6. *Agave vivipara* L. var. *vivipara*

In: *Species plantarum*: 323 (1753a).

=*Agave decipiens sensu auct.* Smith & Steyn (1999b) *non* Baker.

Medium-sized, shortly caulescent, monocarpic, rosulate, perennial, leaf succulent; rosettes up to 1.3 m tall; proliferous through subterranean stolons. **Leaves** rigidly spreading to recurving, narrowly lanceolate, 0.75–1 m long, dark green; margins armed with simple teeth, recurved, 1–2 mm long; apical spine conical, 1–1.5 cm long. **Inflorescence** paniculate, branched, 6–7 m tall, usually bulbiliferous. **Flowers** erect, 5–5.5 cm long, yellowish green. **Stamens** with filaments 4.5–4.8 cm long; anthers excentric, 2 cm long, light green with brownish red speckles. **Fruit** a capsule, ellipsoid to oblong, 3.5–5 cm long. **Seed** not seen. **Distribution**: SA. (Fig. 52).

References: Wijnands (1983), García-Mendoza & Chiang (2003), Jarvis (2007).

It should be noted that *Agave vivipara* var. *vivipara* has locally been confused with *A. decipiens* Baker. The latter has been recorded from tropical areas of the southeastern United States of America, for example the state of Florida. In South Africa the latter species has only been observed in cultivation in gardens of beach-front hotels in Durban in KwaZulu-Natal and in the industrial area of Springs in Gauteng, but has not escaped into nature. The climate in Springs is near-continental and winter temperatures regularly drop below freezing, which indicates the wide ecological amplitude of *Agave decipiens*.

Agave vivipara var. *vivipara* is one of two species of *Agave* naturalised in southern Africa of which its sword-shaped leaves are mid- to dark green (Fig. 53). However, the other one, *A. sisalana*, has smooth leaf margins, while those of *A. vivipara* var. *vivipara* are armed with prominent, greenish brown teeth. *Agave angustifolia*, on the other hand, has a somewhat similar growth form to that of *A. vivipara* var. *vivipara*, but the latter's leaves are generally broader in the middle. In addition, the mid-rosette leaves are carried more or less erect and are much more widely spaced on the short stem, making the leaf bases clearly visible (Fig. 54) [see e.g. Jarvis (2007: 121, plate on the left)]. Furthermore, García-Mendoza & Chiang (2003) showed that *Agave angustifolia* and *A. vivipara* warrant recognition as independent species, a proposal we follow here, as opposed to the treatments of Wijnands (1983) and Thiede (2001) that regarded these two species as conspecific (see also Smith & Steyn, 1999a).

The species was likely introduced for its horticultural potential as an accent plant in large gardens. It has the potential to become a real pest plant as a result of the vast number of bulbils formed on the inflorescences, after flowering.

Fig. 52. Distribution map of *Agave vivipara* L.

Fig. 53. Mid- of to dark green sword-shaped leaves *Agave vivipara* L. carry marginal spines, unlike those of *A. sisalana* Perrine. (Picture by Gideon F. Smith)

Fig. 54. Leaf bases are visible in *Agave vivipara* L. while in *A. angustifolia* Haw. they are obscure. (Picture by Estrela Figueiredo)

7. *Agave wercklei* F.A.C. Weber ex Wercklé

In: *Monatsschr. Kakteenk.* 17: 71–72 (1907a).

=*Agave costaricensis* (This name, sometimes used for the species in the horticultural trade, is of unknown origin.)

Common names: bondelgaringboom (Afrikaans).

Medium-sized to large, acaulescent, monocarpic, rosulate, perennial, leaf succulent; rosettes up to 2 m tall, non-surculose. **Leaves** rigidly spreading, ovate to lanceolate, short-acuminate, 0.7–1.5 m long, light greyish green, often with a whitish grey sheen; margins armed with simple teeth, straight or variously recurved, 3–4 mm long; apical spine conical, 2–3 cm long. **Inflorescence** paniculate, branched, 4–8 m tall, profusely bulbiliferous. **Flowers** erect, up to 8 cm long, basal part light green, tepals golden yellow. **Stamens** with filaments 9 cm long; anthers golden yellow, 1.6 cm long. **Fruit** a capsule, ovoid-angular, 2.2–3 × 1.5–1.8 cm. **Seed** hemispherical, 5 × 4 mm, black. **Distribution**: SA. (Fig. 55).

