pink. **Stamens** 5, filaments 3–4 mm long. **Pistil**: ovary subglobose, 2–3 mm diam, glabrous; styles 3, c. 2 mm long, bipartite to the base, branches ascending, with broadened apices. **Seeds** suborbicular to ovoid, c. 0.3 by 0.2 mm (Fig. 4e), black, shining, testa smooth.

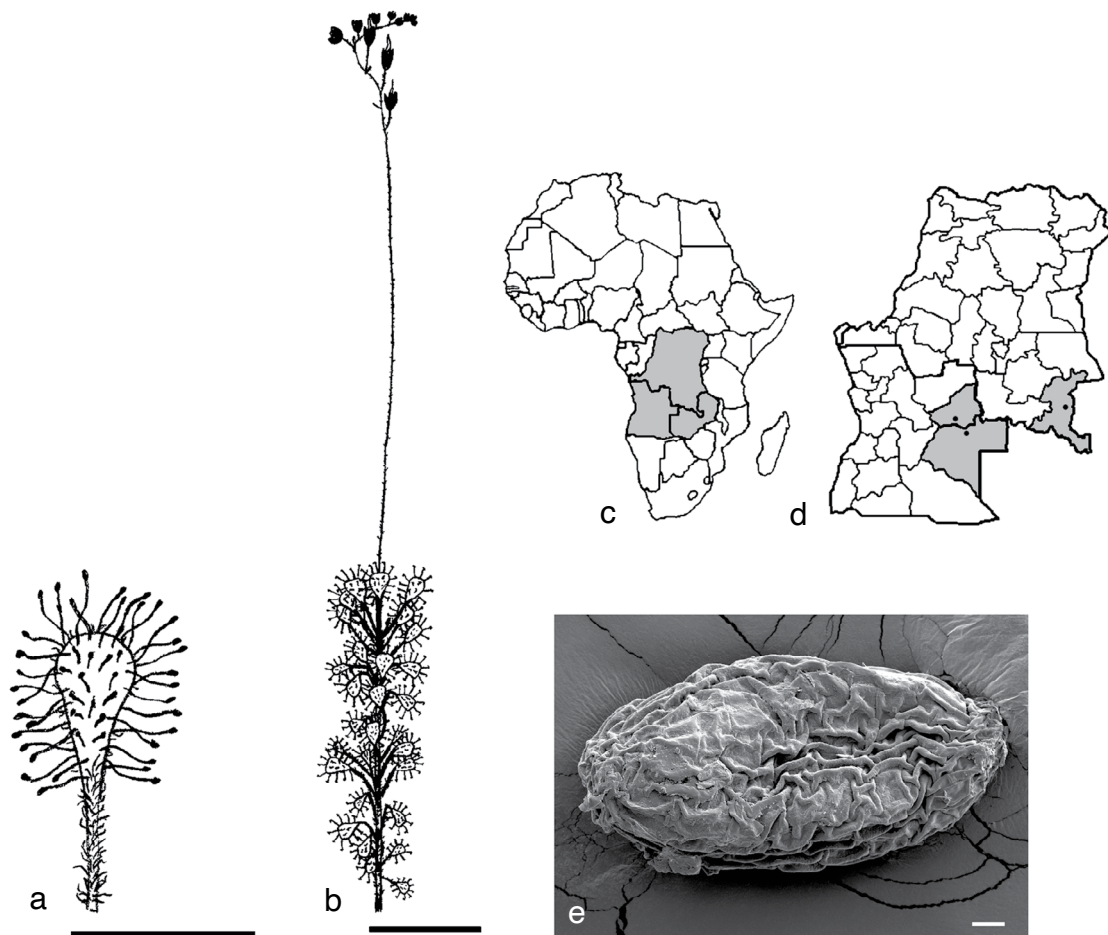
**Distribution** — Angola, DRC, Zambia (Fig. 4c).

**Habitat & Ecology** — Grassy wetlands, upland plateaus.

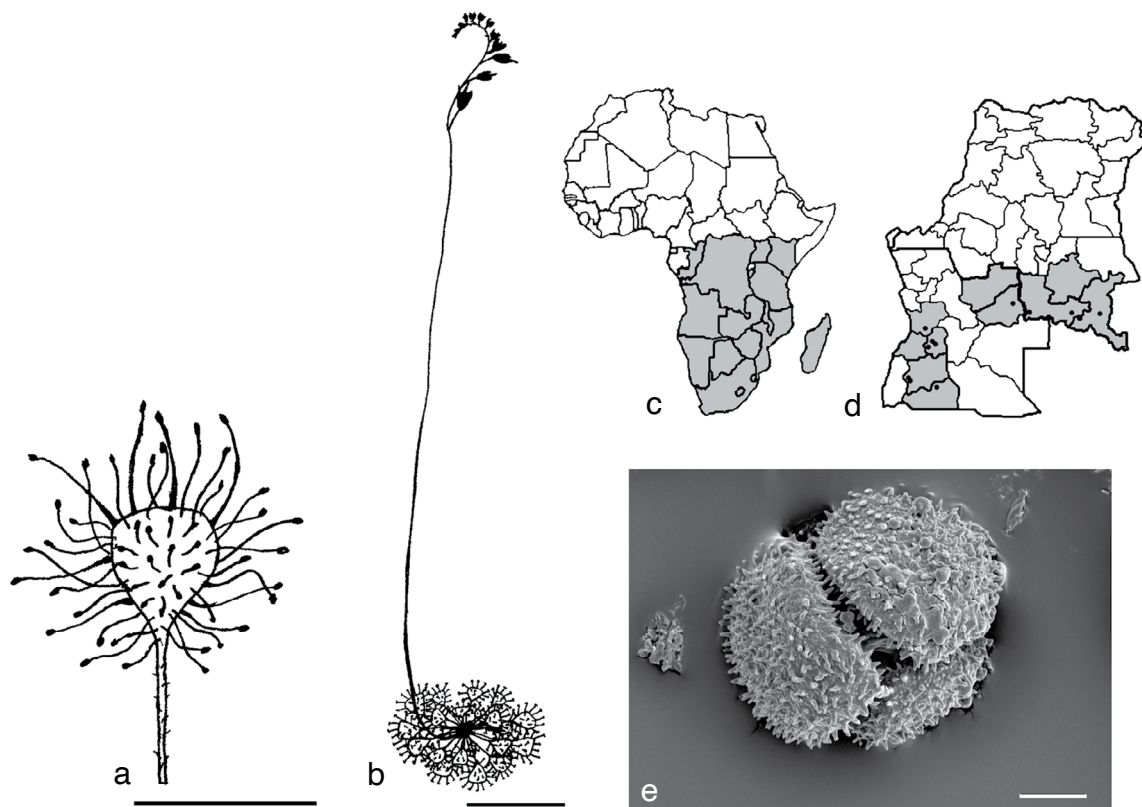
**Additional specimens** (see Fig. 4d for province map). ANGOLA, **Moxico**, Cameia National Park, Biodiversity Observatory, S11°31' E20°55', alt. 1126 m, 3 May 2016, *M. Finckh & Ziegelski* 143303 (HBG). — DRC, **Haut-Katanga**, Cuv. de Kabiashia, rivièrre Kandale, alt. 1000 m, 24 June 1968, *J. Leonard* 4617 (BR).

**Note** — *Drosera compacta* is widely accepted as a synonym of *D. bequaertii*. Both type specimens show many similarities but differ in leaf arrangement (densely vs more openly arranged) and scape indumentum (basally densely pilose vs glandular and pilose). Since this species is only infrequently documented (Robinson et al. 2017) and only few specimens were studied, no comment can be made on separating both taxa. Here, a more detailed analysis is required.





**Fig. 4** *Drosera bequaertii* Taton. a. Leaf shape, typified by the flattened, densely pilose petiole and the obovate to spatulate lamina; b. general morphology: short caulescent, densely pilose herb with spiral leaves and terminal, erect inflorescences; c. distribution (grey) according to the literature; d. province map of Angola and DRC with localities of examined herbarium specimens; e. dry seed,  $260 \times 130 \mu\text{m}$ . — Scale bars: a = 1 cm; b = 2 cm; e =  $20 \mu\text{m}$ .



**Fig. 5** *Drosera burkeana* Planch. a. Leaf shape with a linear petiole that broadens abruptly into the suborbicular to spatulate lamina; b. general morphology: acaulescent, leaves in a rosette and laterally arising, glandular-pubescent inflorescences; c. distribution (grey) according to the literature; d. province map of Angola and DRC with localities of examined herbarium specimens; e. pollen occurs in tetrads with echinate, narrowly conical sculpture elements in high density. — Scale bars: a = 1 cm; b = 2 cm; e =  $10 \mu\text{m}$ .

### 3. *Drosera burkeana* Planch. — Fig. 5

*Drosera burkeana* Planch. (1848) 192; Oliv. (1871) 402; Diels (1906) 88; G.C.C. Gilbert (1951) 552; Keay (1954) 26; J.R. Laundon (1959) 2; (1970) 26; Oberm. (1970) 194; A.S. Rob. et al. (2017) 1338. — Type: *J. Burke s.n.* (holo K), South Africa, Northwest, Macalisberg.

Perennial herb (sometimes annual), acaulescent. *Leaves* in a basal rosette (Fig. 5b), held horizontally; stipules 2–3.5 by c. 1.5 mm, membranous, connate at the base, apex lacerated (3 or more teeth), ferrugineous; lamina suborbicular, obovate to spatulate, 2–10 by 2–9 mm, reddish, adaxial surface and margins bearing tentacles, abaxially pilose, rarely glabrous (Fig. 5a); petiole 2–25 by 0.5–1 mm, linear throughout, abruptly broadening into the lamina, reddish, pilose (or glabrous). *Inflorescences* cymose, with 3–12 flowers; peduncles 1–4 together, 4–33 cm long, arising laterally, ascending, glandular; bracts linear, spatulate to narrowly obovate, 1–2 mm long, glandular or glabrous; pedicels 2–12 mm long, glandular. *Sepals* 5, elliptic to obovate, 2–5.5 by 2–2.5 mm, apex acute or obtuse, serrated, surfaces glandular (especially adaxially). *Petals* 5, obovate, 5–7 by 2–4 mm, pink to purple or white. *Stamens* 5, filaments 3–5 mm long, same colour as petals, anthers yellow. *Pollen* in tetrads, yellow, tetrads c. 40–46 µm diam, single grains c. 30–35 µm diam, pollen grains echinate (Fig. 5e), echini narrowly conical, c. 2 mm long, high density of echini, with short gemmate to clavate sculptural elements between echini. *Pistil*: ovary subglobose to obovate, 1.5–3.5 by 1–2.5 mm, glabrous, green; styles 3, 4–5 mm long, bipartite to the base, branches slender, curved upwards. *Seeds* ovoid, 0.3–0.4 by 0.15–0.2 mm, black, testa reticulate.

**Distribution** — Angola, Botswana, Burundi, Congo, DRC, Kenya, Lesotho, Madagascar, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe (Fig. 5c).

**Habitat & Ecology** — Grows on loam, sand and peat, seasonally to perennially wet spots.

**Additional specimens** (see Fig. 5d for province map). ANGOLA, **Benguela**, Feuchte Wiese bei Humpata, alt. 1900 m, 9 Sept. 1950, *H. Hess* 50/254 (ZT); **Cuanza Sul**, zona de Cassongue estrada em direcção de Kahumbi, após do rio Cuvele fema, Inselberg, alt. 1580 m, 1 Apr. 2007, *T. Leyens* 402 (FR); **Cunene**, Cuvelai, a cerca de 20 km para Cassinga, 22 July 1971, *R. Santos* 2918 (COI); **Huambo**, Huambo, 1923, *H. Vanderyst* 13125 (BR); près de la mission de Huambo, Aug. 1942, *C. Tisserant* A94 (COI); 1 km W der prot. Mission von Elende, Cuma, alt. 1350 m, 25 July 1961, *J.B. Damann* 3099 (ZT); Chianga, alt. 1700 m, 11 June 1962, *Teixeira & Andrade* 6445 (COI); **Huíla**, Serra de Chella, aux environs de Humpata, alt. 2000–2200 m, 1937, *H. Humbert* 16650 (P); Humpata, Chongorola, rio Nene, pântanos, 20 June 1937, *A.W. Exell & F.A. Mendonça* 2989 (COI); Sá da bandeira, Jau, Cangalongue, 3 Oct. 1965, *C. Henriques* 763 (COI); **Lunda**, 100 km norte de Muconda, 12 Aug. 1927, *Carriso & Mendonça* 221a (COI); Rio Caunhango junto da estrada Mucango a Casage, 16 Aug. 1927, *Carriso & Mendonça* 264 (COI). — DRC, **Haut-Katanga**, 6.3 km au NNE du Peste de Katshupa, Plateau des Kundelungu, alt. 1580 m, 3 Aug. 1966, *F. Malaisse* 4490 (BR); 7 km au N du Peste de Katshupa, Plateau des Kundelungu, alt. 1680 m, 1966-08-04, *F. Malaisse* 4504 (BR); 6 km à l'WNW de la touree Oee de la Lut., Plateau des Kundelungu, alt. 1675–1680 m, 25 Mar. 1969, *S. Lisowski et al.* 3975 & 3453 (BR); **Haut-Katanga/Haut-Lomami**, Parc National de l'Upemba, route automobile pour le Shinkulu, alt. 1450 m, 21 May 1948, *G.F. de Witte* 03862 (BR); Parc National de l'Upemba, 24 Sept. 1949, *G.F. de Witte* 07541 (BR); **Lualaba**, Dilolo, Sept. 1931, *Overlaet* 1239 (BR); Biano, S10°16' E26°03', alt. 1575 m, 23 May 1952, *A. Schmitz* 3918 (BR).

### 4. *Drosera elongata* Exell & J.R. Laundon — Fig. 6

*Drosera elongata* Exell & J.R. Laundon (1955b) 42; J.R. Laundon (1970) 29; A.S. Rob. et al. (2017) 1384. — Type: *A.W. Exell & F.A. Mendonça* 1268 (holo BM), Angola, Lunda Sul, Luma-Cassai, 'Tenga', 27 Apr. 1937.

Slender, scrambling, caulescent herb. *Stems* up to 90 cm long, c. 1 mm diam, flexuous, pilose to densely pilose (Fig. 6b). *Leaves* evenly spaced along the stem, alternate to spirally arranged, semi-erect, older leaves perpendicular to stem or slightly

reflexed; stipules 2–5 mm long, membranous, deeply lacerated apically, ferrugineous; lamina obovate to elliptic, 3–6 by 2–4 mm, bearing tentacles adaxially and around the margins, pilose abaxially (Fig. 6a); petiole 0.7–1.5 cm long, slender, pilose. *Inflorescences* cymose, with 2–9 flowers; peduncles 1 or 2 together, 9–25 cm long, arising laterally, ascending, pilose to glandular-pilose; bracts linear to oblanceolate, 2–3 mm long, pilose or glandular-pilose; pedicels 1–6 mm long, pilose to glandular-pilose. *Sepals* 5, lanceolate to elliptic, 3–5 by 1–2 mm, connate at the base, apex obtuse or acute, glandular-pilose. *Petals* 5, obovate, 4–6 by 2–3 mm, obtuse, pink. *Stamens* 5, filaments 2–4 mm long. *Pollen* in tetrads, tetrads c. 45–50 µm diam, single grains c. 30 µm diam, echinate (Fig. 6e), echini conical, c. 2 mm long, sometimes constricted in the middle, in low to medium density, with short gemmate to clavate sculptural elements between echini. *Pistil*: ovary c. 1 by 1.5 mm, glabrous; styles 3, 2-partite at the base. *Seeds* fusiform, 0.5–0.8 by c. 0.2 mm, black, testa smooth (Fig. 6f).

**Distribution** — Angola, Burundi, Congo, DRC, Tanzania, Zambia (Fig. 6c).

**Habitat & Ecology** — Perennially wet places in seasonally dry wet-savannah, upland plateaus.

**Additional specimens** (see Fig. 6d for province map). ANGOLA, **Lunda**, R. Lalege, 14 Aug. 1927, *Carriso & Mendonça* 245a (COI); **Uíge**, Mucaba swampy area, S7°13' E15°5', alt. 1209 m, 23 Feb. 2017, *T. Lautenschläger* 2017-02-113 (DR). — DRC, **Haut-Katanga**, Parc National de l'Upemba, Kiluba, Luswahila, alt. 1880 m, 16 Jan. 1948, *G.F. de Witte* 03249 (BR); Parc National de l'Upemba, Kaziba, alt. 1300 m, 18 Apr. 1949, *G.F. de Witte* 06261 (BR); **Haut-Katanga/Haut-Lomami**, Parc National de l'Upemba, alt. 1680 m, 24 Aug. 1949, *G.F. de Witte* 07540 (BR).

**Note** — Hybridisation with *D. madagascariensis* has been observed, the hybrids show characteristics of both species (Robinson et al. 2017).

### 5. *Drosera flexicaulis* Welw. ex Oliv. — Fig. 7

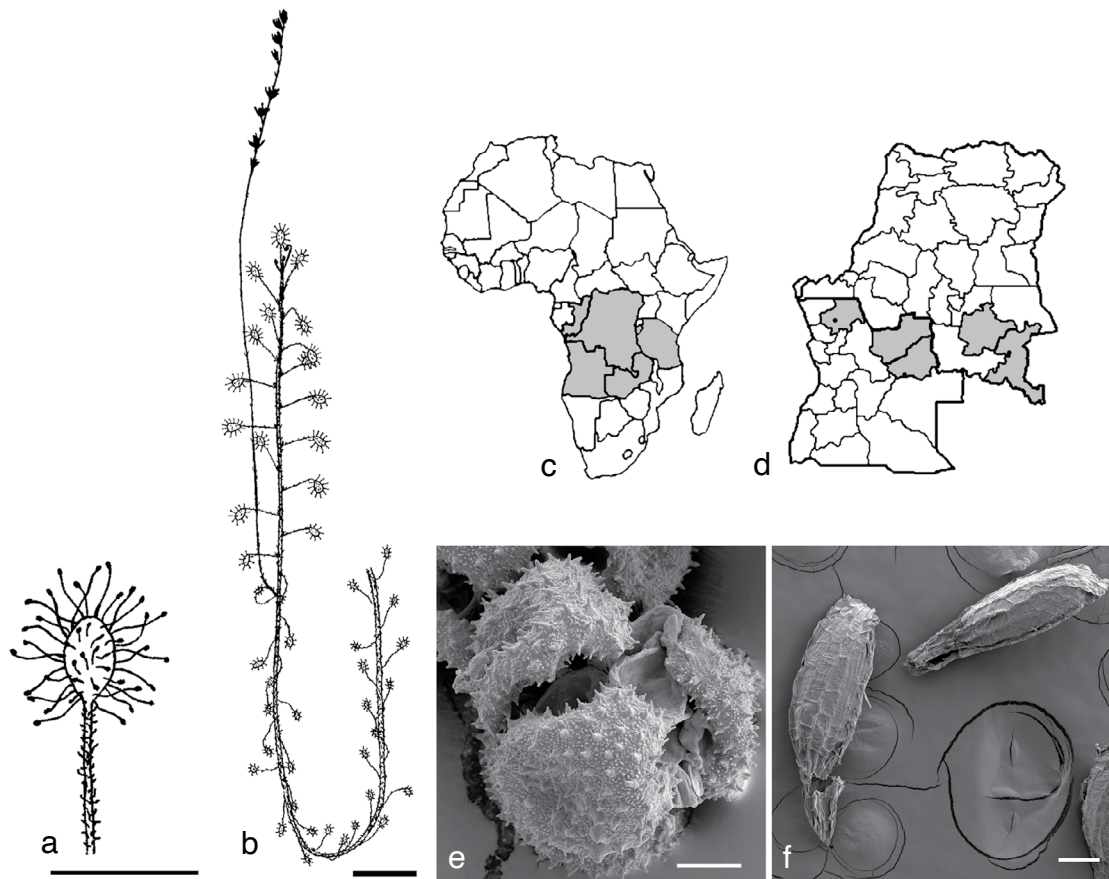
*Drosera flexicaulis* Welw. ex Oliv. (1871) 403; Diels (1906) 98; G.C.C. Gilbert (1951) 554; A.S. Rob. et al. (2017) 1398. — Lectotype (designated by Diels (1906) 98): *F.M.J. Welwitsch* 1181 (lecto LISU), Angola, Huíla, Lopollo, Dec. 1859.

Perennial herb, caulescent. *Stems* up to 25 cm long, erect, slender, glabrous (Fig. 7b). *Leaves* alternate, clustered somewhat into a rosette towards the apex, all leaves including lower leaves mostly erect or ascending (sometimes reflexed); stipules 1–2 mm long, connate at the base, apex lacerated, ferrugineous; lamina lanceolate, narrowly spatulate-ovate or spatulate, 3–15 by 1–5 mm, bearing tentacles adaxially and around the margins, glabrous or sparsely pilose abaxially (Fig. 7a); petioles 0.5–3.2 cm long, slender, glabrous or sparsely pilose. *Inflorescences* cymose, with 3–13 flowers; peduncles 1–4 together, 8–21(–30) cm long, ascending, glabrous; bracts filiform to linear, c. 2 mm long, caducous; pedicels 1–10 mm long, erect, glabrous or sparsely pilose. *Sepals* 5, oblong to lanceolate, 4–7 by 1–2 mm, connate at the base, sparsely pilose to pilose. *Petals* 5, obovate, 5–8 by 2.5–4 mm, white or purple. *Stamens* 5, filaments 4–5 mm long. *Pollen* in tetrads, tetrads c. 45–52 µm diam, single grains c. 25–30 µm diam, echinate (Fig. 7e), echini conical, c. 2 mm long, in low density, with short clavate sculptural elements between echini. *Pistil*: ovary subglobose to ovoid, c. 2 by 1 mm, glabrous; styles 3, c. 2.5 mm long, 2-partite to the base. *Seeds* fusiform, 0.7–0.9 by c. 0.2 mm, black, shiny, testa reticulate.

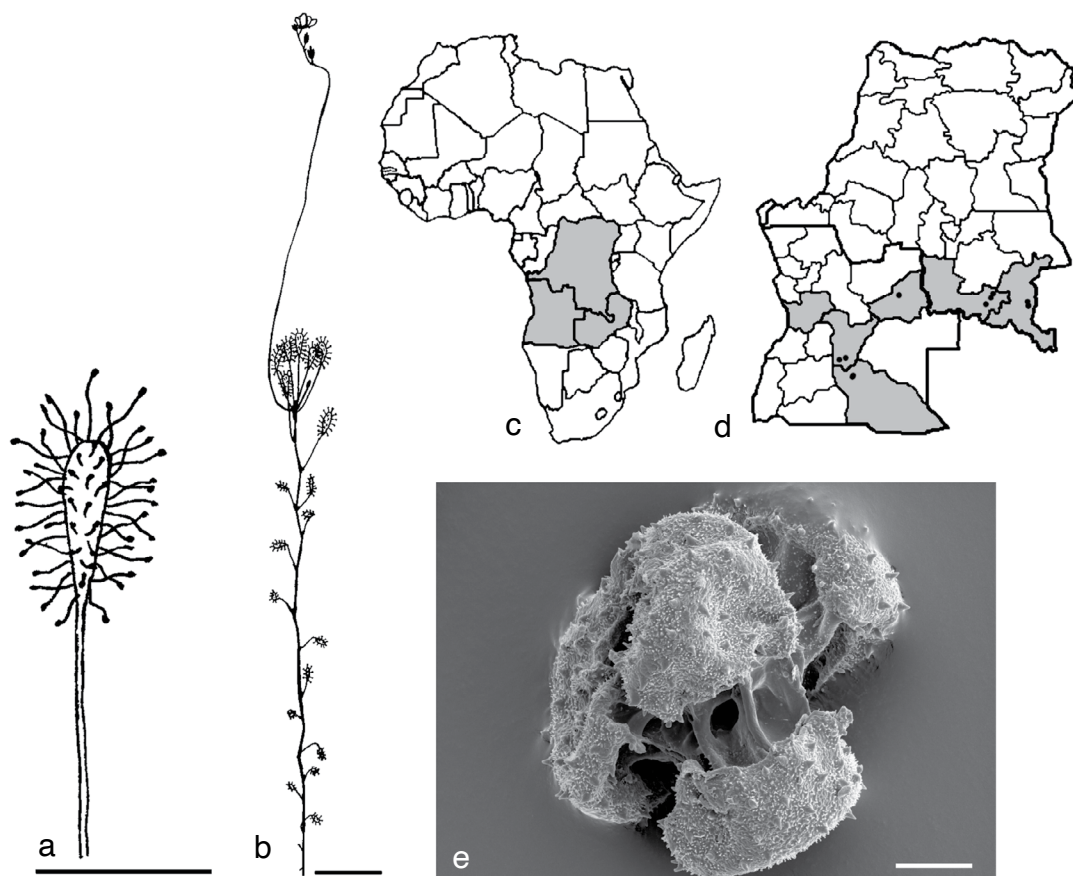
**Distribution** — Angola, DRC, Zambia (Fig. 7c).

**Habitat & Ecology** — Grows on sand and peat, in grassy swamps, seasonally dry wet-savannah.

**Additional specimens** (see Fig. 7d for province map). ANGOLA, **Bié**, junto à margem do rio Chitembo, alt. 1500 m, 31 Oct. 1966, *Teixeira et al.* 10901 (BR);



**Fig. 6** *Drosera elongata* Exell & J.R.Laundon. a. Leaf shape with a pilose petiole and a relatively small, elliptic lamina; b. general morphology: very long stems with horizontal leaves and laterally arising, pubescent inflorescences; c. distribution according to the literature; d. province map of Angola and DRC with localities of examined herbarium specimens; e. pollen in tetrads with echinate, conical sculpture elements in low to medium density; f. dry seed  $450 \times 140 \mu\text{m}$ . — Scale bars: a = 1 cm; b = 2 cm; e =  $10 \mu\text{m}$ ; f =  $20 \mu\text{m}$ .



**Fig. 7** *Drosera flexicaulis* Welw. ex Oliv. a. Leaf shape showing the slender petiole and the narrowly spatulate lamina; b. general morphology: long, slender stems with leaves held erect and laterally arising inflorescences; c. distribution according to the literature; d. province map of Angola and DRC with localities of examined herbarium specimens; e. pollen in tetrads with echinate, conical sculpture elements in low density. — Scale bars: a = 1 cm; b = 2 cm; e =  $10 \mu\text{m}$ .



Cussequ – TFO core site, hilly landscape, fire in last dry season, S13°42' E17°5', 19 Oct. 2012, *M. Finckh* 135547 (HBG); Cussequ – TFO core site, plain: alluvial plain, fire in last dry season, S13°41' E17°6', alt. 1515 m, 29 Oct. 2011, *M. Finckh* 132756 (HBG); **Cuando Cubango**, Menongue, Vila Serpa Pinto, pr. da confluência do Cambumbé com o Cuebe, alt. 1420 m, 12 Feb. 1960, *E.J. Mendes* 2484 (BR, COI); Menongue, andados 14 km de Vila Serpa Pinto para Longa, vale do Cambumbé, alt. 1430 m, 26 Feb. 1960, *E.J. Mendes* 2754 (COI); **Cuanza Sul**, am Longa oberh. Minnesera, alt. 1230 m, 1 Feb. 1900, *H. Baum* 687 (HBG); **Lunda Sul**, Saurimo, 25 Oct. 1932, *R.G.N. Young* 1167 (COI). – DRC, **Haut-Katanga**, 6 km à l'WNW de la touree Oee de la Lut., Plateau des Kundelungu, alt. 1680 m, 25 Mar. 1969, *S. Lisowski et al.* 3789 (BR); près de la touree Oee de la Lut., Plateau des Kundelungu, alt. 1670 m, 26 Mar. 1969, *S. Lisowski et al.* 3552 (BR); 2 km à l'E des tourees de la Lut., Plateau des Kundelungu, alt. 1600 m, 8 Jan. 1971, *S. Lisowski et al.* 13079 (BR); **Lualaba**, Plateau de la Manika (environs Katentania), Nov. 1912, *Homblé* 774 (BR); village Matoki, Plateau de la Manika, alt. 1400 m, 20 Jan. 1969, *S. Lisowski et al.* 5 (BR); Kisoté, Plateau de la Manika, alt. 1500 m, 5 Apr. 1969, *S. Lisowski et al.* 4181 (BR); 2 km à l'W de la rivière Musonai vers le village Djoni, Plateau de la Manika, alt. 1420 m, 23 Mar. 1969, *S. Lisowski et al.* 5651 (BR).

**Note** — This species has been treated as a synonym of *D. affinis* in several Floras (Laundon 1959, 1970, 1978). After morphological analysis this work follows the Flora of Tropical Africa (Oliver 1871) and treats *D. flexicaulis* as a separate species. Both species share the same habitat and have overlapping distributions. Additionally, hybrids of *D. flexicaulis* and *D. affinis* occur, which show characters of both parent species (Robinson et al. 2017).

## 6. *Drosera indica* L. — Fig. 8

*Drosera indica* L. (1753) 282; Oliv. (1871) 402; Diels (1906) 77; G.C.C. Gilbert (1951) 551; Keay (1954) 122; J.R. Laundon (1959) 2, (1970) 25; Oberm. (1970) 201; J.R. Laundon (1978) 64; Akoëgn. et al. (2006) 539; A.S. Rob. et al. (2017) 1418. — Lectotype (designated by Laundon (1959) Droseraceae 2): *P. Hermann* s.n. (lecto BM), India.

Synonyms in Africa only: *Drosera minor* Schumach. (1827) 167. — Type: *C.F. Schumacher* s.n. (holo C, not seen), Guinea.

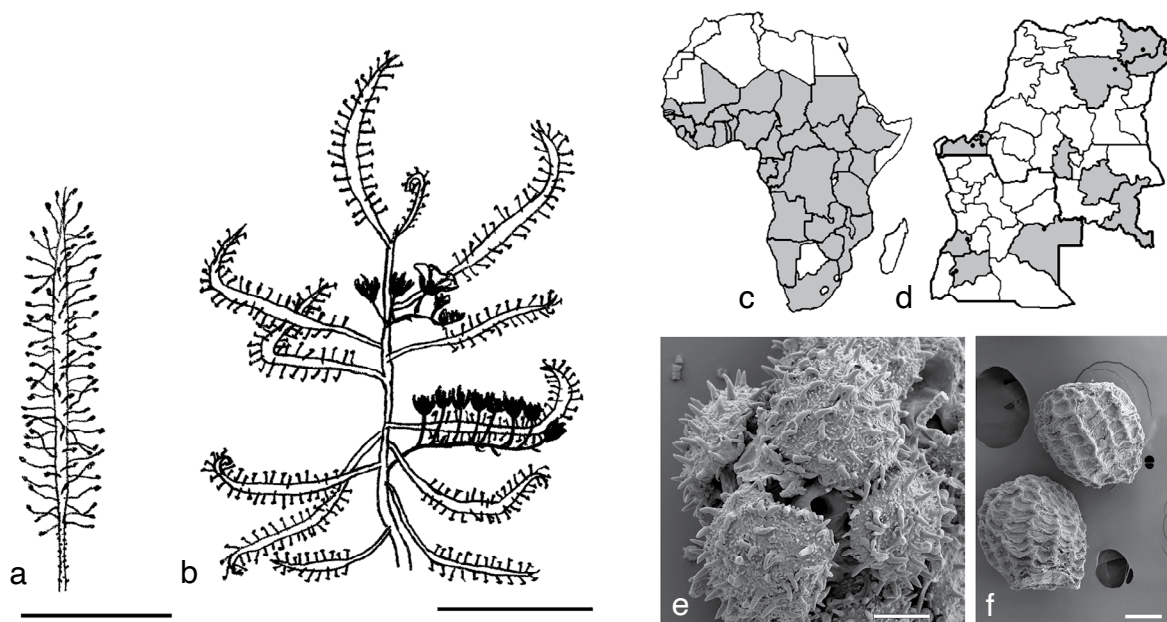
Slender, annual, caulescent herb (Fig. 8b). *Stems* 3–50 cm long, erect or matted, canaliculate, (sparsely) glandular, green. *Leaves* alternate to spirally arranged, evenly spaced, erect, old leaves reflexed; stipules absent, a pair of setae-like hairs at the base of the leaves; lamina linear to filiform, 1–10 cm by

0.4–4 mm, apex long acuminate, adaxial surface and margins bearing tentacles, abaxially glabrous, green (Fig. 8a); petiole 0.1–1.5 cm long, glandular. *Inflorescences* cymose, with 3–20 flowers, recurved; peduncles 0.5–15 cm long, arising laterally from the stem, glandular; bracts linear to spatulate, c. 2.5 mm long, apex more or less dentate; pedicels 0.2–2 cm long, glandular. *Sepals* 5, ± lanceolate, 2–5 by 1–2 mm, apex acute or obtuse, glandular. *Petals* 5, spatulate to obovate, 4–8 by 2.5–6 mm, pink to purple, mauve (in Asia also white). *Stamens* 5; filaments 3–5 mm long, white or pink; anthers yellow. *Pollen* in tetrads, tetrads c. 50–55 µm diam, single grains c. 25 µm diam, long echinate (Fig. 8e), echini narrowly conical, 2–3 µm long, occurring in medium density, with short clavate sculptural elements between echini. *Pistil*: ovary subglobose to ovoid, 1.5–3 by c. 2 mm, glabrous; styles 3, bipartite to the base, branches c. 2.5 mm long, ascending. *Seeds* globose to ovoid, 0.4–0.5 by c. 0.3 mm, apiculate, black, testa reticulate (Fig. 8f).

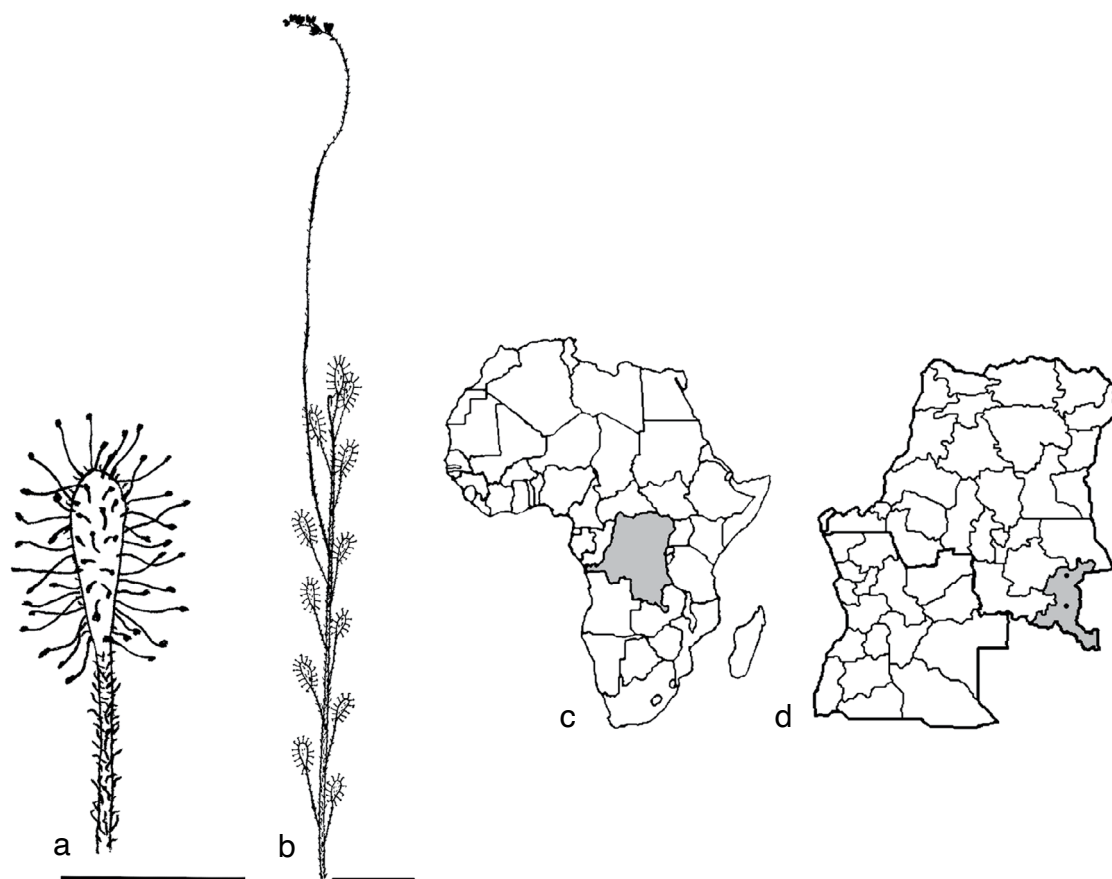
**Distribution** — Widespread in tropical Africa, Asia and Australia (Fig. 8c).

**Habitat & Ecology** — Wide range of seasonally wet habitats (e.g., swamps, pools, rivers and lake shores).

**Additional specimens** (see Fig. 8d for province map). **ANGOLA, Benguela**, Tchiyaka, 20 km nördlich von Quingenge, gefunden auf nasser Felsplatte, alt. 1750 m, 13 Feb. 1955, *J.B. Damann* s.n. (sine numero) (ZT); **Huíla**, Humpata, alt. 1800 m, 5 Apr. 1937, *J. Gossweiler* 11104 (COI); Entre lá da Bandeira e Humpata, alt. 2000 m, 6 May 1937, *A.W. Exell & F.A. Mendonça* 2599 (COI); Lubango, entre Palaca e o Perimetro Florestal, alt. 1960 m, 15 Apr. 1960, *E.J. Mendes* 3613 (COI); **Moxico**, Cameia National Park, Biodiversity Observatory, S11°31' E20°54', alt. 1126 m, 3 May 2016, *Finckh & Zigelski* 143317 (HBG). – DRC, **Haut-Katanga/Haut-Lomami**, Parc National de l'Upemba, Entre la riv. Kanonya et la riv. Lukange, 19 Feb. 1949, *G.F. de Witte* 5544 (BR); **Haut-Uele**, Mai-Kuku, 6 km au-delà Gombari, alt. 1200 m, 16 July 1937, *J. Louis* 4540 (BR); Parc National de la Garamba, route Dungu – Bagbele (Ukwa), km 17 de Bagbele, 25 Aug. 1952, *G. Troupin* 1991 (BR); **Ituri**, Entre Jaradje et Aba, July 1931, *J. Lebrun* 3429 (BR, P); **Kasai-Central**, Samusambu, 65 km de Sandoo, Lulua, 6 June 1932, *Overlaet* 1252 (BR); **Kinshasa**, Kinshasa, 17 May 1915, *Bequaert* 7612 (BR); Congo-Kinsuka, près Leopoldville, July 1944, *Coutreaux* 1011 (BR); Kinsuka, 28 May 1947, *E. Jans* 490 (BR); Ile des Mimosas, Ngaliema, 1 June 1983, *H. Breyne* 4624 (BR); **Kongo Central**, Gombe Matadi, Jan. 1950, *H. Callens* 2594 (BR); **Tshopo**, Niomgaza (Uili-Nepoko), June 1931, *J. Lebrun* 3174 (BR).



**Fig. 8** *Drosera indica* L. a. Leaf shape showing linear to filiform lamina; b. general morphology: caulescent, spiral leaves and laterally arising inflorescences; c. distribution according to the literature; d. province map of Angola and DRC with localities of examined herbarium specimens; e. pollen in tetrads with long echinate, narrowly conical sculpture elements in medium density; f. dry seed, 370 × 300 µm, with conspicuous reticulate pattern. — Scale bars: a = 1 cm; b = 2 cm; e = 10 µm; f = 100 µm.



**Fig. 9** *Drosera katangensis* Taton. a. Leaf shape with pilose petiole and oblong-spathulate lamina; b. general morphology: caulescent, sparsely dispersed leaves and laterally arising, erect inflorescences; c. distribution according to the literature; d. province map of Angola and DRC with localities of examined herbarium specimens. — Scale bars: a = 1 cm; b = 2 cm.

### 7. *Drosera katangensis* Taton — Fig. 9

*Drosera katangensis* Taton (1945c) 309; G.C.C.Gilbert (1951) 550, A.S.Rob. et al. (2017) 1422. — Type: *H. Homblé* 773 (holo BR), DRC, Lualaba. Plateau de la Manika, Nov. 1912.

Caulescent herb. *Stems* up to 15 cm long, erect, densely glandular (Fig. 9b). *Leaves* alternate, sparsely dispersed, basal leaves smaller; stipules c. 2 mm long, apex lacerated into setae-like segments; lamina oblong-spathulate, 5–15 by 1.5–5 mm, abaxially pilose (Fig. 9a); petiole 7–20 mm long, densely pilose/hirsute. *Inflorescences* cymose, with up to 8 flowers; peduncles 1, up to 20 cm long, erect at the base, densely pilose/hirsute (often recurved hairs); bracts linear to lanceolate, c. 5 mm long, glandular; pedicels 2–3 mm long, pilose. *Sepals* 5, oblong, c. 8 by 2 mm, apex obtuse, adaxially densely pilose/hirsute. *Petals* 5, obovate, c. 12 by 4 mm, pink or pinkish. *Stamens* 5; filaments c. 6 mm long; anthers c. 1.5 mm long, sagittate. *Pistil*: ovary ovoid; styles 3, bipartite to the base, branches 2.5–3 mm long, ascending. *Seeds* fusiform, black.

Distribution — DRC (Fig. 9c).

Habitat & Ecology — Wet plains.

*Additional specimens* (see Fig. 9d for province map). DRC, **Haut-Katanga**, 63 km au N du Poste de Katshupa, Plateau des Kundelungu, alt. 1685 m, 28 Jan. 1967, *F. Malaisse* 4986 (BR); Lusinga, Plateau des Kibara, 14 Apr. 1969, *S. Lisowski* et al. 4659 (BR).

**Note** — So far, this species has been collected only from Katanga Province (DRC), but it is likely to occur in neighbouring regions. The herbarium specimens (*F. Malaisse* 4986 and *S. Lisowski* et al. 4659) share characters with *D. flexicaulis* and *D. elongata* (elongated stem, erect leaves) as well as with *D. bequaertii* (erect base of the peduncle, hairiness of leaves and peduncle). Since only few specimens have been collected so far, this species is not well studied. The shared characters

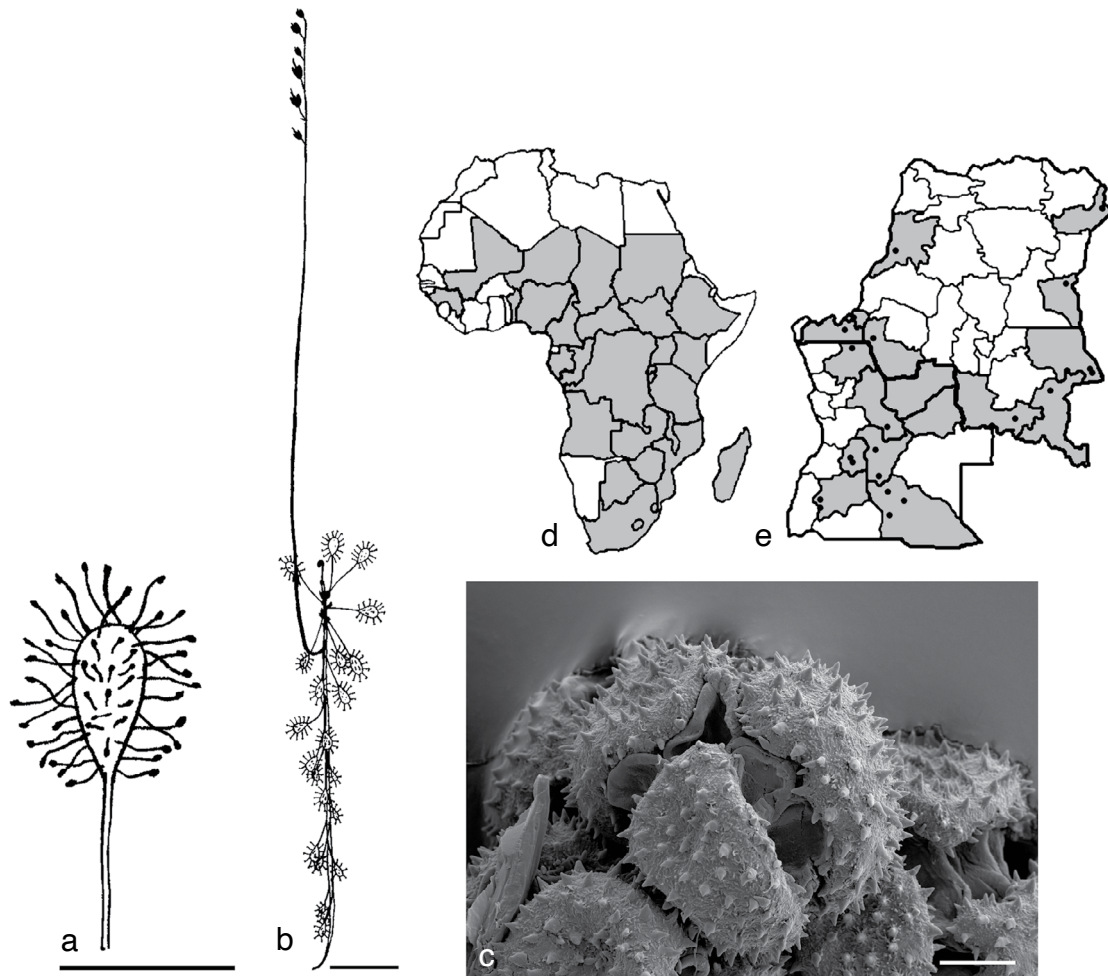
with *D. flexicaulis*, *D. elongata* and *D. bequaertii* indicate that *D. katangensis* could be a hybrid of the above mentioned species (Robinson et al. 2017). The specimen *Homblé* 774 in particular could support that thesis. While three of the four plants are easily identified as *D. flexicaulis*, one plant looks similar to *D. katangensis* showing the erect base of the inflorescence and similar leaf shape and arrangement but it has only sparsely pilose petioles and stem. The examination of fresh material and molecular genetic analysis might shed further light on the taxonomic status of *D. katangensis*.

### 8. *Drosera madagascariensis* DC. — Fig. 10

*Drosera madagascariensis* DC. (1824) 318; Diels (1906) 98; G.C.C.Gilbert (1951) 554; Keay (1954) 121; J.R.Laundon (1959) 5; Oberm. (1970) 200; J.R.Laundon (1978) 68; Troupin (1978) 307; Akoëgn. et al. (2006) 539; A.S.Rob. et al. (2017) 1426. — Type: *Lambert* s.n. (holo G-DC), Madagascar, 1819.

*Drosera congolana* Taton (1945b) 310; G.C.C.Gilbert (1951) 552. — Type: *J. Bequaert* 7191 (holo BR), DRC, Leopoldville, 29 Mar. 1915

Perennial, caulescent herb. *Stems* up to 25 cm long, rarely acaulous (see Note), c. 1 mm diam, only apical part of the stem self-supporting, glabrous or sparsely pilose (Fig. 10b). *Leaves* evenly spaced along the stem, alternate to spirally arranged, occasionally clustered, erect, older leaves reflexed; stipules oblong, 2–6(–8) by c. 1 mm, membranous, lacerated apically, ferruginous; lamina obovate, elliptic or spatulate, 0.4–1.1 (–3) cm by 2–7 mm, bearing tentacles adaxially and around the margins, almost glabrous to pilose abaxially (Fig. 10a); petiole linear, 0.6–2(–3) cm by 0.3–1 mm, glabrous to pilose. *Inflorescences* cymose, with 2–15 flowers, axillary; peduncles 1–3 together; 9–55 cm long, arising laterally, ascending, basally particularly curved, glabrous, glandular or pilose; bracts linear to spatulate, 2–3 mm long, sparsely pilose, caducous; pedicels



**Fig. 10** *Drosera madagascariensis* DC. a. Leaf shape showing a slender, glabrous to pilose petiole and an obovate to spatulate lamina; b. general morphology: caulescent with spiral, reflexed leaves and laterally arising inflorescences; c. distribution according to the literature; d. province map of Angola and DRC with localities of examined herbarium specimens; e. pollen in tetrads with echinate, broadly conical sculptural elements in medium density. — Scale bars: a = 1 cm; b = 2 cm; e = 10 µm.

1–10 mm long, glandular or pilose. *Sepals* 5, elliptic to oblong-lanceolate, 4–7 by 1–2 mm, connate at the base, apex acute or obtuse, glandular and/or pilose. *Petals* 5, obovate, 5–12 by 3.5–6 mm, pink or purple. *Stamens* 5; filaments 2–5 mm long. *Pollen* in tetrads, tetrads c. 45 µm diam, single grains c. 30 µm diam, echinate (Fig. 10e), echini broadly conical, c. 2 mm long, of medium density with short clavate sculptural elements between them. *Pistil*: ovary subglobose to ovoid, c. 2 by 1–1.5 mm, glabrous; styles 3, c. 2 mm long, 2-partite to the base, apices clavate, white to pink. *Seeds* fusiform, 0.7–1 by c. 0.2 mm, brownish black, apiculate, testa reticulate.

**Distribution** — Widespread in tropical Africa, South Africa, Madagascar (Fig. 10c).

**Habitat & Ecology** — Perennially wet habitats (swamps, marshes, river and lake shores, perennially wet places in seasonally dry wet-savannahs).

**Additional specimens** (see Fig. 10d for province map). **ANGOLA**, **Bié**, Silva Porto – Andulo, km 35, S12°09' E16°45', alt. 1700 m, 15 Mar. 1973, *P. Bamps et al.* 4153 (BR); Cussequ – TFO core site, plain, alluvial plain, fire in last dry season, S13°42' E17°6', alt. 1515 m, 29 Oct. 2011, *R. Revermann* 132779 (HBG), *M. Finckh* 132768 (HBG); **Cuando Cubango**, Baixo Cubango, 179 km von Cuangar in Richtung Caiundo, sumpfiges Gelände am Rio Cubango, Moorboden, alt. 1070 m, 29 Jan. 1952, *H. Hess* 52/509 (ZT); Menongue, Vila Serpa Pinto, pr. da confluência do Camumbé com o Cuebe, alt. 1420 m, 12 Feb. 1960, *E.J. Mendes* 2482 (COI); Cuito-Cuanavale, confluência dos rios Tchiengo com o Cuito, alt. 1280 m, 3 Mar. 1960, *E.J. Mendes* 2811 (COI); Cuito-Cuanavale, Longa, Cuango, vale do Cuango, alt. 1370 m, 18 Mar. 1960, *E.J. Mendes* 3185 (BR, P); **Huambo**, Missão de Humabo, Nov. 1942, *C. Tisserant* A310 (COI); Chianga, alt.

1700 m, 11 June 1962, *Teixeira & Andrada* 6446 (COI); Arredores de Nova Lisboa, Chiva, alt. 1700 m, 19 Mar. 1971, *M. de Silva* 3480 (BR, COI); **Huíla**, Serra de Chella, aux environs de Huíla, alt. 1850 m, 1937, *H. Humbert* 16686 (P); Entlang einem Bache auf dem Hochplateau von Bimbe bei Humpata, alt. 2300 m, 9 Sept. 1950, *H. Hess* 50/188 (ZT); Lubango, Chipia, ao km 7 da picada para Missao do Munhino, 11 May 1971, *A. Borges* 248 (BR, COI); **Lunda**, Vila Henrique de Carvalho, rio Chicapa, alt. 1100 m, 16 Apr. 1937, *A.W. Exell & F.A. Mendonça* 636 & 644 (COI); **Malanje**, Quimbango, Congolo, Reserça da Palanca Negra Gigante (ou Reserva do Luando), 7 June 1970, *G. Barbosa et al.* 11963 (COI); **Uíge**, near small lagoon, through which water flows, S6°1' E15°24', alt. 803 m, 25 Feb. 2017, *T. Lautenschläger* 2017-02-139 & 2017-02-111 (DR). – **DRC**, **Equateur**, Ilema (Terr. Coquilhatville), 21 Mar. 1958, *Évrard* 3748 (BR); **Haut-Katanga**, Le long de la route Mitwaba – Manono, à 11 km de Mitwaba – Sermikat, 21 Apr. 1997, *Symoens* 3612 (BR); **Ituri**, Nioka (Mahagi), alt. 1700 m, 29 July 1960, *D. Froment* 758 (BR, P); **Kinshasa**, Route Soo-Ndunu, Maluku, 5 May 1971, *H. Breyne* 2190 (BR); **Kongo Central**, Binza, Route de Ngindinga à Kimvula, Territoire de Madimba, 15 Feb. 1960, *P. Compere* 1479 (BR); Kilenfu-Leg-Boko, S5°01' E15°11', 10 Feb. 2014, *Nsimundele* 2723 (BR); **Kwango**, Nto Mbombo, terr. Popokabaka, 9 Jan. 1959, *L. Pauwels* 1208 (BR); Tangi, alt. 700 m, Jan. 1930, *J. Lebrun* 127 (BR); **Lualaba**, Shaba, Kolwezi – Luena, km 114, Riv. Mutendele, 20 Jan. 1986, *Bamps & Malaisse* 8222 (BR); Environs de Kolwezi, vallée de la Kanamwamfwe, 23 Aug. 2004, *Malaisse & Kisimba* 134 (BR); **Sud-Kivu**, Massif du Kahuzi, Env. du 43 km de la route Bukavu-Walikale, alt. 2200 m, 22 Apr. 1970, *J. Lambinon* 78/228 (BR); **Tanganyika**, Kilunga (Marungu), Apr. 1945, *L. Dubois* 1416 (BR); 3 km à l'W. de Kasiki, Plateau des Marungu, alt. 2000 m, 12 June 1969, *S. Lisowski et al.* 6139 (BR); Mare Mufufu, Plateau des Marungu, alt. 1900 m, 14 June 1969, *S. Lisowski et al.* 6606 (BR).

**Note** — A very variable species with stems occasionally suppressed and dwarf forms (these show often suborbicular



to elliptic leaves and a reddish colour). Hybridisation with *D. elongata* and *D. affinis* is possible. Plants in South Africa with suppressed stems (*D. madagascariensis* var. *major* Burt Davy) were synonymized with *D. curvipes* Planch. and plants from southern Africa were synonymised with *D. ramentacea* Burch. ex DC. Both *D. curvipes* and *D. ramentacea* are now mostly accepted as separate taxa (Robinson et al. 2017). The distinct diagnostic features of *D. madagascariensis* (reflexed leaves, strongly curved base of inflorescence; Fig. 10) make most of the specimens easy to determine. However, the species is known to be highly variable in height, stem length and leaf size and shape depending on the habitat and available nutrients (Robinson et al. 2017). The dwarf form of *D. madagascariensis* (e.g., *H. Breyne* 4636) can be easily mistaken for *D. burkeana* or *D. pilosa*. To distinguish between these species leaf shape, seed shape and morphology and pollen morphology could be used. Furthermore, relatively large and robust specimens occur. Three large specimens are doubtfully determined as *D. madagascariensis* (partly *H. Hess* 50/188, *A.W. Exell* & *F.A. Mendonça* 644 and 636) showing very large obovate to elliptic laminae, densely pilose stems, scapes and leaves and more or less erect to strongly curved inflorescences.

### 9. *Drosera pilosa* Exell & J.R.Laundon — Fig. 11

*Drosera pilosa* Exell & J.R.Laundon (1956) 213; J.R.Laundon (1959) 4; (1970) 26; Troupin (1978) 305; A.S.Rob. et al. (2017) 1452. — Type: *A. Stolz* s.n. (holo BM), Tanzania, Tanganyika territory, Kyimbila District, North of Lake Nyasa, 1885.

Acaulescent, perennial herb (Fig. 11b). Leaves in a basal rosette; stipules c. 3 mm long, connate at the base, apex lacerated; lamina elliptic, ovate or obovate, 4–13 by 2–8 mm, the adaxial surface and margins bearing tentacles, abaxially pilose

(Fig. 11a); petiole 3–15 by up to 2 mm, gradually broadening into the lamina, abaxially pilose. Inflorescences cymose, with 2–6 flowers; peduncles 1 or 2 together, 2–16 cm long, arising laterally from the rosette, ascending, canaliculate, pilose; bracts elliptic, 2–3 mm long; pedicels 1–7 mm long, pilose. Sepals 5, ± elliptic, 3–6 by 1.5–2.5 mm, apex acute, pilose. Petals 5, c. 6 mm long, red to purple. Stamens 5; filaments c. 4 mm long. Pollen in tetrads, tetrads c. 40–45 µm diam, single grains 30–35 µm diam, echinate (to baculate; Fig. 11e), echini broadly conical, 1–2 mm long, in high density with short clavate sculptural elements between them. Pistil: ovary subglobose, c. 1.5 by 2 mm; styles 3, c. 2 mm long, bipartite to the base. Seeds ovoid, 0.3–0.5 by c. 0.2 mm, black, testa smooth (Fig. 11f).

Distribution — Angola, Burundi, Cameroun, DRC, Guinea, Kenya, Malawi, Ruanda, Sierra Leone, Tanzania (Fig. 11c).

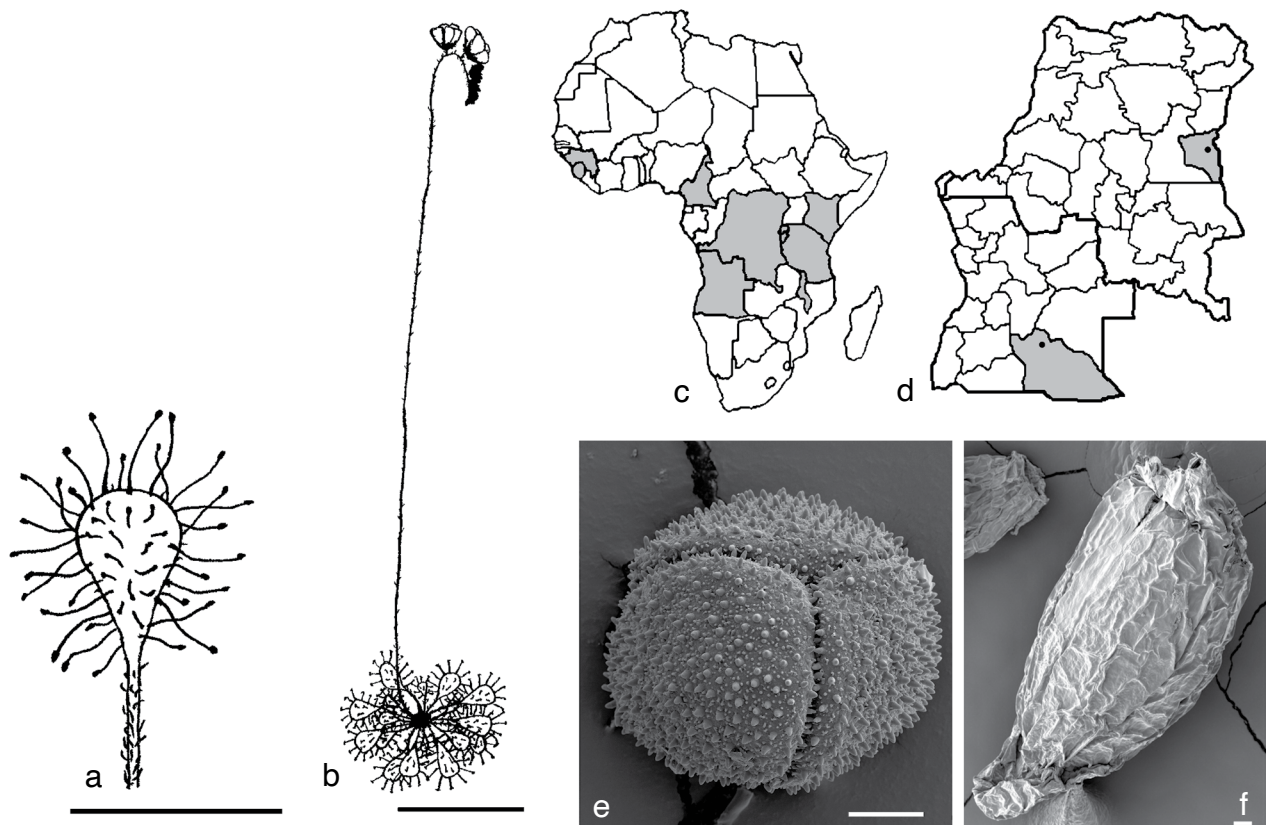
Habitat & Ecology — Montane species.

*Additional specimens* (see Fig. 11d for province map). ANGOLA, **Cuango Cubango**, Cuito-Cuanavale, Longa, vale do Cuiriri, alt. 1360 m, 19 Mar. 1960, *E.J. Mendes* 3212 (COI). — DRC, **Sud-Kivu**, Environs de Kitwabaluzi, S2°53' E28°35', Dec. 1942, *Coutreaux* 999 (BR); Kabare, alt. 2200 m, 9 Dec. 1956, *Christiansen* 1953 (BR); **Unknown province**, Luemba, Sept. 1946, *Kunet* 32 (BR).

Note — Very similar to *D. burkeana* but with pilose peduncle, pedicels and sepals.

### DISCUSSION

The carnivorous genus *Drosera* in Africa is relatively well studied and revised (recent revision for the whole genus in the '*Drosera* of the World'-series: Robinson et al. 2017). The different taxa are mostly well established and accepted in the majority of the different Floras and there is only little discussion about synonyms and accepted taxa. In this work the *Drosera*



**Fig. 11** *Drosera pilosa* Exell & J.R.Laundon. a. Leaf shape with the petiole broadening gradually into the lamina; b. general morpholog: acaulescent, leaves in a rosette and laterally arising, pilose inflorescences; c. distribution (grey) according to the literature; d. province map of Angola and DRC with localities of examined herbarium specimens; e. pollen in tetrads with echinate to baculate, broadly conical sculpture elements in high density; f. dry seed, 420 × 210 µm. — Scale bars: a = 1 cm; b = 2 cm; e = 10 µm; f = 20 µm.

species of Angola and the DRC were studied focusing on the taxonomy including the examination of general morphology, pollen morphology and distribution patterns. In Angola and the DRC, nine *Drosera* species occur.

For the genus *Drosera* several general morphological characters can be identified that work well for taxonomical purposes. In this study, concentrating on Angolan and Congolese taxa and working only with herbarium specimens, the arrangement of the leaves, lamina shape and petiole length (Fig. 2) and the hairiness of leaves, stems and inflorescences were found to be easily usable characters for identification and classification of the different species. For the taxonomical analysis of the different Angolan *Drosera* taxa, several difficulties can be observed:

1. Synonymy of *D. affinis* and *D. flexicaulis*: Both taxa were originally described as separate species in the Flora of Tropical Africa (Oliver 1871). With *D. affinis* described as an acaulescent herb with long slender petioles and *D. flexicaulis* described as a caulescent herb with an erect slender stem (Oliver 1871), the distinction between both taxa seems easy, but in the following years the majority of authors (e.g., Laundon 1970, 1978) decided to synonymize *D. flexicaulis* with *D. affinis* describing it as a caulescent herb with a stem length from 1–23 cm and long slender petioles. After examination of Angolan and Congolese specimens most of the specimens can be easily matched to the original descriptions. Differences in stem length, leaf arrangement and leaf/petiole length are sufficient characters to distinguish specimens of *D. affinis* (Fig. 3) from *D. flexicaulis* (Fig. 7). The possibility of hybridisation between these two species and thus, the occurrence of intermediate forms (Robinson et al. 2017), could explain why these two taxa were synonymized for such a long time.
2. Hybridisation: *Drosera affinis* and *D. flexicaulis* do not present the only example of hybridisation in the Angolan and Congolese taxa of the genus. Hybrids between *D. affinis* and *D. madagascariensis*, as well as between *D. elongata* and *D. madagascariensis* have been observed (Robinson et al. 2017). Two of the herbarium specimens examined showed some characteristics of *D. elongata* (stem length, petiole hairiness and stipule features) but lacked the typical leaf arrangement of the young leaves and lamina shape (*G.F. de Witte 06261* and *07540*). Those specimens could be interpreted as hybrids between *D. elongata* and *D. madagascariensis*. Additionally, two duplicates of *H. Hess 50/188* show an elongated, narrowly spatulate lamina shape and a very short stem while the rest of the plant resembles mostly *D. madagascariensis*. Those plants may be hybrids between *D. affinis* and *D. madagascariensis*. Overlapping distributions and habitats of most of the species (see distribution maps) as well as similarities in pollen size and surface sculpturing contribute to the possibility of hybridisation between the different African *Drosera* species. Hybrids are known throughout the genus, several of them recently described and published (WCSP 2021), e.g., *D. × legrandii* Lowrie & Conran (hybrid of the Australian *D. australis* (N.G. Marchant & Lowrie) Lowrie & Conran and *D. nitidula* Planch.) or *D. × fontinalis* Rivadavia (hybrid of the Brazilian *D. communis* A.St.-Hil. and *D. montana* A.St.-Hil.). For the African *Drosera* species so far only *D. × corinthiaca* R.P. Gibson & E. Green has been described (WCSP 2021) as a hybrid between *D. aliciae* Raym.-Hamet and *D. glabripes* (Harv. ex Planch.) Stein. Molecular genetic analysis could possibly be a tool for further analysis of hybrids of *Drosera* species.

Features of the plant pollen, especially the morphology and ultrastructure can also be a rich source of taxonomical infor-

mation. Often pollen characters are not only useful for plant identification, but also for the reconstruction of phylogenetic relationships (Walker & Doyle 1975, Simpson 2010). The pollen of *Drosera* shows distinct features that could be used for detailed taxon identification. All taxa show pollen tetrads ranging in diameter from 35–55 µm (single grains 23–35 µm) with echinate and short clavate surface sculptures. The differences between the taxa can be observed particularly in density, length and shape of the echini (e.g., compare *D. pilosa* in Fig. 11e and *D. indica* in Fig. 8e). For the integration of these characters into the identification key or the creation of a pollen key for the Angolan *Drosera* species a more detailed analysis is required to distinguish between taxa with very similar looking pollen (e.g., compare *D. elongata* in Fig. 6e and *D. madagascariensis* in Fig. 10e).

Although the study included seed coat analysis of only four species (*D. bequaertii*, *D. elongata*, *D. indica*, *D. pilosa*), some characteristic features could be identified and present a valuable addition for the identification and systematics of the African *Drosera* species. While in most species the testa is more or less smooth, showing only a low amount of reticulation, the seed coat of *D. indica* is considerably reticulate with transverse and longitudinal ridges. Further studies can hopefully complete this aspect.

**Acknowledgements** The University Kimpa Vita was an essential base for our fieldwork and provided logistical support. We are grateful to the Herbarium BR of the Botanic Garden Meise for the assistance. We also thank the Herbaria B, BR, COI, FR, H, P and ZT (Thiers continuously updated) for borrowing and allowing examination and sampling of their herbarium specimens. The fieldwork in Angola was supported by a travel fund from the German Academic Exchange Service (DAAD) and the program ‘Strategic Partnerships’ of the TU Dresden. These published results were obtained in collaboration with the Instituto Nacional de Biodiversidade e Conservação (INBC) of the Ministério da Cultura, Turismo e Ambiente da República de Angola. Since 2012 the Universidade Kimpa Vita in Uíge, Angola and the Technische Universität Dresden, Germany, have a multifaceted cooperation including the establishment of a Botanical Garden with the focus on the documentation of local medicinal plants as well as biodiversity assessments.

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