



## A taxonomic revision of *Boerhavia* (Nyctaginaceae) in southern Africa

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### ABSTRACT

The genus *Boerhavia* in southern Africa is revised. Eight species and one infraspecific taxon are recognized for the *Flora of Southern Africa* region, with *Boerhavia orbicularifolia* Struwig described as new. Four of the species are indigenous, with three endemic to semi-arid parts of Namibia and north-western South Africa. The eight species can be distinguished from one another by the shape and indumentum of the anthocarp. The majority of taxa have no edaphic preferences but *Boerhavia repens* subsp. *repens* is associated with high Mg levels. This is a first attempt at a comprehensive taxonomic revision for the genus in southern Africa, and includes a key to the species, complete nomenclature, and a description of all the infrageneric taxa. Taxon accounts are supplemented with geographical distribution records, notes on the ecology, soil preferences and known traditional uses.

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### 1. Introduction

*Boerhavia* L. is a genus of  $\pm 40$  species distributed in the tropical and subtropical regions of the world and is especially diverse in south-western North America (Douglas and Spellenberg, 2010). Sixteen species of *Boerhavia* occur in Africa (Klopper et al., 2006; African Plant Database, 2010), and seven in the *Flora of Southern Africa* region of which three are indigenous (*Boerhavia deserticola* Codd, *Boerhavia hereroensis* Heimerl and *Boerhavia repens* L. subsp. *repens*) (Germishuizen and Meyer, 2003), and four (*Boerhavia coccinea* Mill., *Boerhavia cordobensis* Kuntze, *Boerhavia diffusa* L. and *Boerhavia erecta* L.) are introduced from the Americas (Codd, 1966; Bromilow, 2010). *deserticola* and *B. hereroensis* are endemic to the region (Germishuizen and Meyer, 2003; Klopper et al., 2006).

*Boerhavia* species are annual or perennial herbs with a diffuse habit, campanulate flowers, and a 3–5-ribbed anthocarp that is either glabrous or glandular pubescent (Bittrich and Kühn, 1993; Jordaan, 2000). The taxonomy of the genus is problematic, as some species are exceptionally polymorphic and treated as complex groups, such as the *B. diffusa*–*B. coccinea* complex (Bogle, 1974; Thulin, 1993; Spellenberg, 2004; Chen and Wu, 2007). Worldwide, *Boerhavia* is often confused with *Commicarpus* Standl., although *Commicarpus* differs from *Boerhavia* in its climbing or scrambling habit, infundibuliform flowers, and 10-ribbed

anthocarps covered in large, viscid and mucilaginous glands (Meikle, 1978; Stannard, 1988; Struwig et al., 2011).

The *Boerhavia* species of southern Africa were first revised by Cooke (1912), who published a key and descriptions of three species. Codd (1966) later reviewed the *Boerhavia* species of southern Africa, and produced a key, description and notes on the distribution of each species. He described the new species *B. deserticola* Codd, but treated *B. coccinea* under the synonyms of *B. diffusa* L. var. *hirsuta* Heimerl and *B. diffusa* L. var. *viscosa* (Lag. & Rodr.) Heimerl. He also misidentified *Boerhavia cordobensis* as *Boerhavia pterocarpa* S. Wats., which is not a cosmopolitan weed and restricted to the Americas (Stirton, 1982).

The tropical African species have been reviewed by Stannard (1988) in *Flora Zambesiaca*, but this account only included *B. coccinea*, *B. diffusa*, *B. erecta* and *B. repens* from southern Africa. These four species, which are cosmopolitan weeds (Codd, 1966; Stannard, 1988), are also included in various accounts concerning the Floras of other parts of the world, including Whitehouse (1996), Spellenberg (2004), Chen and Wu (2007) and Diggs et al. (2008).

This contribution is a first attempt at a comprehensive taxonomic revision for the genus in southern Africa, and includes a key to the species, complete nomenclature, and a description of all the infrageneric taxa. Taxon accounts are supplemented with geographical distribution records, notes on the ecology, soil preferences and known traditional uses.

### 2. Materials and methods

Plant material of seven taxa was collected during fieldwork in Botswana, Namibia and South Africa. Specimens from the following

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southern African herbaria were studied: BLFU, BOL, GRA, J, KMG, KSAN, NH, NMB, NU, PRE, PRU, PUC, UCBG, UNIN, WIND and ZULU (acronyms according to Holmgren et al., 1990).

Fresh flower material was collected into 4% paraformaldehyde, and flowers taken from herbarium specimens were rehydrated for 10 min in boiling water. Three flowers per species (one each from Namibia, Botswana and South Africa, where available) were dissected and the length of the peduncle, pedicel, upper and lower portions of the perianth, stamens and ovary were measured. Mean length and width of anthocarps was determined by measuring ten herbarium specimens per species and three anthocarps per specimen ( $n = 30$ ). Morphological terminology follows Hickey and King (2000).

Distribution records and habitat information were obtained from herbarium specimens as well as observations made during field trips. Localities and species distribution patterns were mapped using ArcView 9.2 (ESRI, 2006). Information on traditional uses was gathered from herbarium label information, and a broad literature survey.

Where fresh plant material was sampled, soil from the top 100 mm of the root zone was also collected. This was repeated for five plants per population in 100 m<sup>2</sup> to make-up a composite soil sample for analysis. All soil samples were air dried and sent to Eco-Analytica for analysis (North-West University, Potchefstroom). Soils were analyzed for cation exchange capacity (CEC), electrical conductivity (EC), pH (H<sub>2</sub>O and KCl), phosphorus (using Bray method), nitrogen (NO<sub>3</sub><sup>-</sup>), sulfur (SO<sub>4</sub><sup>2-</sup>), and extractable K<sup>+</sup>, Mg<sup>2+</sup>, Ca<sup>2+</sup>, and Na<sup>+</sup>. A total extract of 29 metals was done per composite sample. Additionally, particle size distribution was conducted to determine the soil texture.

### 3. Morphology

#### 3.1. Vegetative morphology

*Boerhavia* species are either annual or perennial herbs. *B. deserticola* and *B. hereroensis* are erect, perennial herbs; *B. deserticola* developing numerous, erect stems up to 1 m long from a basal rosette, whereas those of *B. hereroensis* are diffuse, with branches  $\pm$  40 cm long (Fig. 1a). The remaining six species are prostrate or decumbent herbs (Fig. 1b). Among this group, *B. repens* can be distinguished by its prostrate habit and small (less than 30 mm), elliptic leaves of variable sizes at the nodes. *Boerhavia orbicularifolia* is a small herb up to 200 mm tall and not spreading. Vegetative characters do not allow for the further separation of the remaining four species.

The shape of the leaves is variable (Fig. 2) but the species can be divided into two groups. Leaves of *B. coccinea*, *B. cordobensis*, *B. diffusa*, *B. erecta* and *B. orbicularifolia* are relatively broad (oblong to ovate or obovate, or orbicular), whereas those of *B. deserticola*, *B. hereroensis*

and *B. repens* are narrower (linear to elliptic or lanceolate). Leaves in *B. repens* are somewhat dimorphic, with one leaf of each pair larger than the other.

#### 3.2. Reproductive morphology

The inflorescence in *Boerhavia* is a much branched, compound cyme, consisting of a primary peduncle and anthoclinium (rachis/inflorescence axis) with secondary peduncles and anthocliniums (Fig. 3). The primary peduncles are typically or usually 20–150 mm long and the secondary peduncles 5–45 mm long (Table 1). The flowers of *B. orbicularifolia* are either solitary or carried in umbels of up to four flowers per cluster.

The perianth in *Boerhavia* is campanulate (Fig. 4) and divided into an upper petaloid part and a lower, coriaceous part (Fig. 4a). The upper petaloid part is colored white, pink or purple and is 1–4 mm long (Table 1). The lower coriaceous part of the perianth is 1–2 mm long and can be ellipsoid (*B. coccinea*, *B. repens* and *B. orbicularifolia*), clavate (*B. cordobensis* and *B. erecta*), ellipsoid-clavate (*B. diffusa*) or ovoid (*B. deserticola* and *B. hereroensis*) (Fig. 5) and is either 5-ribbed (*B. coccinea*, *B. deserticola*, *B. diffusa*, *B. hereroensis*, *B. repens*, and *B. orbicularifolia*) or 3–5-winged (*B. cordobensis* and *B. erecta*). In addition it is either glabrous (*B. cordobensis*, *B. deserticola* and *B. erecta*) or covered with multicellular, glandular trichomes (*B. coccinea*, *B. diffusa*, *B. hereroensis*, *B. repens*, and *B. orbicularifolia*) (Fig. 5).

After fertilization, the upper, petaloid part of the perianth abscises and the lower, coriaceous part enlarges and develops into a protective structure around the fruit termed the anthocarp (Joshi and Rao, 1934; Vanvinckenroye et al., 1993; Hickey and King, 2000). The shape of the anthocarp, presence of ribs or wings, and the presence or absence and position of glandular hairs are diagnostic for the southern African *Boerhavia* species (Struwig, 2012).

Anthocarps among the southern African species are rather consistent in size, 3–5 × 1–2 mm (Table 2), and either clavate (*B. cordobensis* and *B. erecta*) or ellipsoid-clavate (*B. coccinea*, *B. deserticola*, *B. diffusa*, *B. hereroensis*, *B. repens*, and *B. orbicularifolia*) (Fig. 6). In most species the anthocarps have five conspicuous ribs except in *B. cordobensis*, which has 3–4 wings, and in *B. erecta* which has five wings (Fig. 7). The anthocarp ribs are broader in the southern African endemics, *B. deserticola* and *B. hereroensis* than the other species in the subregion. Anthocarps are glabrous in *B. cordobensis*, *B. deserticola*, and *B. erecta* but are covered with glandular trichomes in *B. coccinea*, *B. diffusa*, *B. hereroensis*, *B. repens*, and *B. orbicularifolia* (Fig. 6).

The anthocarps in *B. cordobensis*, *B. diffusa* and *B. erecta* are pointed apically but obtuse or rounded in the other species, and *B. diffusa* has a characteristic indentation at the apex of the anthocarp (indicated by a white arrow on Fig. 6d).

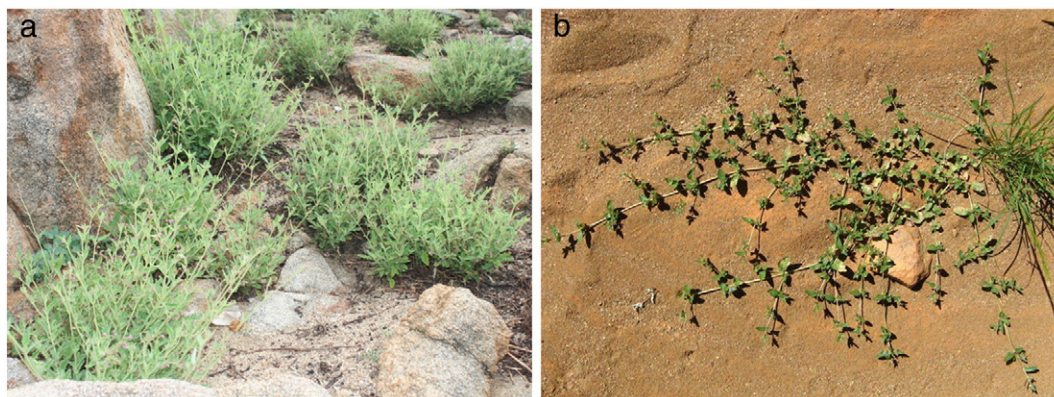
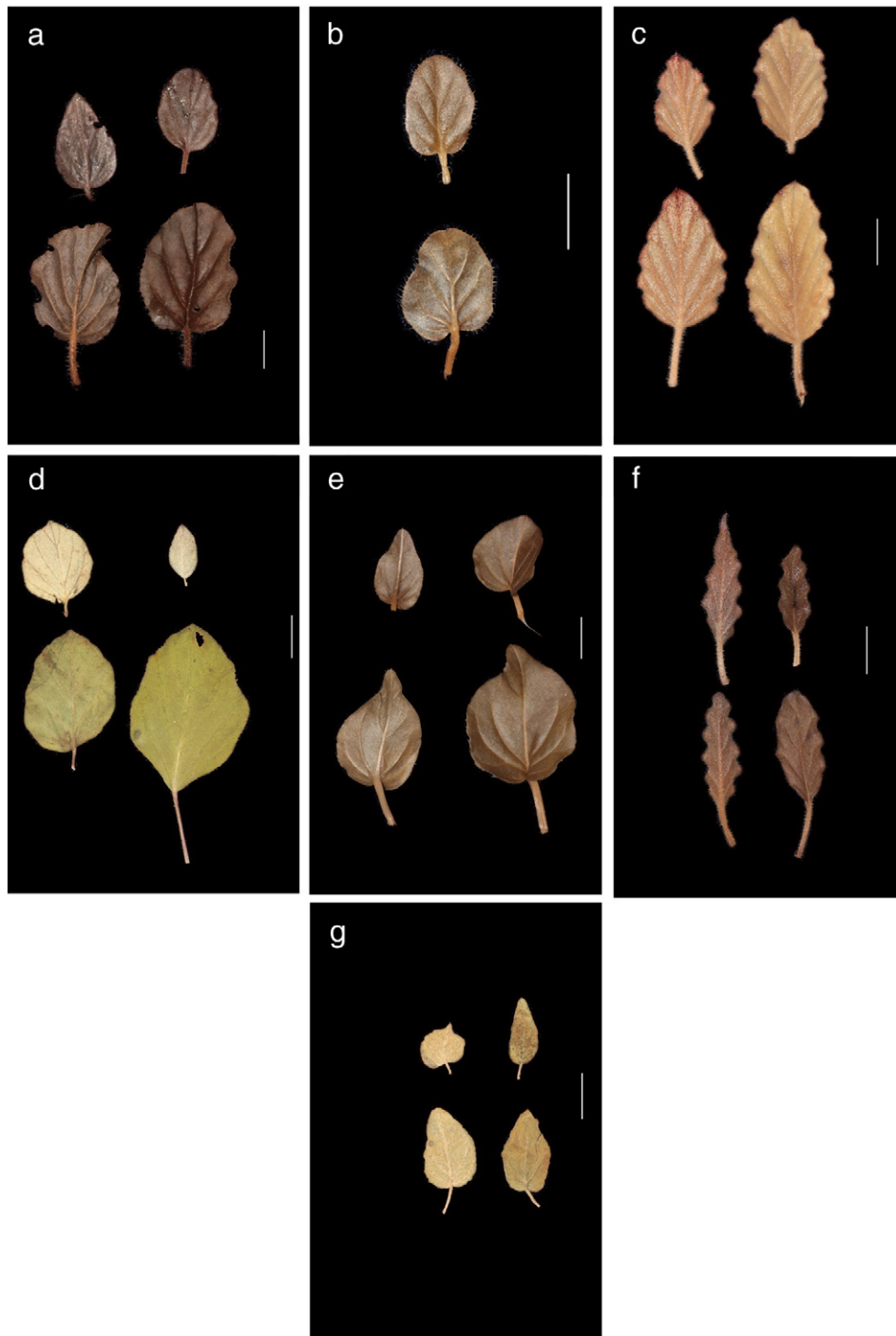


Fig. 1. Growth forms of southern African *Boerhavia* species. (a) Upright growth form of *B. hereroensis* (Photo: S.J. Siebert); (b) prostrate growth form of *B. repens* subsp. *repens* (Photo: A. Dreyer).



**Fig. 2.** Micrographs showing the leaf shape of *Boerhavia* species. (a) *Boerhavia coccinea*; (b) *Boerhavia cordobensis*; (c) *Boerhavia deserticola*; (d) *Boerhavia diffusa*; (e) *Boerhavia erecta*; (f) *Boerhavia hereroensis*; (g) *Boerhavia repens* subsp. *repens*. Scale bars 10 mm.

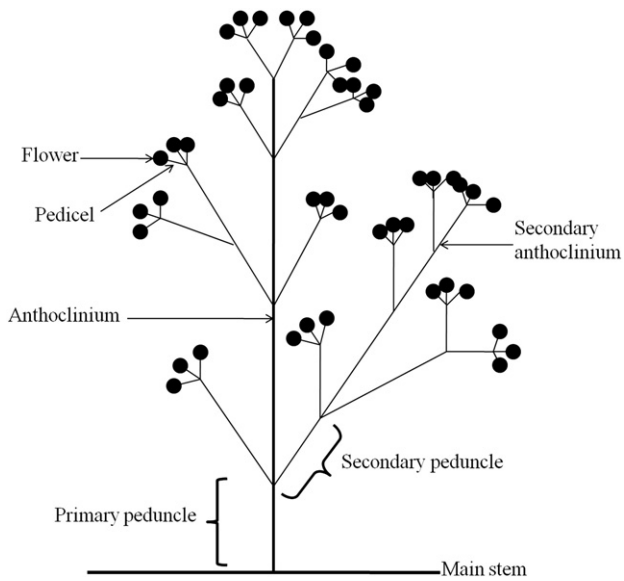
#### 4. Taxonomy

##### 4.1. *Boerhavia*

L., Sp. Pl. 1: 3 (1753); Gen. Pl. ed., 5: 9 (1754); Standl. in Contr. U.S. Natl. Herb 12: 375 (1909), in Contr. U.S. Natl. Herb. 13: 418 (1911), in N. Amer. Fl. 21(3): 204 (1918), Publ. Field Mus. Nat. Hist., Bot. Ser. 11(3): 105 (1931); Heimerl in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 16C: 117 (1934); Codd, Bothalia 9(1): 113 (1966); Schreib. in Prodr. Fl. S.W. Afr. 25: 1 (1969); Stannard in F.Z. 9(1): 20 (1988); Thulin in Fl. Somalia 1: 169 (1993); Whitehouse in F.T.E.A.: 2 (1996); Jordaan in Strelitzia 10: 424 (2000). Type: *Boerhavia erecta* L.

Annual or perennial herbs. Stems slender, erect, decumbent, diffuse or prostrate, woody towards base, glabrate to pubescent, with glandular hairs. Leaves opposite, petiolate; lamina linear or orbicular, obtuse to apiculate, base attenuate to truncate, margins entire or sometimes undulate, glabrous to pubescent. Inflorescence a much-branched terminal or axillary compound cyme or umbel, glabrous to puberulous, bracteate. Flowers 1–5 mm long, bisexual, shortly pedicillate. Perianth divided into a lower and upper part; lower part 1–2 mm long, green or sometimes reddish, coriaceous, constricted above the ovary, ovoid to clavate, 3–5-winged or 5-ribbed, glabrous or with glandular hairs, persistent; upper part 1–4 mm long, campanulate, sometimes with a basal tube, petaloid, pink, purple, maroon or white, caducous after





**Fig. 3.** Schematic representation of the compound cymes of the southern African *Boerhavia* species, showing the position of the primary and secondary peduncles, anthocliniums and pedicels.

anthesis. *Stamens* 1–5, exserted; filaments filiform, connate at base forming a short sheath around ovary; anthers dithecos. *Ovary* ellipsoid, stipitate, 1-ovulate; style filiform, exserted; stigma capitate. *Anthocarp* 3–5 × 1–3 mm, ellipsoid-clavate or clavate, 3–5-winged or 5-ribbed; acute or obtuse; glabrous or covered with glandular hairs; secretes a hygroscopic mucoidal secretion which is produced in columnar cells in the ribs, especially when wetted. *Seed* oblong, brown, with smooth surface; endosperm scanty; embryo hooked.

#### 4.1.1. Distribution and habitat

In southern African *Boerhavia* species are distributed throughout Botswana, Namibia, South Africa and Swaziland (Fig. 7) and prefer well-drained, stony, sandy or loamy soil in dry watercourses or riverbeds and on mountain- or hill slopes in full sun at altitudes of 5–2000 m. Soils ( $N = 20$ ) in which *Boerhavia* species grow are generally lower in nutrients than soils ( $N = 37$ ) associated with *Commicarpus* species (Struwig and Siebert, 2013). This is reflected by the Electric Conductivity values of soils in this study that are half that of soil samples from *Commicarpus* habitats and is ascribed to

substantially lower levels of N, Ca, K and Na. In contrast and probably linked with the preference that many *Boerhavia* species have for disturbed sites, the associated metal concentrations of Cu, Fe, Pb and Zn is higher for soil of *Boerhavia* species.

#### 4.1.2. Phenology

Flowers and fruits are present throughout the year (January to December).

#### 4.1.3. Etymology and common names

*Boerhavia* was named after Hermann Boerhaave (1668–1738), an eighteenth century Dutch botanist, humanist and physician at the University of Leiden. The generic name is often written in the literature as *Boerhaavia* (Bojer, 1842; Hiruma-Lima et al., 2000), but Linnaeus Latinized Boerhaave's name to *Boerhavius* and adopted the spelling *Boerhavia*, which is the correct spelling to be used (Sprague, 1928; Bogle, 1974; Spellenberg, 2004).

*Boerhavia* species are commonly referred to as spiderlings, due to the long, slender, sticky peduncles that resemble a spider's web. In Afrikaans *Boerhavia* species are known as *kleebossies*, referring to the stickiness of the plants and especially their anthocarps.

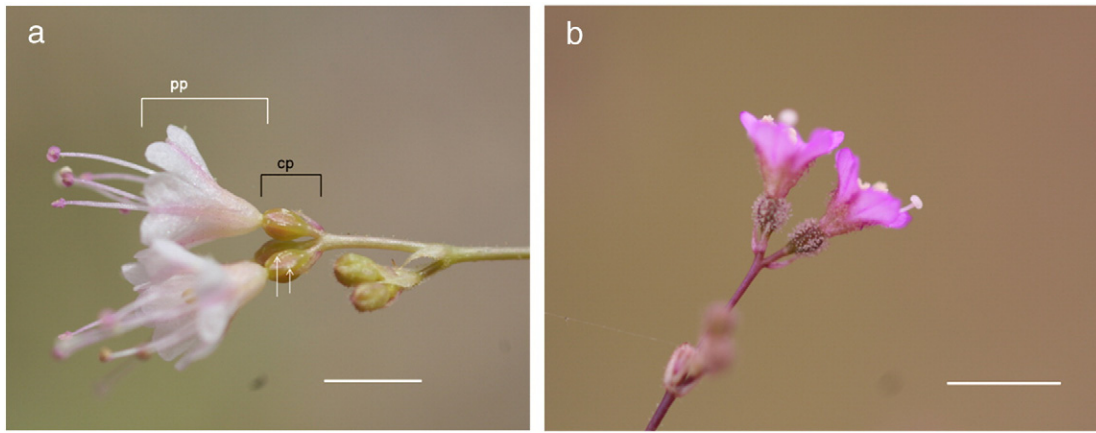
#### 4.2. Key to the species and infraspecific taxa of southern African Boerhavia

- 1a. Plants erect; leaves mostly elliptic-lanceolate, sometimes ovate or oblong.....2.
- 1b. Plants prostrate or decumbent; leaves mostly oblong to orbicular, sometimes elliptic-lanceolate.....3.
- 2a. Lower coriaceous part of perianth and anthocarp glabrous.....*B. deserticola*.
- 2b. Lower coriaceous part of perianth and anthocarp covered in glandular hairs.....*B. hereroensis*.
- 3a. Anthocarp and lower coriaceous part of perianth clavate and glabrous.....4.
- 3b. Anthocarp and lower coriaceous part of perianth ellipsoid-clavate and covered with glandular hairs.....5.
- 4a. Lower coriaceous part of perianth 3–4-ribbed with apices of ribs expanded; anthocarps 3–4-winged, wings straight and not undulate, apices broadly truncate .....*B. cordobensis*.
- 4b. Lower coriaceous part of perianth 5-ribbed with apices of ribs slightly expanded; anthocarps 5-winged, wings undulate, apex truncate.....*B. erecta*.

**Table 1**

Length of the primary and secondary peduncles, flower length, perianth color, and lower floral indumentum of southern African taxa of *Boerhavia*.

Taxon	Length of primary peduncle (mm)	Length of secondary peduncle (mm)	Flower length (mm)	Length upper floral part (mm)	Length lower floral part (mm)	Perianth color	Shape and indumentum of lower floral part
<i>Boerhavia coccinea</i>	(54–) 91 (–118)	(32–) 38 (–43)	(1–) 2.5 (–4)	(1–) 1.6 (–3)	(1–) 1.3 (–1.5)	Pink, white, purple	Ellipsoid, 5-ribbed, glandular hairs present
<i>Boerhavia cordobensis</i>	(60–) 105 (–130)	(20–) 27 (–35)	3	(1.5–) 1.6 (–2)	(1–) 1.4 (–1.5)	Dark purple, purple, pink	Clavate, 3 or 4-winged with apices of ribs expanded, glabrous
<i>Boerhavia deserticola</i>	(95–) 108 (–120)	(34–) 37 (–40)	(4–) 4.5 (–5)	(3–) 3.2 (–4)	(1–) 1.3 (–2)	White, purple	Ovoid, 5-ribbed, glabrous
<i>Boerhavia diffusa</i>	(60–) 105 (–150)	(25–) 42 (–60)	(2–) 2.1 (–3)	(1–) 1.1 (–2)	1	White, pink	Ellipsoid-clavate, 5-ribbed, glandular hairs present
<i>Boerhavia erecta</i>	115	(55–) 60 (–65)	(2–) 2.1 (–3)	1	(1–) 1.1 (–2)	White, pink, purple, reddish	Clavate, 5-winged, glabrous
<i>Boerhavia hereroensis</i>	65	27	(2–) 3.2 (–4)	(1–) 2.2 (–3)	1	Purple, pink	Ovoid, 5-ribbed, long glandular hairs present
<i>Boerhavia repens</i> subsp. <i>repens</i>	(20–) 22 (–24)	(5–) 10 (–20)	(2–) 2.3 (–3)	1	(1–) 1.3 (–2)	White, pink, purplish	Ellipsoid, 5-ribbed, glandular hairs present in the grooves between the ribs
<i>Boerhavia orbicularifolia</i>	2	N/A	2	1	1	White	Ellipsoid-clavate, 5-ribbed, glandular hairs present



**Fig. 4.** Flowers of (a) *Boerhavia deserticola* showing the upper, petaloid part (pp) and the lower, coriaceous part of the flower (cp). Arrows indicate the ribs on the lower part of the flower. Scale bar 3 mm; and (b) flower of *Boerhavia hereroensis*. Scale bar 4 mm (Photos: S.J. Siebert).

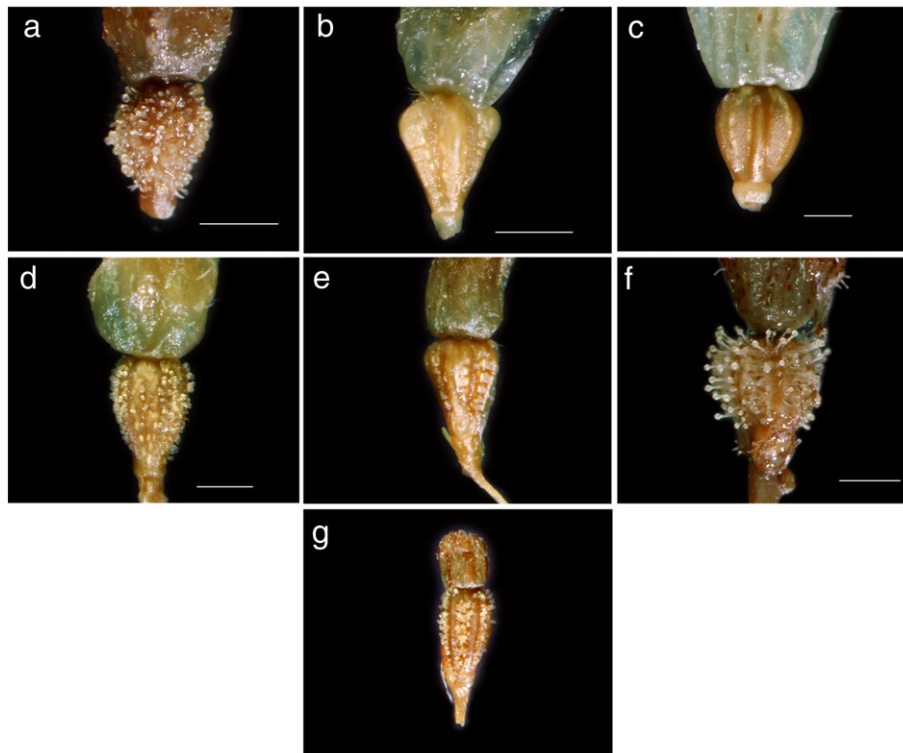
- 5a. Anthocarp 5-ribbed, with indentation near apex, apex acute, calcium oxalate crystals conspicuous between ribs.....*B. diffusa*.
- 5b. Anthocarp 5-ribbed, with rounded apex, calcium oxalate crystals not conspicuous between ribs.....6.
- 6a. Inflorescence an umbel or flowers solitary; plant with short stems up to 100 mm long .....*B. orbicularifolia*.
- 6b. Inflorescence a compound cyme; plant with long trailing stems up to 2 m long.....7.
- 7a. Leaves > 30 mm long; anthocarp narrowly ellipsoid-clavate ( $\geq 4$  mm long).....*B. coccinea*.
- 7b. Leaves < 30 mm long; anthocarp ellipsoid-clavate ( $\leq 4$  mm long) ..... *B. repens* subsp. *repens*.

4.3. *Boerhavia coccinea*

Mill., Gard. Dict., ed. 8, *Boerhavia* no. 4 (1768); Standl. in N. Amer. Fl. 21(3): 205 (1918), Publ. Field Mus. Nat. Hist., Bot. Ser. 11(3): 107 (1931); Troupin in Fl. Rwanda 1: 208 (1978); Stannard in F.Z. 9(1): 22 (1988); Thulin in Fl. Somalia 1: 170 (1993); Whitehouse in F.T.E.A.: 5 (1996); Dequan & Gilbert in Fl. China 5: 433 (2003); Chen & Wu, in Taiwan 52(4): 333 (2007). Type: Jamaica, *Houston s.n.* (BM, neo. — image!), chosen by Hewson & Meikle in Fl. Australia 4: 318 (1984).

*Boerhavia hirsuta* Jacq., Hort. Bot. vindob. 1: 3, t7 (1770). Type: Peru (MA). [fide Whitehouse, 1996].

*Boerhavia caribea* Jacq., Observ. Bot. 4: 5, t84 (1771). Type: Martiniq. [fide Whitehouse, 1996].



**Fig. 5.** Shape and indumentum of the lower part of the flower of *Boerhavia* species. (a) *Boerhavia coccinea*. Scale bar 0.8 mm; (b) *Boerhavia cordobensis*. Scale bar 1 mm; (c) *Boerhavia deserticola*; (d) *Boerhavia diffusa*. Scale bars 0.5 mm; (e) *Boerhavia erecta*. Scale bar 1 mm; (f) *Boerhavia hereroensis*. Scale bar 0.5 mm; (g) *Boerhavia repens* subsp. *repens*. Scale bar 2 mm.

**Table 2**  
Dimensions, shape and indumentum of anthocarps of southern African taxa of *Boerhavia*.

Taxon	Dimensions (mm)	Shape	Indumentum
<i>Boerhavia coccinea</i>	(3–) 4.1 (–5) × (1–) 1.4 (–2)	Narrowly ellipsoid-clavate	5-ribbed, rounded at the apex, glandular hairs between and sometimes on ribs
<i>Boerhavia cordobensis</i>	(3–) 3.5 (–4) × (2–) 2.3 (–3)	Clavate	3 or 4 winged, broadly truncate at the apex, apex ends in a pointed tip, glabrous
<i>Boerhavia deserticola</i>	(3–) 3.9 (–5) × (1–) 1.8 (–2)	Ellipsoid-clavate	5-ribbed, rounded at the apex, glabrous
<i>Boerhavia diffusa</i>	(3–) 3.4 (–4) × (1–) 1.4 (–2)	Ellipsoid-clavate	5-ribbed, with a slight indentation near the apex, apex ends in a pointed tip, glandular hairs present on ribs
<i>Boerhavia erecta</i>	(3–) 3.2 (–4) × (1–) 1.5 (–2)	Clavate	5-winged, wings slightly undulate along the margins, apex truncate, apex ends in a pointed tip, glabrous
<i>Boerhavia hereroensis</i>	(3–) 3.5 (–4) × (1–) 1.7 (–2)	Ellipsoid-clavate	5-ribbed, rounded at the apex, long glandular hairs present
<i>Boerhavia repens</i> subsp. <i>repens</i>	(3–) 3.3 (–4) × (1–) 1.2 (–2)	Ellipsoid-clavate	5-ribbed, rounded at the apex, glandular hairs present between ribs, rarely on ribs
<i>Boerhavia orbicularifolia</i>	3 × 1	Ellipsoid-clavate	5-ribbed, rounded at the apex, glandular hairs present between and on ribs

*Boerhavia* [as *Boerhaavia*] *viscosa* Lag. & Rodr. in *Anales C. Nat.* 4: 256 (1801). *Boerhavia* [as *Boerhaavia*] *diffusa* var. *viscosa* (Lag. & Rodr.) Heimerl, *Beitr. Syst. Nyctag.* 27 (1897). *Boerhavia coccinea* var. *viscosa* (Lag. & Rodr.) Moscosa, *Cat. Fl. Doming.* 1: 180 (1943). Type: originally from Peru, flowered during June and July in Real Jardin Botánico de Madrid (M). [fide Whitehouse, 1996].

*Boerhavia diffusa* Sw., *Observ. Bot.*: 10 (1791). [fide Standley 1918].

*Boerhavia decumbens* Vahl, *Enum. pl.* 1: 284 (1804). Type: Central Paraguay. Morong 93 (PH). [fide Standley 1918].

*Boerhavia* [as *Boerhaavia*] *viscosa* Jacq., *Fragm. bot.*: 41, t46/2 (1804), *nom illegit.*, non Lag. & Rodr. (1801). Type: t. 46/2 in Jacq. *Fragm. Bot.* (1804). [fide Whitehouse, 1996].

*Boerhavia* [as *Boerhaavia*] *laxa* Pers., *Syn. pl.* 1: 36 (1805). Type: In Cayenna. [fide Standley 1918].

*Boerhavia repens* var. *viscosa* Choisy in *DC. Prodr.* 13(2): 453 (1849). Type: Egypt or Arabia, “Thal Arbain”, May, Rüppell (FR, holo.). [fide Whitehouse, 1996].

*B. diffusa* var. *hirsuta* Heimerl, E.J. 10: 9 (1888). Type: South Africa, Northern Cape, Kuruman, Marloth 1102 (B, holo.; PRE, iso.). [fide Whitehouse, 1996].

*Boerhavia* [as *Boerhaavia*] *diffusa* var. *paniculata* Kuntze, *Revis. gen. pl.* 2: 533 (1891). [fide Standley 1918].

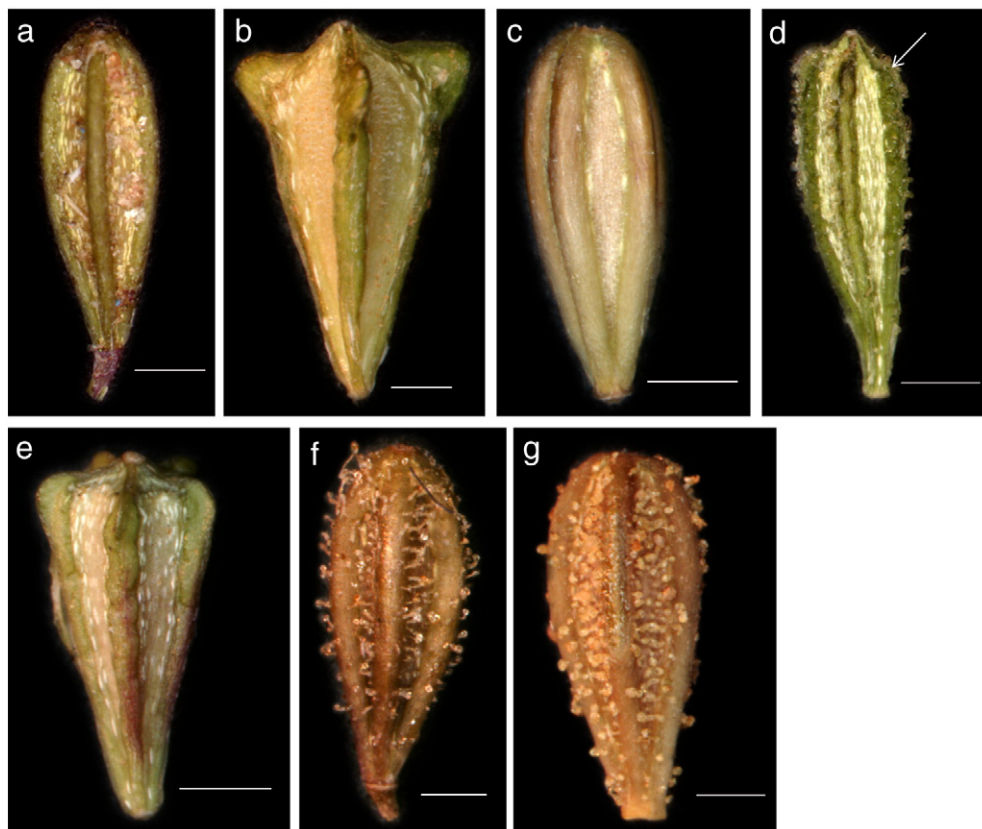
*Boerhavia bracteata* Cooke, K.B. 1909: 421 (1909). Type: South Africa, Mpumalanga, Avoca near Barberton, Galpin 1240 (K, lecto. designated by Whitehouse in F.T.E.A.: 6 (1996); PRE, iso.).

*Boerhavia* [as *Boerhaavia*] *coccinea* f. *parcehirsuta* Heimerl in *Symb. antill.* 7: 212 (1912). [fide Standley 1918].

*Boerhavia coccinea* var.  $\alpha$  Meikle in F.W.T.A. 2(1): 178, fig 66 (1954). [fide Whitehouse, 1996].

*Boerhavia marlothii* Heimerl in E.J. 10: 10 (1888). Type: Hereroland, Otjimbingwe, Namibia, 1886, Marloth 1372 (B, holo., PRE, iso.).

[*B. repens* var. *diffusa* sensu Baker & C.H. Wright in F.T.A. 6(1): 5 (1909), *pro parte, excl. syn.*, non [Whitehouse, 1996], misapplied name.] [fide Whitehouse, 1996].



**Fig. 6.** Longitudinal view of the anthocarps of *Boerhavia* species (a) *Boerhavia coccinea*; (b) *Boerhavia cordobensis*; (c) *Boerhavia deserticola*; (d) *Boerhavia diffusa*; (e) *Boerhavia erecta*; (f) *Boerhavia hereroensis*; (g) *Boerhavia repens* subsp. *repens*. Scale bars 1 mm.



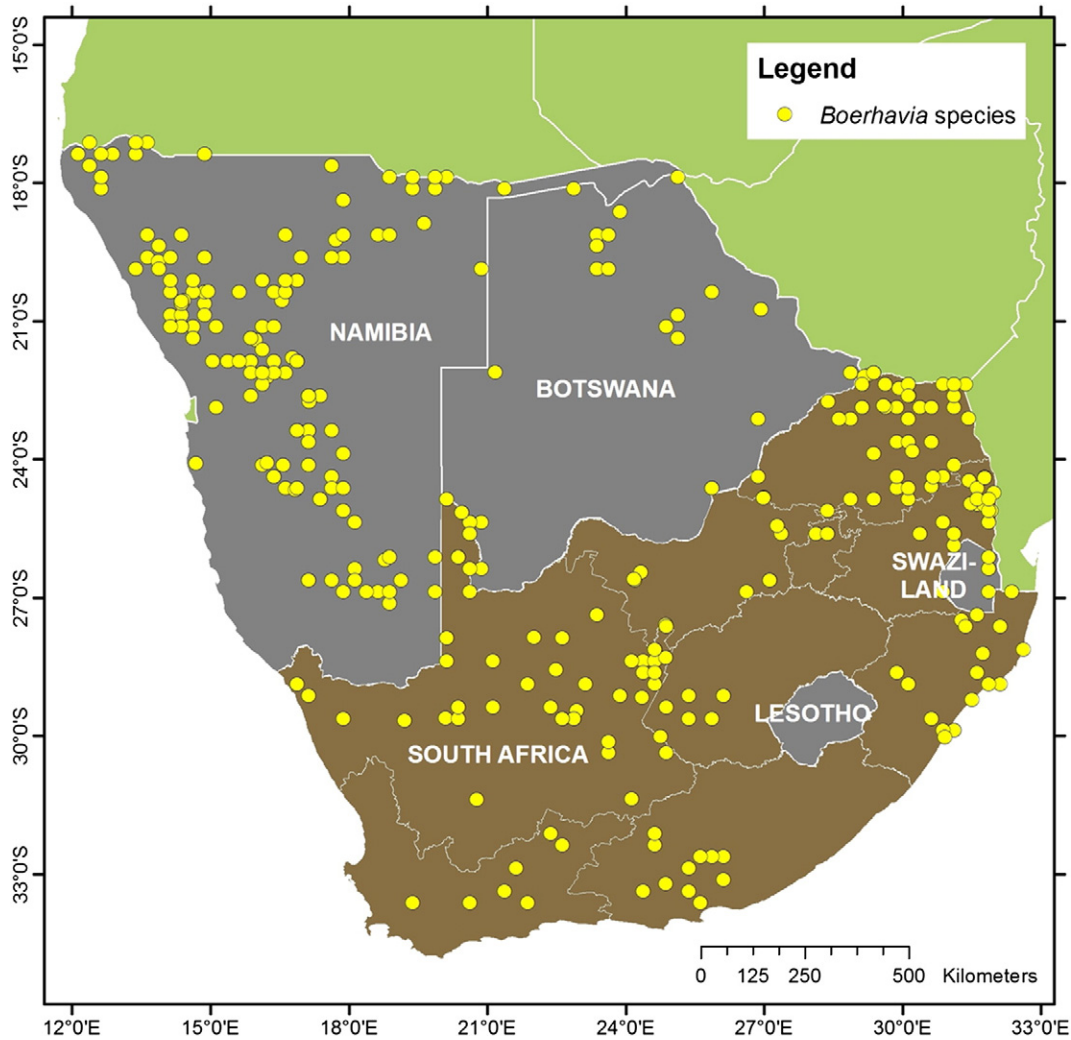


Fig. 7. Known distribution of *Boerhavia* in southern Africa.

[*B. diffusa* sensu F.W.T.A. 1: 152 (1927), non L. (Whitehouse, 1996), misapplied name.] [fide Whitehouse, 1996].

Stems decumbent or prostrate, glabrate to densely pubescent, often with long septate hairs. Leaves with petioles (3–) 5–15 (–25) mm long; lamina elliptic, oblong, ovate, lanceolate or oval, (11–) 13–40 (–42) × (9–) 10–30 (–33) mm; apex acute, apiculate or rounded; base shortly attenuate or rounded; margins entire; glabrous to puberulous, often with long septate hairs along veins and margins. Inflorescence with primary peduncles 54–118 mm long, secondary peduncles 32–43 mm long; 3–many flowers per cluster; pedicels 1 mm long. Flowers 1–4 mm long; lower part of perianth 1–1.5 mm long, ellipsoid, 5-ribbed, glandular hairs present; upper part of perianth 1–3 mm long, pink, purple or white. Stamens 1–5, 1.5–4.5 mm long. Ovary 0.4–0.6 mm long; style 1.3–4.0 mm. Anthocarp 3–5 × 1–2 mm, narrowly ellipsoid-clavate, 5-ribbed, with glandular hairs between ribs, ribs themselves glabrous or covered with hairs.

#### 4.3.1. Intraspecific taxa

*B. coccinea* is a member of the *B. diffusa*–*B. coccinea* complex of which the taxa and their diagnosis is uncertain and in need of taxonomic clarification (Whitehouse, 1996; Spellenberg, 2004; Chen and Wu, 2007). The complex is extremely variable with regard to robustness, pubescence and fruit number in individual inflorescences (Spellenberg, 2004).

These uncertainties are enhanced at infraspecific level. Pubescence is used to distinguish between the infraspecific taxa of *B. coccinea* in Africa, but the variation thereof makes clear demarcations doubtful

(Whitehouse, 1996). Currently two varieties are recognized: var. *coccinea* which occurs in both tropical and southern Africa, and var. *pubescens* (Choisy) Cufod. which only occurs in tropical Africa (Klopper et al., 2006). The young stems of *B. coccinea* Mill. var. *pubescens* are pubescent hairy [isotype: *Kotschy 160* (WAG, Br)]. However, pubescent and glabrate specimens from southern Africa fit the descriptions of *B. diffusa* var. *hirsuta* and *B. diffusa* var. *viscosa* (Codd, 1966), which are both synonyms of *B. coccinea* var. *coccinea* (Stannard, 1988; Whitehouse, 1996). The distinction between the two varieties is therefore not clear and the southern African specimens are treated in the broad sense and not at infraspecific level.

Two forms of *B. coccinea* occur in southern Africa, the typical crimson-flowered neotropical taxon and a pink- or cream-flowered taxon with larger fruit. Molecular work is underway to determine the identity of these taxa.

#### 4.3.2. Distribution and habitat

*B. coccinea* is considered to be native to the neotropics (Chen and Wu, 2007), although it is naturalized throughout the tropics and widely regarded as a cosmopolitan species (Whitehouse, 1996). It is distributed throughout Central America, South America, Mexico, West Indies, Eurasia, Africa and Australia. In southern Africa *B. coccinea* occurs in Namibia, Botswana and Swaziland, and in the KwaZulu-Natal, Limpopo, Mpumalanga and Northern Cape provinces of South Africa (Fig. 8). Although Codd (1966) regarded this species to be

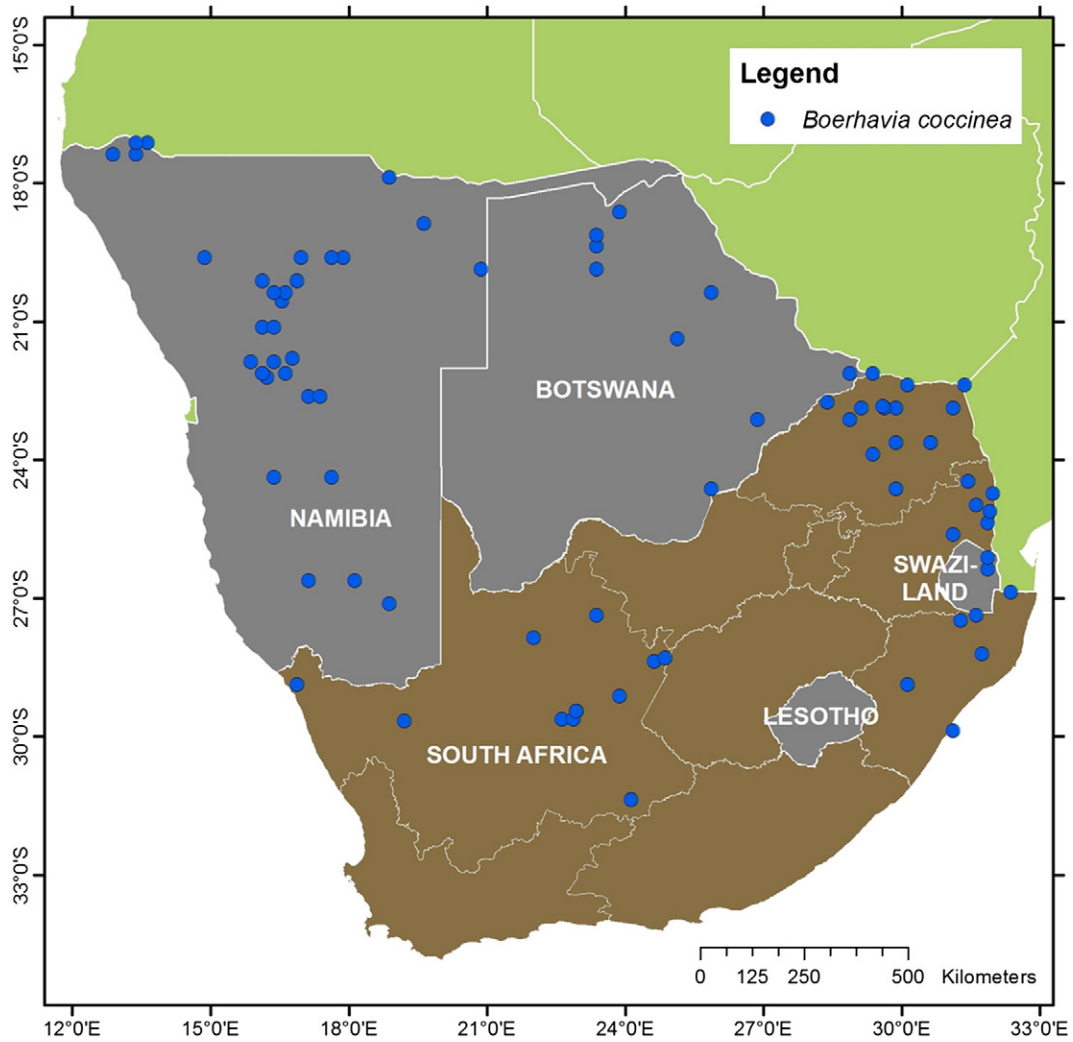


Fig. 8. Known distribution of *Boerhavia coccinea* in southern Africa.

indigenous to southern Africa, Whitehouse (1996) and Chen and Wu (2007) regard it to be introduced to Africa.

Plants are found on riverbanks, hills or mountains and on ridges, often along roadsides, on quartzite, dolomite or dolerite in shade to full sun at altitudes of 350–2 000 m. The species is associated with well-drained stony or sandy (88%) soil that contains higher levels of K and Fe than recorded for most other species in the genus (Tables 3 and 4). The highest mean level of Cu (130.15 mg/kg) in this study was extracted from the three soil samples for this species (Table 4).

4.3.3. Phenology

Flowering and fruiting takes place in spring, summer and early autumn (September to April).

4.3.4. Etymology and common name

The specific epithet, *coccinea*, means scarlet and the species is commonly known as ‘scarlet spiderling’ or *perskleeftossie* (Afrikaans).

4.3.5. Traditional uses

In Namibia the roots of *B. coccinea* are used to treat gastroenteric conditions and a prolapsed uterus, and the roots and the leaves are eaten as a vegetable (Von Koenen, 2001). In Nigeria the whole plant is eaten as a leafy vegetable and is used as fodder for animals. It is also used to treat various ailments such as convulsions, asthma, scabies, skin rashes and small pox. The roots are specifically used to treat yaws, jaundice, heart and kidney diseases and dropsy (Edeoga and Ikem, 2002). In Tanzania the leaves and roots are used to treat oral candidiasis and aphthous ulcers (Maregesi et al., 2007), as well as liver problems and toothache

Table 3

Soil structure, nutrients and pH of soils associated with southern African taxa of *Boerhavia*. N, Namibia; SA, South Africa.

Species	Country	n	Sand	Silt	Clay			P	N	S	Ca	Mg	K	Na	pH	EC	CEC
					(%)												
<i>Boerhavia coccinea</i>	N; SA	3	88	8	4	0.085	0.016	0	3 085	1 888	0.612	226	18.0	7.97	7.46	82	9.76
<i>Boerhavia cordobensis</i>	SA	3	78	17	5	0.064	0.055	0	12 553	6 745	0.537	264	77.5	7.84	7.49	143	15.53
<i>Boerhavia deserticola</i>	N	3	85	10	5	0.085	0.004	0	15 168	6 020	0.397	155	24.0	8.18	7.26	101	17.57
<i>Boerhavia diffusa</i>	SA	3	89	6	5	0.076	0.031	0	4 338	1 488	0.343	90	18.0	7.25	7.11	118	8.40
<i>Boerhavia erecta</i>	SA	3	82	12	6	0.087	0.143	0	61 800	5 208	0.084	179	17.5	7.46	7.08	70	16.96
<i>Boerhavia hereroensis</i>	N	3	86	11	3	0.068	0.035	0.01	1 341	1 392	1.038	212	15.5	7.58	7.55	288	9.11
<i>Boerhavia repens</i> subsp. <i>repens</i>	N	2	86	6	8	0.086	0.015	0	6 845	8 730	1.275	136	16.5	8.38	7.58	62	11.59



**Table 4**Metal concentrations (mg/kg) of soil associated with southern African taxa of *Boerhavia*. N, Namibia; SA, South Africa.

Species	Country	n	Ba	Al	Pb	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
<i>Boerhavia coccinea</i>	N; SA	3	53.33	10 415	5.18	500	35.28	51.5	469	25,450	9.66	26.08	130.15	19.55
<i>Boerhavia cordobensis</i>	SA	3	46.03	13 203	40.73	405	34.10	57.2	383	17,580	8.29	33.53	18.07	113.05
<i>Boerhavia deserticola</i>	N	3	103.98	21 215	5.09	1094	99.20	24.2	972	37,475	13.95	14.67	21.31	45.23
<i>Boerhavia diffusa</i>	SA	3	32.20	8 848	17.66	370	14.36	23.4	163	9210	3.81	11.39	8.19	20.70
<i>Boerhavia erecta</i>	SA	3	76.58	8 715	2.57	1170	45.58	24.7	374	16,735	8.32	22.75	18.46	24.25
<i>Boerhavia hereroensis</i>	N	3	25.20	6 210	6.73	156	8.38	10.2	169	6750	1.72	4.68	3.61	19.15
<i>Boerhavia repens</i> subsp. <i>repens</i>	N	2	218.18	23 600	19.84	115	22.15	35.3	785	28,900	9.44	24.92	14.80	52.13

(Neuwinger, 2000). It has been reported that the whole plant can be used to treat gastrointestinal infections (Tapia-Pérez et al., 2003).

#### 4.3.6. Diagnostic characters

In southern Africa, *B. coccinea* can be confused with *B. diffusa* s.l. as both species are similar in habit and foliage, but the anthocarps in *B. coccinea* are narrowly ellipsoid-clavate with glandular hairs present in the areas between ribs and on the ribs, whereas those of *B. diffusa* s.l. are ellipsoid-clavate, with ribs that are characteristically indented near the apex, which ends in a pointed tip, and have glandular hairs present on the ribs.

#### 4.3.7. Additional specimens examined

NAMIBIA. 1916 (Gobaub): Otjiwarongo, C39, Outjo road (-DB), 10 Feb 2009, Struwig 75 (PRE, WIND). 2016 (Otjiwarongo): Otjiwarongo, Kudubos, road behind Camp 1 (-DA), 12 Feb 2009, Struwig 77 (PRE, WIND). 2116 (Okahandja): Kalkfeld, Otjiwarongo, at junction of D2404 and D2414, roadside (-AB), 12 Feb 2009, Struwig 81 (PRE, WIND); Karibib, road to Otjimbingwe, roadside (-CD), 3 Feb 2009, Struwig 67 (PUC, WIND); Okahandja, D2110, first dry streambank after entrance to farm Okatjiho (-DD), 12 Feb 2009, Struwig 55 (PUC, WIND). 2216 (Otjimbingwe): Karibib, road to Otjimbingwe (-AA), 3 Feb 2009, Struwig 68 (PUC, WIND). 2416 (Maltahöhe): north of Maltehöhe, south of Naukluft, Kyffhausen Farm (-AD), 12 Mar 1995, Burgoyne 3499 (PRE, WIND).

BOTSWANA. 1923 (Maun): Botswana, Okavango Delta, Dead Tree Island, near no. 8 HATAB camping site (-AB), 24 Feb 1997, Roodt 313 (PRE).

South Africa. LIMPOPO. 2229 (Waterpoort): Messina District, Geefswaldt (-AB), 8 Jan 1974, Theron 2795 (PRE); 9 km on Waterpoort-Alldays road (-DC), 17 Nov 2009, Struwig 110 (PRE, PUC); Wyllie's Poort, just before Hendrik Verwoerd tunnel coming from Louis Trichardt (Makhado), next to the road (-DD), 17 Nov 2009, Struwig 108 (PRE, PUC). 2230 (Messina): R572, ± 500 m before N1 from Mapungubwe on side of road (-AC), 19 Nov 2009, Struwig 120 (PRE, PUC).

NORTHERN CAPE. 2922 (Prieska): Hay, Magoras (-BD), 01 Mar 1937, Acocks 1985 (KMG).

#### 4.4. *B. cordobensis*

Kuntze, Revis. gen. pl. 3 (3): 264 (1898). Type: Argentina, Cordoba, Lorentz 403 (F, holo.—Aluka image!; B, iso.).

Stems decumbent or prostrate, puberulent, with scattered long septate hairs. Leaves with petioles (3–) 5–19 (–25) mm long; lamina deltoid, oblong, lanceolate, elliptic or ovate, (14–) 15–42 (–47) × (8–) 9–32 (–34) mm; apex obtuse, acute, acuminate or apiculate; base obtuse or truncate; margins entire, sometimes undulate; glabrous, with long septate hairs along veins and margins. Inflorescence with primary peduncles 60–130 mm long, secondary peduncles 20–35 mm long; 5–many flowers per cluster; pedicels 1 mm long. Flowers 3 mm long; lower part of perianth 1–1.5 mm long, clavate, 3- or 4-ribbed with apex of ribs expanded, glabrous; upper part of perianth 1.5–2 mm long, purple or pink. Stamens 2 or 3, Ovary ellipsoid, stipitate; style

filiform, exserted. Anthocarp 3–4 × 2–3 mm, clavate, 3- or 4-winged, broadly truncate-apiculate, glabrous.

#### 4.4.1. Distribution and habitat

*B. cordobensis* is native to central-western Argentina (López, 1998) and has been introduced to Namibia, Botswana and South Africa, where it is widespread in the drier, predominantly western parts (Fig. 9). It was first recorded in South Africa in 1919 as a weed in the Kimberley District (Codd, 1966), but was incorrectly identified as *B. pterocarpa* (Stirton, 1982). *B. cordobensis* occurs in dry riverbeds, on floodplains, plains, hillslopes or mountainsides and ridges in semi-shade to full sun at 310–1775 m altitude, growing in moist to well-drained stony, sand to sandy loam soil (Table 3). The preferred soil of *B. cordobensis* is characterized by the highest values of K and Na in the study, but the lowest value of P (Table 3). The soil of this species also had the highest levels of the metals Pb (40 mg/kg) and Zn (113.05 mg/kg) (Table 4).

#### 4.4.2. Phenology

Flowering and fruiting occurs in summer to early autumn (November to April).

#### 4.4.3. Etymology and common names

The specific epithet, *cordobensis*, means from Cordoba (Argentina), which is the type locality. It is commonly known as 'sticky spiderling' or *kleefbossie* (Afrikaans).

#### 4.4.4. Diagnostic characters

*B. cordobensis* can be distinguished from other members of *Boerhavia* in southern Africa by the clavate anthocarp with 3 or 4 wings and a broadly truncate apex.

#### 4.4.5. Additional specimens examined

NAMIBIA. 2217 (Windhoek): Windhoek, D1463, at T-junction sign before Aris farm (-CC), 13 Feb 2009, Struwig 82 (PUC, WIND).

South Africa. LIMPOPO 2229 (Waterpoort): Mapungubwe National Park, Maloutswa Bird Hide (-AA), 18 Nov 2009, Struwig 112 (PRE, PUC); Pont Drift, Breslau 2MS, dam wall area (-AC), 28 Jul 1998, Straub 499 (PRE); Pont Drift, Breslau 2MS, dam wall area (-AC), 20 Nov 1998, Straub 808 (PRE). 2230 (Messina): R525, 4 km after Tsipise (-CA), 19 Nov 2009, Struwig 122 (PRE, PUC).

NORTH-WEST. 2626 (Klerksdorp): Klerksdorp, Doringkruin, corner of Moepel Avenue and Oleander Avenue (-DC), 16 Jan 2010, Struwig 132 (PRE, PUC). 2724 (Taung): Taung, ± 6 km SW of Manthestad (-DB), 22 Mar 2009, Gotze 146 (PUC).

MPUMALANGA. 2430 (Pilgrim's Rest): R36, just before the Shoe Cave sign (-DA), 20 Nov 2009, Struwig 130 (PRE, PUC).

FREE STATE. 2926 (Bloemfontein): Bloemfontein, showgrounds (-AA), 04 Feb 2000, Zietsman 4105 (PRE, PRU).

NORTHERN CAPE. 2822 (Glen Lyon): Witsand Nature Reserve, 62.5 km SW of Postmasburg, farm Witsand 250. [0.5 km NE of Doornaar Homestead] (-CB), 17 Apr 1995, Bosch 61 (KMG). 2824 (Kimberley): Kimberley, behind theater (-DB), 17 Nov 1975, Leistner 938 (PRE). 2920 (Boomrivier): Augrabies National Park, green island in rest camp

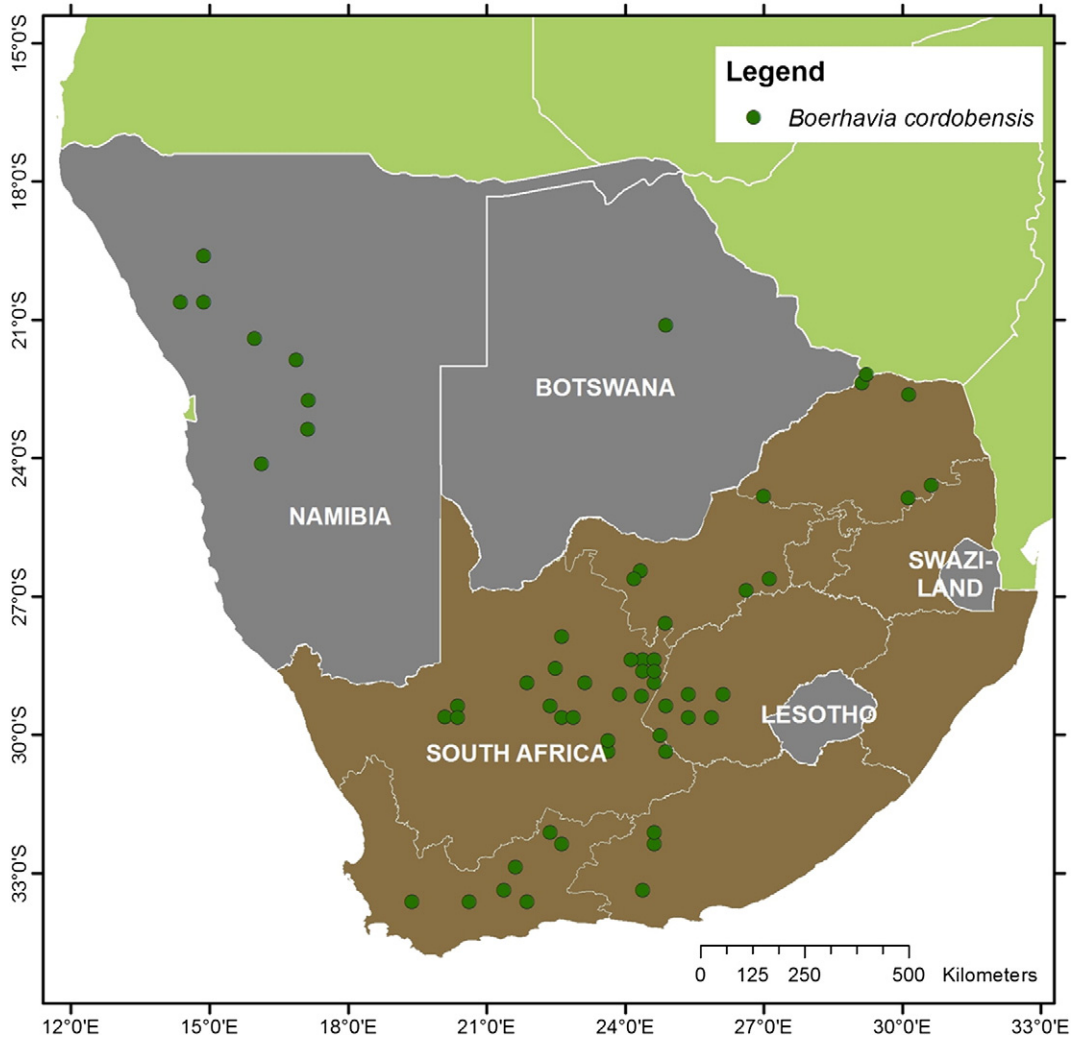


Fig. 9. Known distribution of *Boerhavia cordobensis* in southern Africa.

(–CB), 01 Apr 2009, Siebert 3962 (PUC). 3023 (Britstown): Britstown district, Volstruispoort farm, edge of Brinkspan (–BC), 14 Jan 1986, Retief & Germishuizen 27 (PRE).

WESTERN CAPE. 3321 (Ladismith): Between Calitzdorp Spa and Rooiberg Pass (–DB), 04 Feb 2001, Meyer 3420 (PRE).

#### 4.5. *B. deserticola*

Codd, Bothalia 9(1): 119 (1966). Schreib. in Prodr. Fl. S.W. Afr. 25: 2 (1969). Type: Namibia, Kaokoveld Reserve, Orupembe, waterhole near Sanitatas, 5 May 1957, De Winter & Leistner 5722 (PRE, holo.!; K, M, iso.).

Perennial herb. Stems numerous, up to 1 m long, erect from a basal rosette, pubescent with long, septate hairs. Leaves with petioles (6–) 10–33 (–41) mm long; lamina elliptic, lanceolate or ovate, (15–) 16–48 (–55) × (5–) 6–33 (–34) mm; apex apiculate, acute or rounded; base shortly attenuate; margins undulate; densely pubescent with long, septate hairs. Inflorescence with primary peduncles 95–120 mm long, secondary peduncles 34–40 mm long; 2 – many flowers per cluster, pedicels 2 mm long. Flowers 4–5 mm long; lower part of perianth 1–2 mm long, green tinged pink, ovoid, 5-ribbed, glabrous; upper part of perianth 3–4 mm long, with a basal tube, white or purple. Stamens 4–6; 6 mm long. Ovary ellipsoid, stipitate; style filiform, exserted. Anthocarp 3–5 × 1–2 mm, clavate, 5-ribbed, ribs conspicuous, rounded at apex, glabrous.

#### 4.5.1. Distribution and habitat

*B. deserticola* is endemic to the Erongo, Khomas, Kunene, Otjozondjupa and Oshikoto regions of Namibia (Fig. 10) and grows in well-drained to dry stony, sandy, sandy-loam or gravelly soil in gullies, riverbeds and riverbanks, on plains, hillsides or mountain slopes, in full sun at altitudes of 556–1029 m. Soils are characterized by low levels of N (Table 3) but some of the highest levels of the metals Al, Fe, Mn, Ti and V (Table 4). The soil associated with this species has the highest Cation Exchange Capacity (CEC) of all samples.

#### 4.5.2. Phenology

Flowers and fruits are produced throughout the year (January to December).

#### 4.5.3. Etymology and common names

The specific epithet, *deserticola*, means a dweller in the desert, and the species is commonly known as 'desert spiderling' or *woestynkleefbossie* (Afrikaans).

#### 4.5.4. Diagnostic characters

*B. deserticola* and *B. hereroensis* both have clavate anthocarps with five conspicuous ribs and rounded apices but the anthocarps of the former are glabrous and those of the latter covered with long septate hairs.

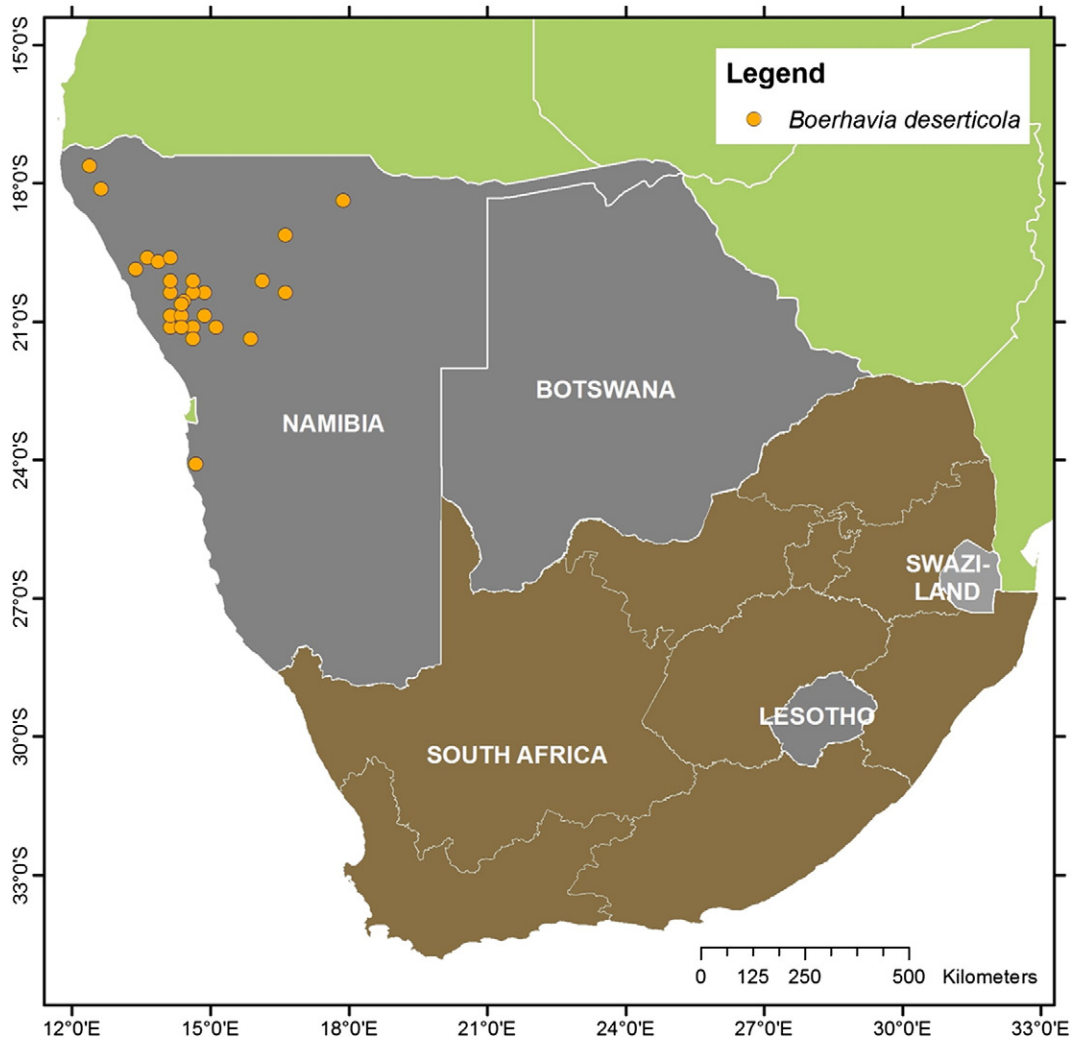


Fig. 10. Known distribution of *Boerhavia deserticola* in southern Africa.

#### 4.5.5. Additional specimens examined

NAMIBIA. 1913 (Sesfontein): road to Sesfontein, in dry streambank (-DB), 08 Mar 2009, *Struwig 43* (PUC, WIND); Kunene, on a plain in Barab river-valley (-DA), 06 Jul 2000, *Gindrig & Henning 60* (PRE, WIND). 2014 (Khorixas): Welwitchia, Bloemhof, old 484 Farm (-BC), *Muller & Giess 387* (PRE); Twyfelfontein, in dry streambed (-CB), 08 Feb 2009, *Struwig 42* (PUC, WIND). 2016 (Otjiwarongo): Outjo District, Spaarwater, old 711 Farm (-AA), 30 Mar 1974, *Merxmüller & Giess 30622* (PRE). 2114 (Uis): Brandberg, Numas Gorge (-AA), 19 Mar 1977, *Muller & Giess 357* (PRE); Uis, Brandberg, entrance to Tsisab gorge (-AA), 06 Feb 2009, *Struwig 38* (PUC, WIND); Uis, Damaraland, Brandberg, Witvrou (-BA), 14 Dec 1974, *Van Wyk 692* (PUC); Uis, Brandberg, hillslope (-BA), 06 Feb 2009, *Struwig 37*. (PUC, WIND); Brandberg S (-BC), 19 Apr 1990, *Baker 29* (PUC, WIND); Omaruru District, Brandberg, Tsisabschlucht (-BC), 12 Sep 1967, *Urschler s.n.* (PRE).

#### 4.6. *B. diffusa*

L., *Sp. Pl.* 1: 3 (1953); Meikle in *F.W.T.A. ed. 2* (1): 178 (1954); Codd, *Bothalia* 9(1): 115 (1966); Schreb. in *Prodr. Fl. S.W. Afr.* 25: 3 (1969); Agnew, *Upland Kenya Wild Fl.*: 162 (1974); Stannard in *F.Z.* 9(1): 21 (1988); Thulin in *Fl. Somalia* 1: 171 (1993); Bromilow, *Problem Pl. S. Afr.*: 226 (1995); Whitehouse in *F.T.E.A.*: 3 (1996); Dequan & Gilbert in *Fl. China* 5: 434 (2003). Type: Virgin Islands, St Coix,

Teague Bay, West Indies laboratory, 30 May 1977, *Fosberg 56776* (BM, holo. —Aluka image!; B; BISH; GH; K; MO; NSW, iso. type conserved by Whitehouse (1998)).

*Boerhavia africana* Lour., *Fl. cochinch.* 1: 16 (1790). *Commicarpus africanus* (Lour.) Dandy, *F.P.S.* 1: 152 (1950). Type: Mozambique, Loureiro. [*vide Whitehouse, 1996*].

*Boerhavia paniculata* Rich., *Actes Soc. Hist. Nat. Paris* 1: 105 (1792). Type: Cayenne, Le Blond *s.n.* (P, holo.) [*vide Whitehouse, 1996*].

*Boerhavia* [as *Boerhaavia*] *adscendens* Willd., *Sp. Pl.* 1: 19 (1797). Type: Guinea, Isert *s.n.* in *Herb. Willdenow 768* (B-W, holo.). [*vide Whitehouse, 1996*].

*B. repens* var. *diffusa* (L.) Hook.f., *Fl. Brit. India* 4(2): 709 (1885). Type: from South Africa. [*vide Whitehouse, 1996*].

Stems decumbent, diffuse or prostrate, glabrate to puberulous. Leaves with petioles (8–) 10–30 (–33) mm long; lamina elliptic, lanceolate, ovate, oblong, orbicular or obovate, (18–) 21–58 (–61) × (11–) 13–40 (–46) mm; apex apiculate, acuminate, rounded or obtuse; base shortly attenuate or obtuse; margins entire, sometimes undulate; glabrous with long septate hairs along margins and scattered along veins. Inflorescence with primary peduncles 60–150 mm long, secondary peduncles 25–60 mm long, glabrate, 2–5 flowers per cluster; pedicels 1 mm long. Flowers 2–3 mm long; lower part of perianth 1 mm long, ellipsoid-clavate, 5-ribbed, glandular hairs present; upper part of perianth 1–2 mm long, pink, purple or maroon. Stamens 2 or 3, slightly exserted, 1.5–2.5 mm long. Ovary 0.5 mm long; style 1–1.5 mm long.



*Anthocarp* 3–4 × 1–2 mm, ellipsoid-clavate, 5-ribbed, ribs indented near apex, apex ending in pointed tip, glandular hairs present on ribs.

#### 4.6.1. Intraspecific taxa

*B. diffusa* belongs to a complex of which the number of infraspecific taxa and their diagnosis is uncertain and based on highly variable characters (Spellenberg, 2004; Chen and Wu, 2007). Codd (1966) distinguished three *B. diffusa* varieties for southern Africa, i.e. *B. diffusa* var. *diffusa*, *B. diffusa* var. *hirsuta* and *B. diffusa* var. *viscosa*, but the latter two are synonyms of *B. coccinea* (Whitehouse, 1996). As molecular work is required to clarify this complex, it is currently not possible to distinguish infraspecific taxa of *B. diffusa* present in southern Africa. The species is therefore treated in a broad sense.

#### 4.6.2. Distribution and habitat

*B. diffusa* is native to South America and an introduced weed in South Africa (Bromilow, 2010). It is distributed throughout Botswana, Namibia and predominantly the savanna region of South Africa (Fig. 11), growing in moist, well-drained to dry, stony, sandy, loamy or gravelly soil on riverbanks, floodplains, plains or coastal dunes, and is often found along roadsides. It prefers calcrete, limestone or basalt outcrops in shade to full sun at altitudes of 5–1 370 m. Soils have the lowest pH of all samples tested, although still close to

neutral, lowest level of K and lowest CEC (Table 3). The species also prefers soil with lower concentrations of metals (Table 4).

#### 4.6.3. Phenology

Flowers and fruits are produced throughout the year (January to December).

#### 4.6.4. Etymology and common names

The specific epithet, *diffusa*, means spreading or diffuse. The species is commonly known as 'red spiderling' or *rooikleeffbossie* (Afrikaans).

#### 4.6.5. Traditional uses

In Namibia the roots are used to treat gastroenteritic problems, a prolapsed uterus and the seeds are used to treat dysentery (Muzila, 2006). Codd 6883 (PRE) records the use of this plant as pig feed, a use which has not previously been documented. *B. diffusa* is used extensively as a medicinal plant worldwide and is used to treat various ailments (Saikia et al., 2006; De Albuquerque et al., 2007; Lehman et al., 2007; Ragupathy et al., 2008).

#### 4.6.6. Diagnostic characters

*B. diffusa* can be distinguished from other members of *Boerhavia* in southern Africa by an indentation of the ribs near the apex (Fig. 6d). The plants often produce flowers and subsequent anthocarps on a

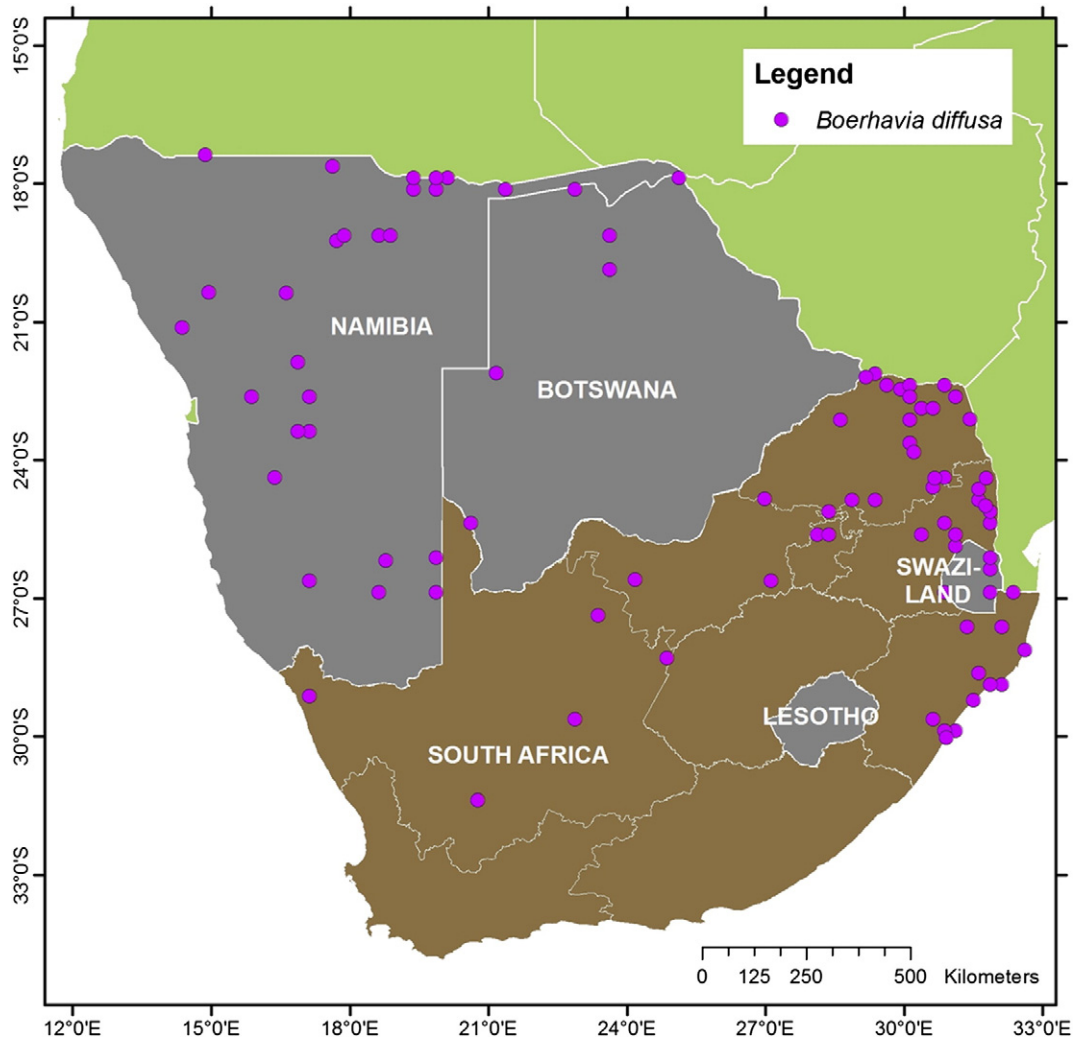


Fig. 11. Known distribution of *Boerhavia diffusa* in southern Africa.

short peduncle in the axis of the leaves, in addition to the typical inflorescence.

#### 4.6.7. Additional specimens examined

NAMIBIA. 1917 (Tsumeb): Tsumeb, main street (–BA), 10 Feb 2009, *Struwig 74* (PUC, WIND). 1918 (Grootfontein): Near homestead on Taranaki farm, 84 km from Grootfontein on road to Rundu (–BA), 06 Mar 1995, *Germishuizen 7575* (PRE, WIND). 2014 (Khorixas): Khorixas Rest Camp (–BD), 08 Feb 2009, *Struwig 70* (PUC, WIND). 2115 (Karibib): Omaruru, in middle of main road (–BD), 11 Apr 2010, *Struwig 174* (PUC, WIND); Omaruru, Loskop farm (–BD), 11 Apr 2010, *Struwig 178* (PUC, WIND).

BOTSWANA. 1923 (Maun): Okavango Delta, Moremi Game Reserve, N gate (–BA), 02 May 1995, *Roodt 228* (PRE). 2221 (Okwa): Main road to Mmamuno (–AA), 02 Feb 2009, *Struwig 66* (PUC).

South Africa. LIMPOPO. 2229 (Waterpoort): Mapungubwe National Park, Rhodesdrift, garden of section ranger (–AA), 18 Nov 2009, *Struwig 117* (PRE, PUC). 2330 (Tzaneen): Tzaneen, Letaba River Eco Park Lodge, chalet C3 (–CC), 19 Nov 2009, *Struwig 125* (PRE, PUC). 2429 (Zebediela): Nebo district, Arabie, lawn in front of offices, (–CD), 01 Nov 1978, *Lessing 58* (PRE).

NORTH-WEST. 2627 (Potchefstroom): Potchefstroom, Bailliepark, roadside (–CA), 02 Apr 2008, *Siebert 3490* (PUC).

MPUMALANGA. 2430 (Pilgrim's Rest): R36, stalls opposite the Shoe Caves (–DA), 20 Nov 2009, *Struwig 129* (PRE, PUC). 2431 (Acornhoek): Kruger National Park, Satara day visitors site (–BD), 09 Mar 2010, *Struwig 140* (KNP, PUC); Kruger National Park, Skukuza rest camp, along Sabie river (–DC), 24 Apr 2009, *Siebert 3965* (PUC).

KWAZULU-NATAL. 2831 (Nkandla): Richards Bay, Mtuzini Nature Reserve, Inkwazi campsite (–DD), 12 Mar 2009, *Struwig 88* (NH, PUC); Richards Bay, Mtuzini Nature Reserve, Inkwazi campsite 18 (–DD), 12 Mar 2009, *Struwig 89* (NH, PUC). 2832 (Mtubatuba): Richards Bay, Small Crafts harbor, Naval Hill island (–CC), 12 Mar 2009, *Struwig 90* (NH, PUC). 2931 (Stanger): Tugela Mouth (–BA), 13 Mar 2009, *Struwig 91* (NH, PUC). 3030 (Port Shepstone): Amanzimtoti, Winkelspruit lagoon (–BB), 09 Mar 2009, *Struwig 85* (NH, PUC).

NORTHERN CAPE. 2824 (Kimberley): Kimberley Division, Leeuwpoot, N of E slopes of dolerite koppie (–DA), 26 Jan 1938, *Acocks 8578* (BOL, PRE).

#### 4.7. *B. erecta*

L., Sp. Pl. 1: 3 (1953); Choisy in DC., Prodr. 13(2): 450 (1849); Standl. in Contr. U.S. natl. Herb. 12: 380 (1909), in Contr. U.S. natl. Herb. 13: 246 (1911), in N. Amer. Fl. 21(3): 210 (1918), Publ. Field Mus. Nat. Hist., Bot. Ser. 11(3): 106 (1931); Heimerl in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 16C: 118 (1934); Meikle in F.W.T.A. 2(1): 178 (1954); Codd, *Bothalia* 9(1): 115 (1966); Agnew, *Upland Kenya Wild Fl.*: 162 (1974); Stannard in F.Z. 9(1): 21 (1988); Thulin in Fl. Somalia 1: 170 (1993); Bromilow, *Problem Pl. S. Afr.*: 226 (1995); Whitehouse in F.T.E.A.: 2 (1996). Type: Mexico, habitat in Vera Cruz, Herb. Linn. No. 9.1 (LINN, neo.—digital image!, designated Fawcett & Rendle (1914); PRE, photo!).

*Boerhavia* [as *Boerhaavia*] *elongata* Salisb., Prodr.: 56 (1796) [fide Standley, 1918].

*Boerhavia* [as *Boerhaavia*] *virgata* H.B.K., Nov. Gen. & Sp. 2: 215 (1817). Type: Cumana, Venezuela. *Bonpland & Von Humboldt 1224* (P, holo., B, iso.) [fide Standley, 1918].

*Boerhavia* [as *Boerhaavia*] *discolor* H.B.K., Nov. Gen. & Sp. 2: 215 (1817). Type: Ecuador, *Bonpland & Von Humboldt 3845* (P, holo.) [fide Standley, 1918].

*Boerhavia* [as *Boerhaavia*] *atomaria* Raf., Autik. bot.: 40 (1840). Type: Florida. [fide Standley, 1918].

*Valeriana latifolia* Mart & Gal. in Bull. Acad. Brux. 11: 24 (1844). Type: Mexico, 1840, *Galeotti 2558* (Br, holo.) [fide Standley, 1918].

*B. paniculata* var. *subacuta* Choisy in DC. Prodr. 13: 451 (1849) [fide Standley, 1911].

*Boerhavia* [as *Boerhaavia*] *thornberi* M.E. Jones, Contr. W. Bot. 12: 72 (1908). *B. erecta* var. *thornberi* (M.E. Jones) Standl. in Contr. U.S. natl. Herb. 12: 381 (1909). Type: Arizona, Tucson, United States of America, 20 September 1903, *Thornber 10* (US, iso.) [fide Standley, 1918].

Stems decumbent or prostrate, puberulent, with scattered long septate hairs. Leaves with petioles (5–) 6–34 (–35) mm long; lamina oblong, lanceolate, elliptic, deltoid or ovate, (15–) 20–47 (–51) × (10–) 12–25 (–29) mm; apex apiculate, acuminate, acute or obtuse; base shortly attenuate, obtuse or truncate; margins entire, sometimes undulate; glabrous, sometimes with long septate hairs along margins and veins. Inflorescence with primary peduncles ± 115 mm long, secondary peduncles 55–65 mm long, glabrous to puberulous; 4–10 flowers per cluster; pedicels 1 mm long. Flowers 2–3 mm long; lower part of perianth 1–2 mm long, clavate, 5-ribbed, glabrous; upper part of perianth 1 mm long, pink, purple or white. Stamens 2, slightly exerted, 2–2.5 mm long. Ovary 0.5 mm; style 1–2 mm long. Anthocarp 3–4 × 1–2 mm, clavate, 5-winged, wings slightly undulate along margins, apex truncate, ending in pointed tip, glabrous.

#### 4.7.1. Distribution and habitat

*B. erecta* is a native of tropical America (Chen and Wu, 2007), but is naturalized in Namibia and South Africa, mainly in the Eastern Cape, Gauteng, Limpopo, Mpumalanga and North-West (Fig. 12). It was first recorded from southern Africa in 1934 in the Bloemfontein District, South Africa (Codd, 1966). The species grows in well-drained stony, gravel, sand, loam or clay soil in riverbeds, on plains, mountain slopes or hillsides and ridges, often along roadsides, in shade to full sun at altitudes of 250–1250 m. Compared to other species of the genus, *B. erecta* prefers soil with the high levels of N, Ca (61,800 mg/kg) and Ti (1 170 mg/kg) (Tables 3 and 4).

#### 4.7.2. Phenology

Flowers and fruits are produced from spring until late autumn (October to May).

#### 4.7.3. Etymology and common names

The specific epithet, *erecta*, means erect or upright, probably referring to the upright inflorescences and is commonly known as 'erect spiderling' or *regop-kleefbossie* (Afrikaans).

#### 4.7.4. Traditional uses

In Africa the plant is used to treat rheumatism, scabies, convulsion in children and arterial high blood pressure. The root is used to treat chest abscesses and dyspepsia and is added to local beers as an aphrodisiac (Neuwinger, 2000; Schmelzer, 2006). In South Africa the leaves are eaten as a traditional leafy vegetable (Ntuli et al., 2012).

#### 4.7.5. Diagnostic characters

*B. erecta* can be distinguished from other members of the genus in southern Africa by its 5-winged anthocarp with wings slightly undulate along the margins.

#### 4.7.6. Additional specimens examined

NAMIBIA 2217 (Windhoek): Windhoek, corner of Stein street and Schwabe street (–CA), 21 Jun 2012, *Struwig 145* (WIND).

South Africa. LIMPOPO. 2229 (Waterpoort): Waterpoort, Tshipise, 1 km N of Tshipise on the Madimbo road (–DA), 09 Dec 1977, *Du Preez 125* (PRE). 2431 (Acornhoek): Phalaborwa district, Phalaborwa Water Board, 14 km S of Phalaborwa works area. Farm Sheila 10 KU (–AA), 24 Mar 1987, *Retief 567* (PRE); Kruger National Park, Satara, road to staff village (–BD), 03 Sep 2010, *Struwig 135* (KNP, PUC).

NORTH-WEST. 2527 (Rustenburg): Rustenburg Platinum, AMPLATS. Rustenburg Base Metals Refinery, south of chimney stack (–CB), 21 Jan

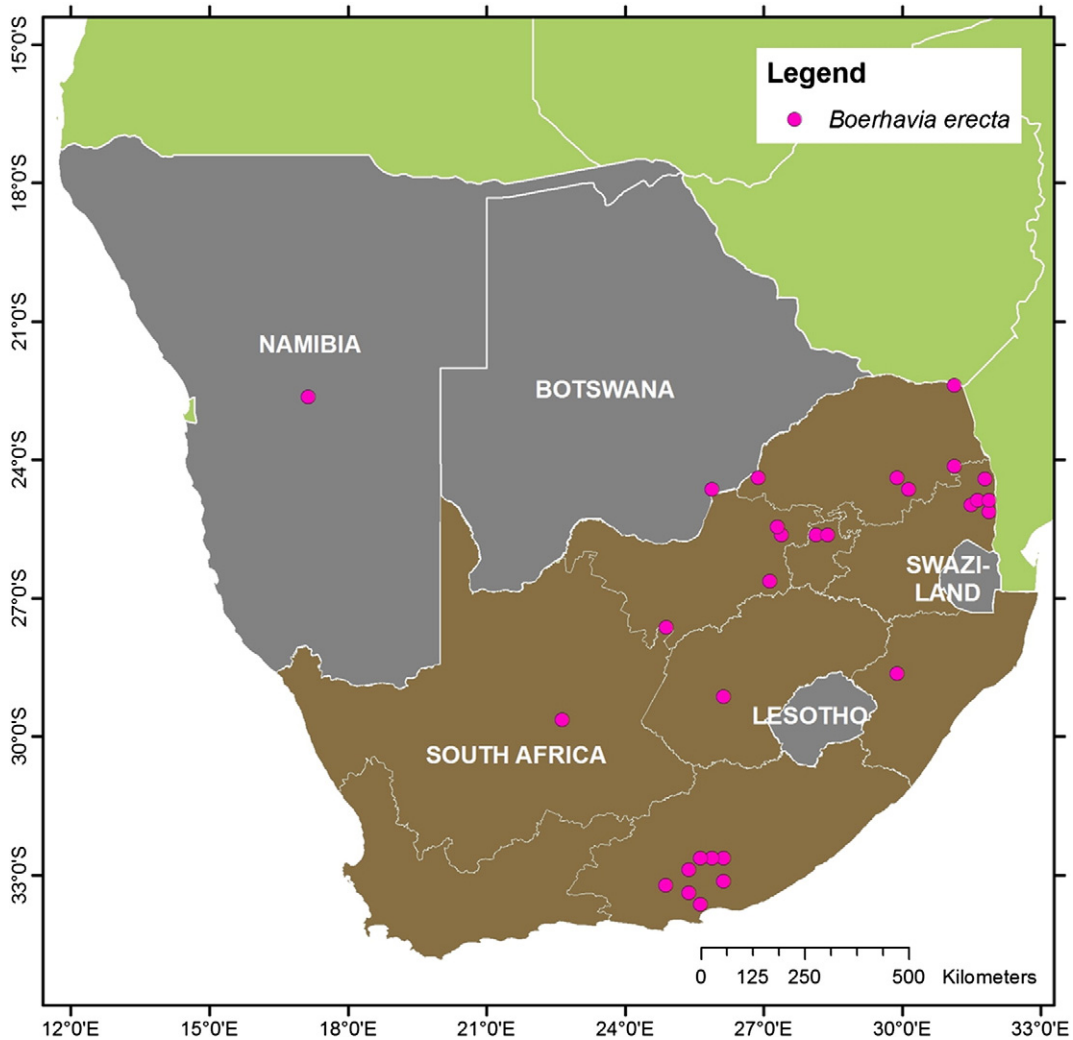


Fig. 12. Known distribution of *Boerhavia erecta* in southern Africa.

1999, Balkwill, McCallum & Campbell-Young 10840 (J). 2627 (Potchefstroom): Potchefstroom, N12 Plot 283, roadside (–CA), 04 Dec 2008, Struwig 23 (PRE, PUC); Potchefstroom, Miederpark (–CA), 01 Feb 2009, La Grange & Lubbe 11 (PUC); Potchefstroom, Bailliepark, 108 Steyn Street (–CA), 02 Feb 2010, Struwig 133 (PRE, PUC); Potchefstroom, next to TX Scrap Yard, Ross Street (–CA), 26 Apr 1995, Cilliers s.n. (PUC).

MPUMALANGA. 2430 (Pilgrim's Rest): Lydenburg District, Burgersfort, Potlake Nature Reserve, about 2 km from entrance, Jaglust (–CA), 05 Nov 1999, Van Wyk & Siebert 1341 (J, PRU). 2431 (Acornhoek): Kruger National Park, Skukuza Research Camp, (–DC), 16 Mar 2010, Struwig 143 (KNP, PUC); Kruger National Park, Skukuza Rest Camp, along Sabie River (–DC), 23 Apr 2009, Siebert 3964 (PUC).

FREE STATE. 2926 (Bloemfontein): Bloemfontein District, Tempe farm (–AA), 01 Dec 1934, Motsami 4958 (PRE).

#### 4.8. *Boerhavia hereroensis*

Heimerl in Bot. Jahrb. 10: 9 (1889); Heimerl in Engl. & Prantl, Nat. Pflanzenfam. ed. 2, 16C: 118 (1934). Codd, Bothalia 9(1): 118 (1966); Schreib. in Prodr. Fl. S.W. Afr. 25: 3 (1969). Type: Namibia, Otjimbingwe, Marloth 1403 (L, holo. –Aluka image!; PRE, iso.!).

Perennial herb. Stems branches upright, diffuse, densely pubescent with long, septate hairs. Leaves with petioles (7–) 8–27 (–38) mm long; lamina elliptic, lanceolate, linear or ovate; (18–) 20–40

(–41) × (5–) 7–27 (–34) mm; apex apiculate; base shortly attenuate or rounded; margins entire, sometimes undulate; pubescent with long septate hairs. Inflorescence with primary peduncles ± 65 mm long, secondary peduncles ± 27 mm long; pubescent; 2–4 flowers per cluster; pedicels 1 mm long. Flowers 2–4 mm long; lower part of perianth 1 mm long, ovoid, 5-ribbed, with long, septate hairs; upper part of perianth 1–3 mm long, with a basal tube; pink or purple. Stamens 2 or 3, 2–2.5 mm long, included. Ovary ellipsoid, stipitate; style filiform, exserted. Anthocarp 3–4 × 1–2 mm, ellipsoid-clavate, 5-ribbed, rounded at apex, pubescent with long, septate hairs.

#### 4.8.1. Distribution and habitat

*B. hereroensis* is endemic to southern Africa, and is especially prevalent in Namibia with outlying populations in the Northern Cape, South Africa (Fig. 13). It grows in well-drained stony, gravel, sandy or loamy soil in dry watercourses, on riverbanks, hillsides and mountain slopes in shade to full sun at altitudes of 500–1700 m. The soil associated with this species has the lowest recorded levels of Ca, Mg and Na in this study, with a Mg:Ca ratio of more than 1 (Table 3). It has a high electrical conductivity of 288 mS/m (Table 3). The soil has low concentrations of metals (Table 4).

#### 4.8.2. Phenology

Flowers and fruits are produced in summer to late autumn (December to May).



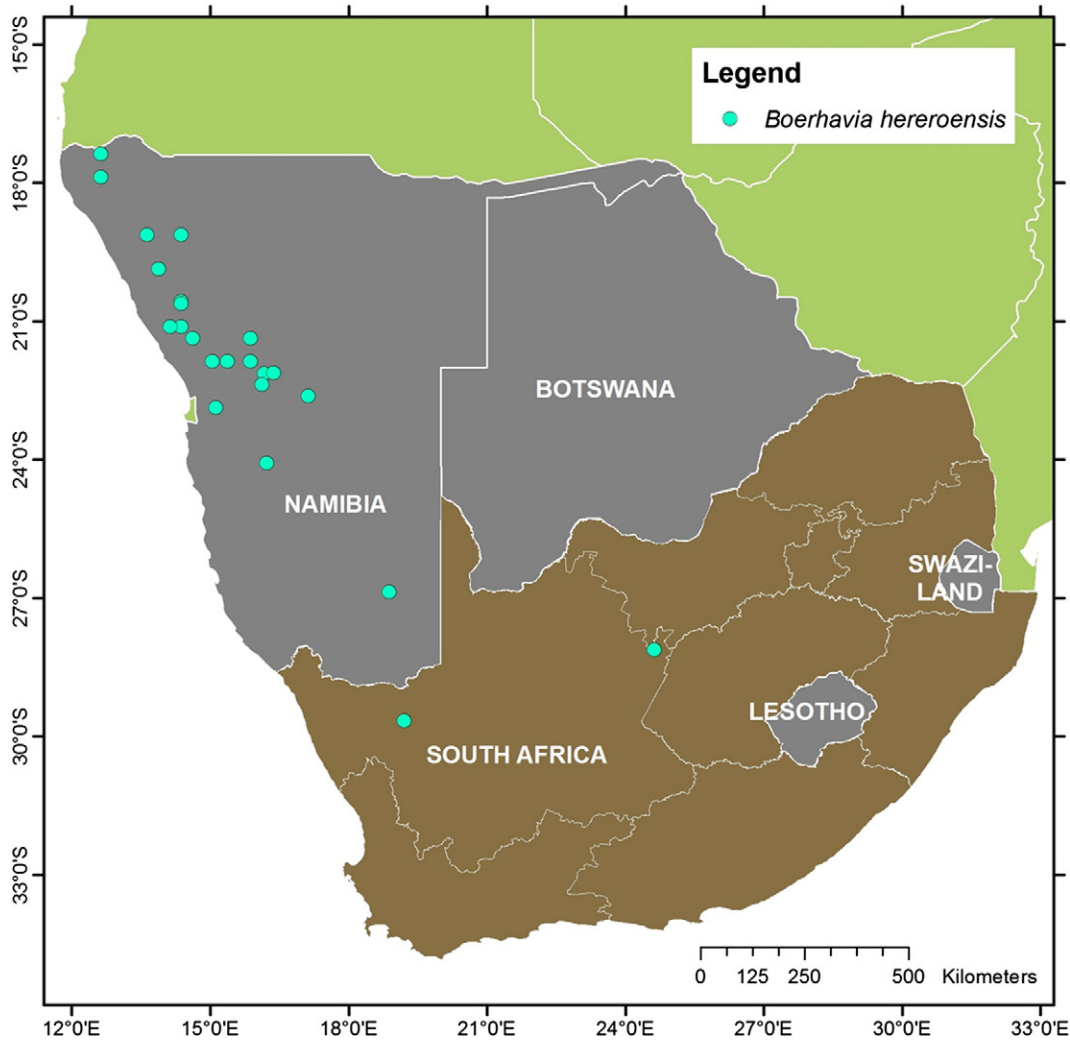


Fig. 13. Known distribution of *Boerhavia hereroensis* in southern Africa.

#### 4.8.3. Etymology and common names

The specific epithet, *hereroensis*, means from Hereroland (Namibia). It is commonly known as 'Herero spiderling' or *Herero-kleefbossie* (Afrikaans).

#### 4.8.4. Diagnostic characters

*B. hereroensis* is morphologically similar to *B. deserticola* in that both taxa have elliptic, lanceolate to ovate leaves with undulate margins, the lower coriaceous part of the flower is ovoid and the anthocarp is 5-ribbed and ellipsoid-clavate. It differs in having extremely glandular, hairy anthocarps, smaller, dark pink flowers and a diffuse habit.

#### 4.8.5. Additional specimens examined

NAMIBIA. 2014 (Khorixas): Twyfontein Lodge, hills behind lodge (-CB), 07 Feb 2009, *Struwig 40* (PUC, WIND). 2114 (Uis): Uis, Brandberg, Hunganob valley area (-AB), 04 Mar 1978, *Craven 718* (PUC). 2115 (Trekopje): Omaruru district, Daksberge, deep shade along riverbank (-BD), 20 Mar 1965, *Hardy 2025* (PRE); Usakos, Klein Spitzkuppe, mountain slope (-CC), 05 Feb 2009, *Struwig 35* (PUC, WIND); Karibib, Klippenberg Country Club, hill behind restaurant (-DD), 04 Feb 2009, *Struwig 34* (PUC, WIND). 2116 (Okahandja): Omaruru district, Okasongoro farm, between Omaruru and Kalkfeld, farm dam (-AA), 03 Mar 1983, *Germishuizen 2527* (PRE). 2216 (Otjimbingwe): Otjimbingwe (-AC), 01 Jan 1886, *Marloth 1403* (BOL). 2217 (Windhoek): Windhoek Municipality area (-CA), 17 Dec 1962,

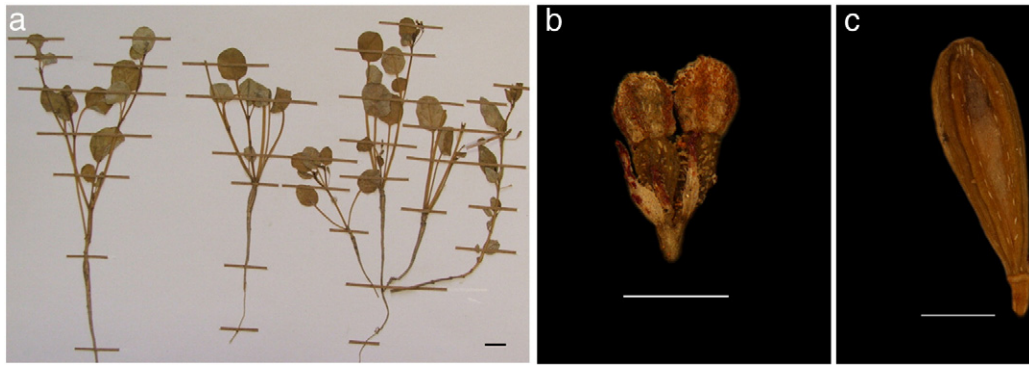
*Hanekom 354* (PRE, WIND). 2718 (Grünau): Great Karasberg-slopes of Wasserfall Alt Ravine, 22 Jan 1913, *Pearson 8474* (BOL).

SOUTH AFRICA. NORTHERN CAPE. 2824 (Kimberley): Gordonia, Riemvasmaak, 7.5 m. S by E of Riemvasmaak (-BA), 22 May 1952, *Seydel 1436* (PRE). 2919 (Pofadder): Prieska, N, Stofbakkies (-CA), 01 Mar 1934, *Wilman s.n.* (KMG).

#### 4.9. *Boerhavia orbicularifolia* Struwig, sp. nov.

Decumbent herb up to 200 mm tall, not spreading. Leaves orbicular, oval or oblong. Inflorescence an umbel. Anthocarps ellipsoid-clavate, glabrate. Type: Namibia. Okaukuejo. 15 km S of Okaukuejo, 6 March 1976, *Giess & Loutit 14128* (WIND, holo.! PRE, iso.).

Annual. Roots up to 100 mm long, swollen, turnip-shaped. Stems herbaceous, puberulent branching directly from base, decumbent, 100–200 mm tall, not spreading. Leaves with petioles (9–) 11–27 (–35) mm long; lamina orbicular, oval, oblong or lanceolate, (12–) 14–20 (–23) × (8–) 10–15 (–17) mm; apex rounded or sometimes apiculate; base obtuse or rounded; margins entire, sometimes undulate; glabrous, often with septate hairs along margins. Flowers solitary or in an inflorescence. Inflorescence an umbel, peduncles 2 mm; 1–4 flowers per cluster; pedicels ± 1 mm long. Flowers 2 mm long; lower part of perianth 1 mm long, ellipsoid, 5-ribbed, puberulous; upper part of perianth 1 mm long, white. Stamens 1. Ovary ellipsoid. Anthocarp 3 × 1 mm, ellipsoid-clavate, 5-ribbed, apex rounded, glabrate with hairs on ribs and between ribs. Fig. 14.



**Fig. 14.** (a) Holotype of *Boerhavia orbicularifolia* (Giess & Loutit 14128). Scale bar 10 mm; and micrographs of the (b) flower and (c) the anthocarp. Scale bars 1 mm.

#### 4.9.1. Distribution and habitat

*B. orbicularifolia* is endemic to the Oshana and Hardap regions of Namibia (Fig. 15). It grows in black limestone in vlei-like depressions that stands under water for a while after rain in the Okaukuejo region and in stony, sandy-loam soil on arenite in full sun in the Maltahöhe region.

#### 4.9.2. Etymology and common names

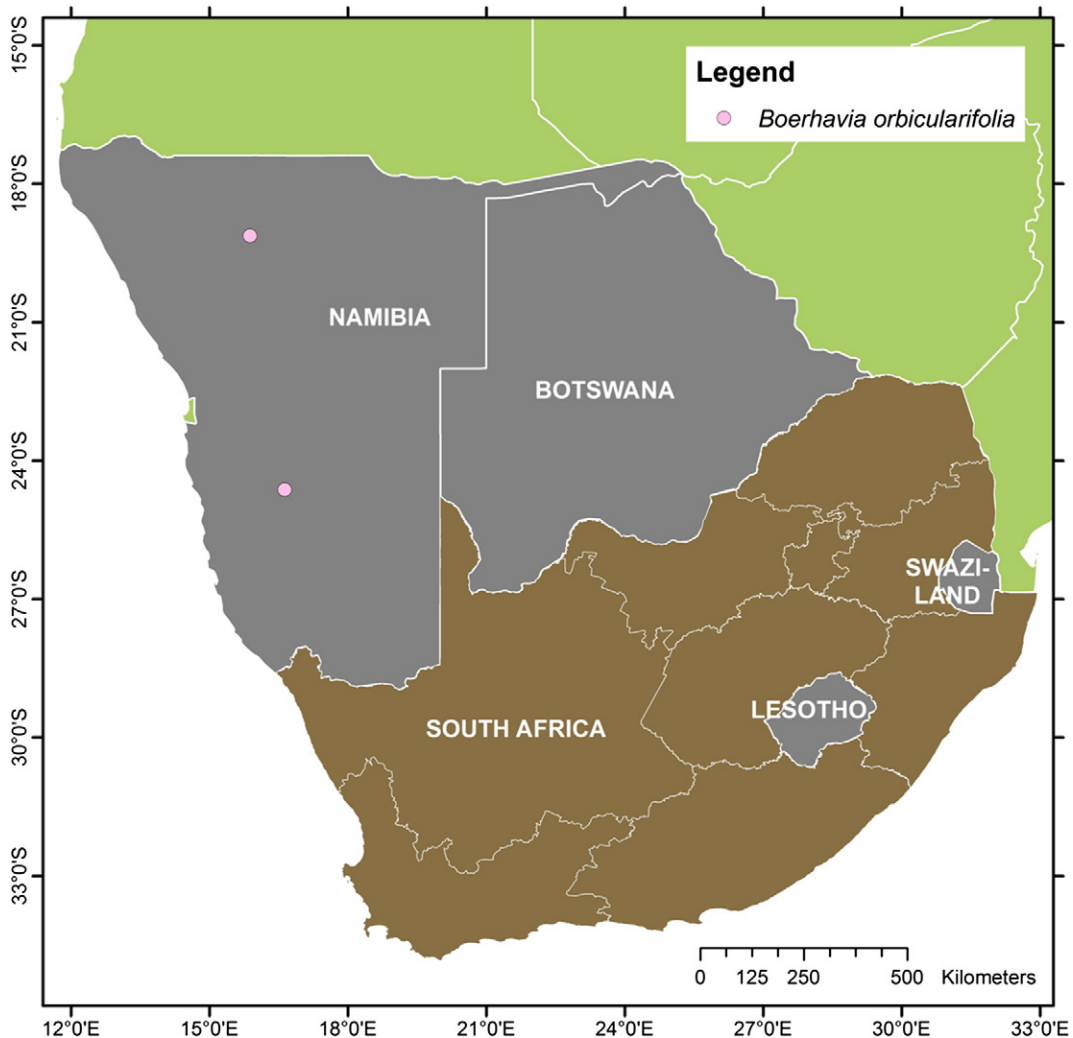
The specific epithet, *orbicularifolia*, means with round, disk-shaped leaves.

#### 4.9.3. Diagnostic characters

*B. orbicularifolia* can be distinguished from other *Boerhavia* species in southern African by its small habit, orbicular, oval or oblong leaves, its umbellate (not cymose) inflorescence, and its glabrate anthocarps.

#### 4.9.4. Additional specimens examined

NAMIBIA. 2416 (Maltahöhe): 60 km N of Maltahöhe on road to Walvis Bay, (-DA), 11 Mar 1995, Burgoyne 3488 (WIND).



**Fig. 15.** Known distribution of *Boerhavia orbicularifolia* in southern Africa.

4.10. *B. repens*

L., Sp. Pl. 1: 3 (1953); P.O.A.C: 174 (1895); Baker & C.H. Wright in F.T.A. 6(1): 4 (1909); Meikle in F.W.T.A. 2(1): 178 (1954); Codd, Bothalia 9(1): 121 (1966); Schreib. in Prodr. Fl. S.W. Afr. 25: 3 (1969); Agnew, Upland Kenya Wild Fl.: 162 (1974); Fosberg, Smithson. Contrib. Bot. 39: 8 (1978); Stannard in F.Z. 9(1): 24 (1988); Thulin in Fl. Somalia 1: 169 (1993); U.K.W.F. 2: 83 (1994); Whitehouse in F.T.E.A.: 6 (1996); Dequan & Gilbert in Fl. China 5: 433 (2003); Chen & Wu in Taiwan 52: 335 (2007). Type: Egypt, Herb. Linn. No. 9.8 (LINN—digital image!, lecto., designated by Codd: 121 (1966); PRE, photo!).

*Boerhavia vulvarifolia* Poir., Encycl. Méth. Bot. 5: 55 (1804). *B. repens* var. *glabra* Choisy in DC. Prodr. 13(2): 453 (1849). Type: Egypt, Delile (P, holo.). [fide Whitehouse, 1996].

*B. repens* var. *minor* Del., Descr. Egypte Hist. nat. 2: 146 (1813). *B. diffusa* var. *minor* (Del.) Cuf. in Bull. Jard. Bot. Brux. 23 (Suppl.): 77 (1953). Type: Egypt, Delile (MPU, holo.). [fide Codd, 1966; Whitehouse, 1996]

4.10.1. *Boerhavia repens* L. subsp. *repens*

Annual herb. Stems prostrate, puberulent. Leaves with petioles (3–) 5–15 (–20) mm long; lamina lanceolate, elliptic, ovate or oblong, (10–) 14–29 (–30) × (6–) 7–15 (–16) mm; apex apiculate, acuminate or rounded; base obtuse; margins entire, sometimes undulate; leaf pairs at nodes anisophyllous, glabrate. Inflorescence with primary peduncles 20–24 mm long, secondary peduncles 5–20 mm long;

glabrate to puberulent; 2–4 flowers per cluster; pedicels 1 mm long. Flowers 2–3 mm long; lower part of perianth 1–2 mm long, ellipsoid, 5-ribbed, glandular hairs present in grooves between ribs; upper part of perianth 1 mm long, white, pink or purple. Stamens 1 or 2, included, 0.6–0.8 mm long. Ovary 0.3–0.5 mm long; style 0.6–1.2 mm long, exserted. Anthocarp 3–4 × 1–2 mm, ellipsoid-clavate, 5-ribbed, rounded at apex, glandular hairs present in area between ribs and rarely on the ribs.

4.10.1.1. *Infraspecific taxa*. Two subspecies of *B. repens* occurs in tropical Africa (Klopper et al., 2006); subsp. *repens* and subsp. *diandra* (L.) Maire & Wieller. The latter is distributed in Egypt, tropical Africa, Palestine and Pakistan (Maire, 1962; Nasir, 1977; Klopper et al., 2006). *B. repens* subsp. *diandra* was differentiated from other subspecies in northern Africa by Maire (1962) based on stamen number (subsp. *diandra* having 2 stamens and subsp. *eu-repens* having 3 stamens) and leaf size and pubescence (subsp. *diandra* having small leaves less than 35 mm with glabrous or loosely hairy stems and leaves; subsp. *viscosa* having big leaves, 50 × 35 mm, and glandular-villous stems and leaves). Maire however, did not differentiate between subsp. *diandra* and subsp. *repens*. *B. diandra* (*B. repens* subsp. *diandra*) is described as glabrous with two stamens (Linnaeus, 1753). As subsp. *repens* can have one or two stamens, the only distinction between the subspecies is the hairiness of the stems and fruit; subsp. *diandra* being glabrous and subsp. *repens* being puberulous to glabrate. The southern African specimens studied were puberulous to glabrate, and are therefore considered to

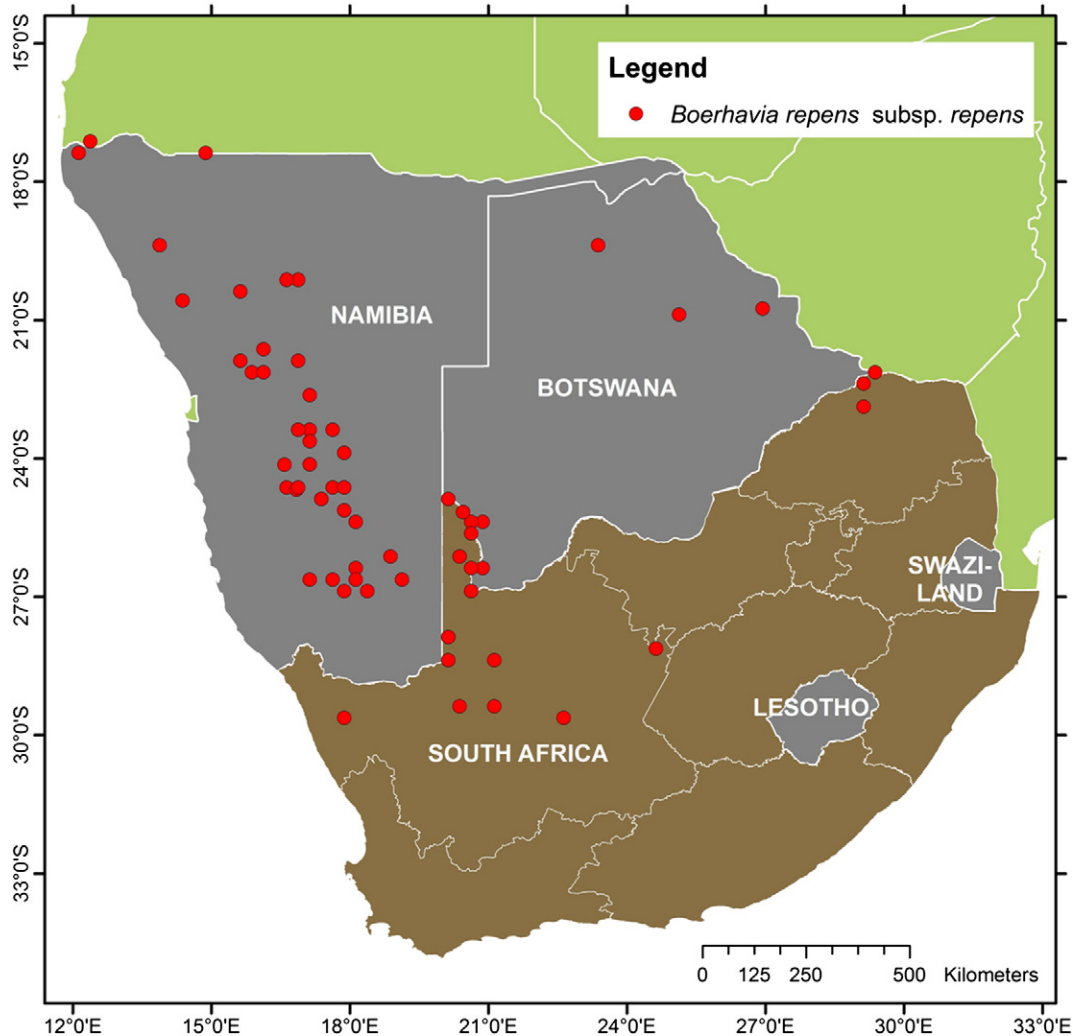


Fig. 16. Known distribution of *Boerhavia repens* subsp. *repens* in southern Africa.



be subsp. *repens*. The infraspecific taxa of *B. repens* however, require revision.

**4.10.1.2. Distribution and habitat.** *B. repens* subsp. *repens* is widespread in Africa and Asia (Codd, 1966; Chen and Wu, 2007). In southern Africa it is distributed throughout Botswana, Namibia and the arid parts of the Northern Cape and Limpopo, South Africa (Fig. 16). Plants prefer moist to well-drained stony, sand, clay, gravel, loam or alluvial soil of pans, depressions, riverbeds, plains or hill slopes, often along roadsides in full sun at altitudes of 557–1370 m. The species prefers alkaline soil with high Mg (8739 mg/kg) concentrations and a Mg:Ca ratio of 1.275 (Table 3). This unique soil preference within the genus is enhanced by its tolerance to high metal concentrations, with soil samples characterized by the highest levels of Ba (218 mg/kg) and Al (23,600 mg/kg), and the second highest levels of Mn (785 mg/kg) and Fe (28,900 mg/kg) in the study (Table 4).

**4.10.1.3. Phenology.** Flowers and fruits are produced from summer to late autumn (November to May).

**4.10.1.4. Etymology and common names.** The specific epithet, *repens*, means creeping and refers to its prostrate habit. It is commonly known as ‘alena spiderling’ or *alena-kleefbossie* (Afrikaans).

**4.10.1.5. Traditional uses.** There are no recorded uses for *B. repens* in southern Africa but it is used elsewhere in Africa to treat various ailments such as stomach-aches, yaws, jaundice, gonorrhoea, dropsy, asthma, scabies, skin rashes and small pox (Muzila, 2006). The plant is also eaten as a vegetable and is used as fodder for animals (Muzila, 2006).

**4.10.1.6. Diagnostic characters.** *B. repens* is distinguished from other *Boerhavia* species in southern Africa by its prostrate habit, anisophyllous leaf pairs, and ellipsoid-clavate anthocarp with glandular hairs between the ribs.

**4.10.1.7. Additional specimens examined.** NAMIBIA. 1714 (Ruacana Falls): Kunene, Mahenene Research Station fields (–DB), 15 Dec 1999, Kolberg HK1006 (PRE, WIND). 2014 (Khorixas): Twyfelfontein Lodge, visitors parking (–CB), 07 Feb 2009, Struwig 69 (PUC, WIND). 2016 (Otjiwarongo): Outjo district, Franzfontein, beneath dolomite mountain in rock cave, gate to the N (–BA), 13 Mar 1974, Merxmüller & Giess 30306 (PRE, WIND). 2416 (Maltahöhe): M47, Capricorn Rest, (–BA), 08 Apr 2010, Struwig 161 (PUC, WIND); Maltahöhe, D850, roadside (–DA), 09 Apr 2010, Struwig 168, 170 (PUC, WIND). 2417 (Mariental): Mariental District, 70 km from Mariental, farm Voigtsgrund (–CD), 12 Mar 1983, Immelman 588 (PRE).

South Africa. LIMPOPO. 2229 (Waterpoort): Messina, Waterpoort, Greefswaldt, west-facing slope (–AB), 08 Jan 1974, Theron 2797 (GRA, PRE); Breslau 2MS Farm (near Pontdrift) (–AC), Straub 833 (PRE).

NORTHERN CAPE. 2520 (Mata Mata): Kalahari Gemsbok National Park, Kousaunt (–AC), 07 Apr 1997, Mucina s.n. (PRE). 2720 (Noenieput): Gordonia, Obobogorap, 120 miles NW of Upington (–CC), 08 Apr 1960, Leistner 1783 (KMG, PRE). 2820 (Kakamas): Keimoes district (–AD), 06 Apr 1950, Theron 772 (PRE). 2824 (Kimberley): Hay division, 11 Apr 1937, Acocks 1978 (KMG, PRE). 2921 (Kenhardt): Kenhardt division, 25.8 miles SW by W of Kenhardt (–AC), 04 Feb 1961, Acocks 21788 (PRE).

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