References: Wercklé (1907b), Thiede (2001), Smith & Steyn (2002a), Smith & Steyn (2003).

Interestingly, Carlos Wercklé, who did valuable work on the ferns and vegetation of Costa Rica, validated the name of this taxon that had been proposed to commemorate him by Weber and so *Agave wercklei* was named after himself (Wercklé, 1907a, b).

This is the only species of *Agave* naturalised in southern Africa that does not proliferate through basal or stem suckers before, or after, flowering (Fig. 56). To compensate for the lack of basal sprouts it produces thousands of bulbils (Fig. 57) on the tall branched inflorescence after flowering (Fig. 58). These drop to the ground and easily strike root where they fall (Fig. 59). The flowers are a pleasant bright yellow colour (Fig. 60).

Fig. 55. Distribution map of *Agave wercklei* F.A.C.Weber ex Wercklé.

Fig. 56. Rosettes of *Agave wercklei* F.A.C.Weber ex Wercklé are non-suckering. (Picture by Gideon F. Smith)

Fig. 57. Bulbils of *Agave wercklei* F.A.C.Weber ex Wercklé. (Picture by Neil R. Crouch)

It is unknown when and where the species was introduced into South Africa. It was more than likely brought in for its value as a horticultural plant, given that it will not sucker in a pot or the open ground, making it more manageable than species such as *Agave americana* and *A. sisalana*. The species was originally recorded from a single locality near the Baakens River Valley in Port Elizabeth in the Eastern Cape Province, but has more recently also been observed near Pietermaritzburg in KwaZulu-Natal.

Fig. 58. Branched inflorescence of *Agave wercklei* F.A.C.Weber ex Wercklé. (Picture by Neil R. Crouch)

Fig. 59. Bulbils of *Agave wercklei* F.A.C.Weber ex Wercklé rooting and forming a colony. (Picture by Neil R. Crouch)

Fig. 60. Bright yellow flowers of *Agave wercklei* F.A.C.Weber ex Wercklé. (Picture by Neil R. Crouch)

Furcraea Vent.

Robust, monocarpic, usually rosulate multi-annual perennials arising from short rhizome or short erect caudex, some species caulescent, palm tree-like. **Stem** up to 1.2 m tall, commonly with monocotyledonous type secondary growth. **Leaves** usually crowded in an apical or basal rosette, leathery to succulent, amplexicaul, persisting for many years, vibrant or glaucous green; each vascular bundle with well-developed fibrous cap at phloem pole. **Inflorescence** terminal, tall, fast-growing, terminating in a panicle, often massive. **Flowers** pendulous, campanulate, bisexual, regular or somewhat irregular, pedicellate, 3-merous throughout, often replaced by small, globular bulbils. **Perianth** white to greenish white, petaloid, 3 + 3, spreading, often fleshy, free, not forming a tube. **Stamens** inserted, 3 + 3, basally expanded; anthers mostly dorsifixed, introrse, versatile opening by longitudinal slits, linear to oblong. **Filaments** swollen below middle. **Ovary** inferior, 3-locular, with septal nectaries; placentation axile; ovules in 2 vertical rows in each locule; style stout, swollen basally with 3 prominent angles, inserted, terminal; stigma 3-lobed. **Fruit** a loculicidal capsule. **Seeds** many, black, flattened.

References: Ventenat (1793), Drummond (1907), Verhoek (2002), Crouch & Smith (2011).

Furcraea is a small genus in which only 21 species are included. Several attain tree-like dimensions, and their stems can reach a length of 1.2 m or more. The leaves are a vibrant or glaucous green colour and arranged in a terminal rosette, giving the plants a palm tree-like appearance when old. The flowers are pendulous, bell-shaped, and, in cultivated and naturalised forms often replaced by small, globular bulbils. The perianth is mostly free, forming a very short tube. The filaments are swollen below the middle. The style is stout and swollen basally with three prominent angles.

Most species have been introduced from tropical America, and one of these has become established in southern tropical Africa. This species, *Furcraea foetida* (L.) Haw. (=*F. gigantea* Vent.), escaped from sites of habitation and plantations established for fibre production, mainly in the bushveld (savanna) and subtropical eastern areas of the subcontinent. It is colloquially known as Mauritius hemp or green aloe, and is also naturalised in Zambia and Zimbabwe. Although not yet recorded from Angola, Malawi or Mozambique, it more than likely also occurs in the subtropical areas of these countries.

Furcraea foetida (L.) Haw.

In: *Synopsis plantarum succulentarum*: 73 (1812).

=*Agave foetida* L.
=*Furcraea gigantea* Ventenat

Common names: furcraea, green aloe, Mauritius hemp (English); furcraea, nooiensgaringboom (Afrikaans).

Large to massive, acaulescent or short-stemmed, multi-annual, monocarpic, rosulate, perennial, leaf succulent; rosettes up to 2.5 m tall, proliferous through stem suckers. **Leaves** erect at first, becoming spreading, stiff, lanceolate, 1.8–2.4 m long, verdant green to yellowish green; margins hard, distally smooth, armed with a few hooked, simple teeth towards base; apex a firm, blunt point. **Inflorescence** paniculate, branched, 5–12 m tall, always bulbiliferous. **Flowers** pendulous, 7–10 cm long, in clusters of 2–5, white to shades of greenish white. **Stamens** inserted; filaments short, basally expanded; anthers centric to excentric, 3–3.6 cm long, yellow. **Ovary** inferior, 1.2–1.5 cm long; style inserted, dilated, 3-lobed proximal to middle; stigma 3-lobed. **Fruit** a capsule, loculicidally dehiscent, infrequently produced. **Seeds** many, flat, in 2 rows per locule, black. **Distribution**: SA. (Fig. 61).

References: Howard (1979), Verhoek (2009), PIER (2010), Crouch & Smith (2011).

Plants can be easily distinguished from agavoid look-alikes as a result of their light green leaf colour (Fig. 62), leaf margins that are smooth along the distal half (Fig. 63), down-turned, bell-shaped flowers (Fig. 64), and round bulbils (Fig. 65). The inflorescence can reach a height of 12 m and typically has drooping lateral branches (Fig. 66). *Furcraea foetida* occurs naturally from Guadaloupe south through northern South America to Brazil and the Caribbean (Greater Antilles) (Crouch & Smith, 2011).

The arrival of *Furcraea foetida* in South Africa may be traced to its importation by the Natal Botanical Gardens (now the Durban Botanic Gardens) sometime before the early 1880's, c. 130 years ago (Crouch & Smith, 2011). Plants were previously established in plantations from where they have started escaping. Initial eradication efforts may have to be focused on the physical removal of plants. However, this labour intensive process may prove to be feasible in the case of isolated populations only.

Fig. 61. Distribution map of *Furcraea foetida* (L.) Haw.

Fig. 62. Leaves of *Furcraea foetida* (L.) Haw. are verdant green. (Picture by Neil R. Crouch)

Fig. 63. The leaves of *Furcraea foetida* (L.) Haw. lack teeth at the distal end. (Picture by Neil R. Crouch)

Fig. 64. The flowers of *Furcraea foetida* (L.) Haw. are bell-shaped and drooping. (Picture by Geoff R. Nichols)

Fig. 65. Bulbils of *Furcraea foetida* (L.) Haw.
(Picture by Neil R. Crouch)

Fig. 66. Inflorescences of *Furcraea foetida* (L.) Haw. (Picture by Geoff R. Nichols)

AIZOACEAE Martinov

(Ice plant family; *Vygiefamilie*)

by

M. Walters

Annual, biennial or perennial herbs, subshrubs or shrubs, rarely plants reduced to a single leaf-pair. **Stems** erect or prostrate and mat-forming, or underground. **Leaves** usually simple, often fleshy or scale-like, opposite or sometimes alternate, margins mostly entire; epidermis sometimes with bladder cells, often papillate to pubescent; blade flat, terete or triquetrous; true stipules absent, sometimes a stipuliform appendage present or leaves sessile or with leaf sheath. **Inflorescence** a terminal or seemingly axillary cyme, or flowers solitary; bracts present or absent. **Flowers** usually bisexual, rarely unisexual, actinomorphic, perigynous to hypogynous or epigynous, hypanthium present, with or without pedicel. Perianth consisting of sepals and petals or perigone. **Sepals** (3–)5(–8), sometimes petaloid and coloured, often with dorsal subapical appendage. **Petals** commonly absent or numerous, distinct or connate proximally, often 2–4 seriate, linear. **Stamens** 1–very numerous, free or connate at base, rarely connate with petals forming a tube; anthers bilocular, dehiscing by longitudinal slits. **Ovary** superior, inferior or semi-inferior, 1–5- or many- carpellate, syncarpous; ovules 1–many per carpel; styles 1–25 or absent, distinct or partly connate; stigmas 2–25. Nectaries absent, separate or in a ring around ovary. **Fruit** a hygrochastic loculicidal, rarely septicidal or xeromorphic capsule, with or without membranes covering the seeds, sometimes dehiscence circumscissile, or fruit a hard 1-seeded nut, or more rarely a drupe. **Seed** 1–many, usually ± ovoid, sometimes with aril, usually papillose.

References: Hartmann (2001a), Vivrette *et al*. (2003).

The family treatment here follows that of Smith *et al*. (1998) and Hartmann (2001a), and excludes the Molluginaceae while including groups sometimes considered families of their own, e.g. Sesuviaceae, Tetragoniaceae and Mesembryanthemaceae. The Aizoaceae, as treated here, consists of about 130 genera and 2 500 species (Vivrette *et al*., 2003).

Members of the Aizoaceae are found on all continents (except Antarctica) (Vivrette *et al*., 2003), throughout the tropics and subtropics with the centre of diversity (at species level) being in the southwestern part of Africa (Smith *et al*., 1998; Hartmann, 2001a). Species may occur in habitats as diverse as dry subtropical deserts, wet tropical coasts, and snow-covered subtropical mountains, but the highest number of genera and species inhabit semi-arid (100–400 mm annual precipitation) winter-rainfall areas (Hartmann, 2001a). Particularly the group popularly known as mesembs ('vygies' in Afrikaans; also known as fig-marigolds, flowering stones, ice plants and midday flowers), have diversified extensively in southern Africa's winter-rainfall area, with over 1 500 species being known from, and mostly restricted to, this region (Smith *et al*., 1998; Van Jaarsveld *et al*., 2000).

Many members of the family are of economic importance as ornamentals and are in

cultivation worldwide resulting in a number of species occurring outside their natural distribution ranges e.g. *Carpobrotus edulis* (L.) N.E.Br., *Mesembryanthemum crystallinum* L. or *Disphyma crassifolium* (L.) L.Bolus (Vivrette *et al*., 2003). Some species are also used to stabilise sand dunes in coastal regions (Heywood *et al*., 2007), while others are important in the southern African medicinal plant trade (Smith & Crouch, 1999).

Only one species from a single genus is naturalised in southern Africa.

Tetragonia L.

Annual or perennial herbs or subshrubs, with shiny, translucent bladder cells, resulting in a white appearance of the leaves, glabrous, pilose, or papillate. Stems erect, ascending or prostrate, semi-woody at base. **Leaves** alternate, often opposite basally; petiole short to long; blade flat, ovate to almost linear, margins entire to slightly sinuate or shallowly lobed; epidermis with variously-shaped papillae, often of two types with one elongate and hairy; stipules absent. **Inflorescences** axillary clusters of flowers or flowers solitary, sessile or peduncled; bracts usually absent. **Flowers** bisexual or unisexual, inconspicuous, 0.5–1 cm in diameter, sessile or pedicellate. **Perianth** campanulate, adnate to ovary; lobes (3–)4(–7), green or yellow adaxially, basally united into a short tube. **Petals** and petaloid staminodia absent. **Stamens** 1–20, usually twice the number of the perianth lobes, perigynous. **Pistil** 3–10-carpellate. **Ovary** inferior, (1–)3–10-loculed; ovule 1 per locule, pendulous; styles 3–10; stigmas 3–10. **Fruit** a woody, indehiscent nut with persistent perianth, ridged, winged or tuberculate, usually with 4 rows of ornaments, often apically as horns, brown to black. **Seeds** 1–10, sub-reniform or pyriform, light brown, arils absent.

References: Adamson (1955), Taylor (1994), Hartmann (2001b), Lu & Hartmann (2003), Vivrette (2003).

Tetragonia consists of about 60 species (Lu & Hartmann, 2003; Vivrette, 2003) with representatives in Africa, South America, East Asia, Australia and New Zealand, where they prefer tropical climates though are also found in drier climates in the southern hemisphere (Taylor, 1994; Hartmann, 2001b). Some members of the genus have naturalised elsewhere (Lu & Hartmann, 2003; Vivrette, 2003).

The name for the genus comes from the Greek words *tetra* (four) and *gone* (reproductive organs), and refers to the four-angled or four-winged fruits found in many of the species (Hartmann, 2001b).

There are 32 species of *Tetragonia* in South Africa (Germishuizen *et al*., 2006). *Tetragonia tetragonioides* was classified in subgenus *Tetragonoides* DC. (Adamson, 1955). The subgenus is characterised by the simple fruit, 1–8-celled, with cells as many as fruit cells, stamens up to twice the number of perianth segments and ovary bulging above the insertion of the perianth (Adamson, 1955). *T. tetragonioides* can be distinguished from the other species in the subgenus that occur in South Africa with the following key [adapted from Adamson (1955)]:

Key to distinguish *T. tetragonioides*

1. Flowers in groups of 3–5 or more **2**
1'. Flowers solitary or in pairs **3**

2. Flowers sessile, ovary projecting as a cone; fruit with 3–4 flat projections at the top . . . . . **(*Tetragonia microptera*)**
2'. Flowers shortly pedicellate; ovary with 2–3 obtuse projections around the styles; fruit ridged with spine-like outgrowths on the ridges . . . . . **(*Tetragonia echinata*)**

3. Fruit covered all over with spine-like outgrowths . . . . . **(*Tetragonia acanthocarpa*)**
3'. Fruit without spine-like outgrowths **4**

4. Plant papillose-hairy all over; stamens as many as perianth segments; fruit ridged . . . . . **(*T. caesia*)**
4'. Plant glabrous-papillose; stamens twice as many as perianth segments; fruit smooth, with horn-like projections at the top . . . . . ***Tetragonia tetragonioides***

Tetragonia tetragonioides (Pall.) Kuntze

In: *Revisio Generum Plantarum* 1: 264 (1891) (as "*tetragoniodes*").

=*Demidovia tetragonoides* Pall. (basionym)
=*Tetragonia expansa* Murray

Common name: New Zealand spinach (English).

Annual herbs, prostrate to ascending, up to 60 cm tall. Stems mat-forming; internodes with densely placed bladder cells when young. **Leaves** alternate; petiole 0.5–3 cm long, thick, winged; blade rhomboid-ovate or deltoid-ovate, 0.5–10.7 × 2.5–8 cm, base truncate, pale green abaxially, dark green adaxially, epidermis with large, globose papillae abaxially, fewer along the margins,. **Flowers** solitary, rarely 3, sessile or with pedicel up to 2 mm long. **Perianth** with tube 2–3 mm long; lobes spreading, usually 4, up to 2 mm long, ovate to semi-orbicular, papillate and green outside, bright yellow to yellowish green and minutely papillate inside. **Stamens** 10–13, clustered or scattered. **Fruit** turbinate, 0.8–1.2 cm long and 1 cm in diameter; horns 4–6. **Seeds** as many as locules, pyriform, smooth, amber to light brown. **Distribution**: SA. (Fig. 67).

References: Hartmann (2001b), Lu & Hartmann (2003), Vivrette (2003).

First collected from New Zealand, this plant became known as a food plant and has spread all over the world (Hartmann, 2001b), becoming naturalised in many regions (Lu & Hartmann, 2003; Vivrette, 2003). As the common name suggests, New Zealand spinach may be eaten, raw or cooked, as a leaf vegetable and is a delicious spinach substitute (Fig. 68) (Plants for a Future, 2008). Seeds require

warm temperatures to germinate and plants are cultivated and sold as a summer spinach in temperate regions. In certain Asian cultures it is believed to be effective against enteritis and stomach ache (Sung *et al*., 1998), as well as stomach cancer and stomach ulcers (Kato *et al*., 1985).

It is naturalised in the coastal region of KwaZulu-Natal in South Africa. It is possible that the introduction of this species is due to plants being washed ashore from passing ships (Fox & Norwood Young, 1982). A place near Richards Bay is known as Spinach Point due to the fact that local Zulus would load their canoes with plant material from that area (Fox & Norwood Young, 1982). Plants are frost-sensitive (Plants for a Future, 2008) and unlikely to survive the cold winters of the South African interior above the Great Escarpment without protection under glass or in plastic tunnels. Thus far the species does not appear to be problematic and no eradication measures are necessary. However, where possible, known populations should be monitored for future expansion. Vegetatively plants (Fig. 69, 70) look similar to some representatives of what Smith *et al.* (1998) termed the 'weedy mesembs', but the flowers of *T. tetragonioides* are insignificant (Fig. 71), unlike the strawberry-red ones of the similar-looking *Aptenia cordifolia* (L.F.) Schwantes, for example.

Fig. 67. Distribution map of *Tetragonia tetragonioides* (Pall.) Kuntze.

Fig. 68. A dish prepared from *Tetragonia tetragonioides* (Pall.) Kuntze leaves. (Picture by Gideon F. Smith)

Fig. 69. Colony of *Tetragonia tetragonioides* (Pall.) Kuntze. (Picture by Neil R. Crouch)

Fig. 70. Plant of *Tetragonia tetragonioides* (Pall.) Kuntze. (Picture by Neil R. Crouch)

Fig. 71. Flowers and crystalline leaf surface of *Tetragonia tetragonioides* (Pall.) Kuntze. (Picture by Neil R. Crouch)

BASELLACEAE Moq.

(Madeira-vine family; *Madeira-klimopfamilie)*

by

M. Walters

Usually glabrous vines or decumbent to procumbent herbs; roots and stem base fibrous to sometimes tuberous and thickened, entire plants fleshy to succulent; stems glabrous, rarely asperous (or puberulent when young). **Leaves** spirally arranged, petiolate (sometimes almost sessile), simple, entire (rarely dentate by glands), sometimes with reddish margin often softly succulent; stipules absent. **Inflorescence** an axillary or terminal spike, raceme, panicle or dichasium; bracts persistent or deciduous; pedicel present or absent; bracteoles 2 (rarely absent), opposite, at pedicel apex, sometimes displaced when pedicel lengthens, persistent or deciduous. **Flowers** sessile or pedicellate, actinomorphic, bisexual (rarely functionally unisexual), cleistogamous or chasmogamous, small. **Sepals** 2, valvate, opposite, free to the base or partly connate, fused with petals at least at the base, entire, persistent, often somewhat accrescent in fruit, membranous to thick (rarely fleshy), sometimes with dorsal wing or gibbous at the base, greenish, whitish, yellowish or reddish at anthesis or pale, brownish or ± black when in fruit. **Petals** usually 5, persistent, often somewhat accrescent in fruit, connate at the base only or up to ⅔ of their length, greenish, whitish, yellowish or reddish at anthesis or pale, brownish or ± black when in fruit, membranous to thick (rarely fleshy). **Stamens** 5, epipetalous, basally connate or fused up to ¾ of their length with the petals; anthers dorsifixed or basifixed, tetrasporangiate, 2-locular, dehiscent by longitudinal or apical slits. **Ovary** superior, 3-carpellate, syncarpous, 1-locular with a single basal ovule; styles 3 or 1 that is 3-partite to the base or almost so; stigmas linear to capitate or 3-lobed (rarely bifid). **Fruit** a thin-walled nutlet, indehiscent, smooth (sometimes rugose), surrounded at the base to completely enclosed by the persistent dry or fleshy perianth. **Seed** with a membranous testa, usually rust-coloured, embryo annular to cochleate.

References: Sperling & Bittrich (1993), Eggli (2002a), Vincent (2003), Eriksson (2007).

The Basellaceae is a small family consisting of four genera (*Anredera* Juss., *Basella* L., *Tournonia* Moquin-Tandon, *Ullucus* Caldas.) with 19 species of mostly succulent, short-lived, twining, scandent or trailing vines or herbs. Three genera (*Anredera*, *Tournonia* and *Ullucus*) are native to the tropics of the New World and the Andean regions of America. The genus *Basella* occurs in Madagascar, South and East Africa and one species, *Basella alba* L., has a pantropical distribution (Sperling & Bittrich, 1993; Eriksson, 2007).

Species in the Basellaceae are mostly distinguished by their reproductive parts. Flowers of *Basella* are sessile and arranged on generally unbranched spikes (*B. paniculata* Volkens is abundantly branched). *Anredera* and *Ullucus* have pedicellate flowers in racemes or panicles; *Tournonia* is distinguished by its axillary dichasia (Eriksson, 2007).

Most species prefer open, dry habitats (e.g. scrub, rocky slopes and sandy areas). The centre of diversity for the family is found in the Andean region, with some species preferring the lowlands while others may grow at altitudes of 3 500 m or more. Despite the number of species found in this region, the centre of origin for the family might actually be in southeastern Africa (Eriksson, 2007).

A few of the species in the family Basellaceae have economic importance as crops or ornamentals. Some of the species in the genus *Anredera* are cultivated as ornamentals. *Basella alba* is widely cultivated as a leafy vegetable and the cultivated forms of *Ullucus tuberosus* Caldas are an important, traditional food crop in the South American Andes (Sperling & Bittrich, 1993).

Two species from two genera of the Basellaceae are naturalised in southern Africa.

Key to the two naturalised genera [adapted from Sperling & Bittrich (1993)]:

1. Filaments outwardly reflexed in bud and anthesis, anthers dorsifixed, flowers shortly or distinctly pedicellate, sweet smelling . . . . . .***Anredera***

1'. Filaments straight in bud and anthesis, anthers basifixed, flowers sessile, unscented . . . . . .***Basella***

Anredera Juss.

Twining vines with or without tuberous roots; stems glabrous or puberulent when young. **Leaves** alternate, with a short to distinct petiole; blade slightly fleshy, entire, lanceolate to broadly elliptic, cordate or obovate, apex obtuse to acuminate. **Inflorescence** a raceme or panicle, shortly to distinctly pedunculate; bracteoles distinct, subtending the flowers, triangular to broadly ovate. **Flowers** shortly or distinctly pedicellate, minute and often cleistogamous, bisexual (rarely functionally unisexual), fragrant. **Sepals** rhombic or rounded, ovate to elliptic, free, apex obtuse, whitish, yellowish or reddish at anthesis or pale, brownish or ± black, ± dry when in fruit. **Petals** ovate or elliptic to obovate, connate at the base into a short tube or rarely completely free, apex obtuse, at anthesis whitish, yellowish or reddish or in fruit pale, brownish or ± black, ± dry when in fruit. **Stamens** 5; filaments reflexed in bud, connate into a short tube, fused with tepals; anthers dorsifixed and longitudinally dehiscent. **Ovary** globose to pyriform; style 1 (undivided to 3-partite) or 3; stigmas clavate to capitate or 3-lobed (rarely bifid). **Fruit** globose to pyriform, at the base surrounded or completely enclosed by the persistent perianth. **Seed** erect, laterally flattened to nearly globose.

References: Sperling & Bittrich (1993), Eggli (2002a), Vincent (2003), Eriksson (2007).

Anredera is a genus native to the New World occurring from Florida and Texas down to Argentina with the majority of species growing in the Andean region at altitudes between 1 500 and 3 500 m (Sperling & Bittrich, 1993; Eriksson, 2007). Some of the species with widespread distributions, however, also have wide altitudinal

ranges. The genus encompasses 12 species, with a few grown as ornamentals throughout the world, some of which have become locally naturalised in other tropical or subtropical areas (Eriksson, 2007).

Anredera cordifolia (Ten.) Steenis

In: *Flora Malesiana*, Series I, Spermatophyta 5(3): 303 (1957).

=*Anredera baselloides* (Kunth) Baill.
=*Anredera cordifolia* (Ten.) Steenis subsp. *gracilis* Xifreda & Argimón
=*Boussingaultia baselloides* Kunth
=*Boussingaultia cordata* