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

A. Rjosk¹,* C. Neinhuis¹, M. Monizi², T. Lautenschläger¹

### Key words

Angola  
Democratic Republic of the Congo  
*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.

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### 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, Huila 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 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 (caulescent taxa) and/or alternately spirally along the elongated stem (caulescent taxa; Fig. 1a5). The leaves vary in shape and size (e.g., linear, spathulate, 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 pentamorous (in some taxa tetramerous) flowers are composed of 5 connate sepals, 5 petals, 5 stamina 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 pentamorous. 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:

a. taxonomic analysis and identification of herbarium specimens collected in Angola and the Democratic Republic of the Congo;
b. assembly of all morphological characters of the different Angolan and Congolese taxa into species descriptions;
c. creation of distribution maps of the different Angolan and Congolese taxa;
d. 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 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


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; pediole 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. *Petals* 5 (rarely 4–8); ± connate at the base. *Pall.* 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, sand, seasonally and perennially wet and low-nutrient habitats.

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

1. Stipules absent, lamina linear ........................ 6. *D. indica*
2. Stipules present, lamina lanceolate, spatulate, obovate, ovate, elliptic, suborbicular or orbicular ........................ 2
3. Acaulescent, leaves in a basal rosette, leaves horizontal ........................ 3
4. Caulescent, including short stems (one to several cm long, rarely appearing acaulescent), young leaves erect, older leaves variable (erect, perpendicular to stem, reflexed) ........................ 5
5. Seeds fusiform, seed testa reticulate, peduncle strongly curved at the base, peduncle, pedicels and sepals glabrous, glandular or pilose, petals pink or purple. — Usually acaulescent, rarely dwarf forms with suppressed stems ........................ 8. *D. madagascariensis*
6. 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
7. Petiole narrow, abruptly broadening into the suborbicular to spatulate lamina, peduncle, pedicels and sepals glandular, petals white or purple, seed testa reticulate 3. *D. burkeana*
8. 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*
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 ± perpendicular to the stem (rarely reflexed), peduncle ± curved at the base 7
7. Stem up to 90 cm long, older (but still green) leaves ± perpendicular to stem, lamina obovate to elliptic, peduncles and petioles glabrous/sparsely pilose or densely pilose . 8
7. Stem shorter (max. 25 cm long, sometimes longer), older (but still green) leaves ± erect, lamina ± spatulate, peduncles and petioles glabrous/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 spatulate, spatulate 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
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 spatulate 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 μm diam, single grains c. 23–30 μm diam, echinate (Fig. 3e), echini ± conical, c. 2 μm 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).
Habitat & Ecology — Wet meadows, swamps, perennially wet places in seasonally dry wet-savannas.

Additional specimens (see Fig. 3d for province map). **Angola.** *Bíé*, Camacupa, Cuenda, quedas, alt. 1200 m, 6 Oct. 1965, Teixeira & Matos 8995 (BR); *Huila*, Huila, Oct. 1898, E. Dekindt 466 (BR); Na margem do rio Nene, a montante da ponte, junto da Estrada de Huila para Jau, 17 Dec. 1955, E.J. Mendes 1144 (COI); *Cuanza* and *Ruperto* (see Fig. 3d for province map). **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.

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; e. pollen in tetrads with echinate, conical sculpture elements in medium density. — Scale bars: a = 1 cm; b = 2 cm; e = 10 µm.

2. *Drosera bequaertii* Taton — Fig. 4


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, ferrugineous, 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 ovate, 3–4.5 by 1.5–2 mm, connate at the base, occasionally apex serrate, glandular. **Sepals** 5, lanceolate to ovate, 3–4.5 by 1.5–2 mm, bright pink. **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*. Cuv. de Kabiashia, rivière 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, $260 \times 130 \mu m$. — Scale bars: a = 1 cm; b = 2 cm; e = 20 \mu 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 m.
3. Drosera burkeana Planch. — Fig. 5


Perennial herb (sometimes annual), caulescent. 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 glandular (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-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), echin conical, c. 2 mm long, sometimes constricted in the middle, in low to medium density, with short gema te to clavate sculptural elements between echini. Pistil: ovary c. 1 by 1.5 mm, glandular; 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, Carrisso & Mendonca 245a (COI); Uige, Mucaba swampy area, S7°13'E5'5", alt. 1209 m, 23 Feb. 2017, L. Lautenschläger 2017-02-113 (DR). — DRC, Haut-Katanga, Parc National de l’Upemba, Kiluba, Luswahia, alt. 1880 m, 16 Jan. 1945, G.F. de Witte 03249 (BR); Parc National de l’Upemba, Kaziba, alt. 1300 m, 18 Apr. 1949, G.F. de Witte 05261 (BR); Haut-Katanga/Haut-Loamani, Parc National de l’Upemba, alt. 1680 m, 24 Apr. 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


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; pedicules 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 2.5–4.4 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), echin 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 at 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, Bie, 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 × 140 µm.

— Scale bars: a = 1 cm; b = 2 cm; e = 10 µm; f = 20 µm.

Fig. 7  *Drosera flexicaulis* Welw. ex Oliv. a. Leaf shape showing the slender petiole and the narrowly spathulate 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 µm.
Cussete – TFO core site, hilly landscape, fire in last dry season, S13°42′E17°5′, 19 Oct. 2012, M. Finckh 135547 (HBG); Cussete – 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 confluencia 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’WW de la tourée Oe de la Lut., Plateau des Kundelungu, alt. 1680 m, 25 Mar. 1969, S. Lisowski et al. 3789 (BR); près de la tourée Oe de la Lut., Plateau des Kundelungu, alt. 1670 m, 26 Mar. 1969, S. Lisowski et al. 3552 (BR); 2 km a l’E des tourées de la Lut., Plateau des Kundelungu, alt. 1600 m, 8 Jan. 1971, S. Lisowski et al. 13079 (BR); Lualaba, Plateau de la Manika (environs Katantania), 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’IW de la rivière Musonial vers le village Dijon, 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 1981) 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


Slender, annual, caulescent herb (Fig. 8b). Stems 3–50 cm long, erect or matted, canalicate, (sparously) glandular, green. Leaves alternate to spirally arranged, even 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 spathulate, 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, spathulate 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 tetrad, tetrad s. 50–55 µm, single grains c. 25 µm 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 2 cm, 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. Tchikaya, 20 km nördlich von Quinenge, gefunden auf nasser Felsplatte, alt. 1750 m, 13 Feb. 1955, J.B. Damann s.n. (sine numero) (ZT); Huila, Humpata, alt. 1800 m, 5 Apr. 1937, J. Gossweiler 11104 (COI); Entre là 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); Mozíco, Cameia National Park, Biodiversity Observatory, S11°31′E20°54′, alt. 1126 m, 3 May 2016, Finckh & Ziegelisi 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-Kinshasa, près Leopoldville, July 1944, Couteaux 1011 (BR); Kinsuka, 28 May 1947, E. Janet 490 (BR); île des Mimosas. Ngaliema, 1 June 1983, H. Breyne 4624 (BR); Kongo Central, Gombe Matadi, Jan. 1950, H. Callens 2594 (BR); Tshopo, Niomgaza (Uli-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 tetrad 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.
Drosera katangensis Taton — Fig. 9


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

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.

Drosera madagascariensis DC. — Fig. 10


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 acaulescent (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, ferrugineous; 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...
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-savannas).

**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); Cusseque – TFO core site, plain, alluvial plain, fire in last dry season, S13°42' E17°6', alt. 1515 m, 29 Oct. 2011, R. Revermann 132778 (HBG), M. Finkh 132768 (COI); *Cuando Cubango*, Baixo Cubango, 179 km von Cuangar in Richtung Cuando, sumpfiges Gelände am Rio Cubango, Moorboden, alt. 1070 m, 29 Jan. 1952, H. Hess 52/509 (ZT); Menongue, Vila Serpa Pinto, pr. da confluenza de Camumbe com o Cuebe, alt. 1420 m, 12 Feb. 1960, E.J. Mendes 2482 (COI); Cuito-Cuanavale, confluenza 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*, Mission de Humabo, Nov. 1942, C. Tisserant A310 (COI); Chiala, alt. 1700 m, 11 June 1962, Teixeira & Andrade 6446 (COI); Arredores de Nova Lisboa, Chiva, alt. 1700 m, 19 Mar. 1971, M. de Silva 3480 (BR, COI); *Huilá*, Serra de Chella, aux environs de Huila, alt. 1850 m, 1937, H. Humbert 16686 (P); Entlang einem Bache auf dem Hochplateau von Binme bei Humpata, alt. 2300 m, 9 Sept. 1950, H. Hess 50/188 (ZT); Lubango, Chipis, 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, Reserva da Piananca Negra Gigante (or Reserva do Luando), 7 June 1970, G. Barbosa et al. 11963 (COI); *Uige*, 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 (BR). – DRC, *Équateur*, Illema (Terr. Coquilhatville), 21 Mar. 1958, Évrard 3748 (BR); *Haut-Katanga*, Le long de la route Mwaba – Manono, à 11 km de Mwabwa – Sermikat, 21 Apr. 1977, Symoens 3612 (BR); *Ituri*, Nioka (Mahagi), alt. 1700 m, 29 July 1960, D. Froment 758 (BR, P); *Kinshasa*, Route Soo-Nduhu, Maluku, 5 May 1971, H. Breyne 2190 (BR); *Kongo Central*, Binza, Route de Ngudjina à Kinwula, Territoire de Madimba, 15 Feb. 1960, P. Compère 1479 (BR); *Kilifi-Njuri*, S5°01' E15°11', 10 Feb. 2014, Nsirnundele 2723 (BR); *Kwango*, Nto Mbombo, terr. Popokabaka, 9 Jan. 1959, L. Pauwels 1208 (BR); Tangi, alt. 700 m, Jan. 1930, J. Lebrun 127 (BR); *Luanda*, Shaba, Kolwezi – Luena, km 114, Riv. Mutendele, 20 Jan. 1966, Bamps & Malaissé 8222 (BR); Environs de Kolwezi, vallée de la Kanamwamvwe, 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*, Le long de la route Route Soo-Nduhu, Maluku, 5 May 1971, H. Breyne 2190 (BR); *Tongwe*, Binza, Route de Ngudjina à Kinwula, Territoire de Madimba, 15 Feb. 1960, P. Compère 1479 (BR); Kifunfu-Leg-Boko, S5°01' E15°11', 10 Feb. 2014, Nsirnundele 2723 (BR); *Zaire*, Librard, alt. 2000 m, 12 June 1969, S. Lisowski et al. 6139 (BR); *Zambia*, Luapula, 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 Burtt 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. Brenne 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


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.


**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*
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 acaulis herb with long slender petioles and *D. flexicaulis* described as a caulis 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 caulis 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 spathulate 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. & 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* Rayn.-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 information. Often pollen characters are not only useful for plant identification, but also for the reconstruction of phylogenetic relationships (Walker & Daynes 1975; Sinsch 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.

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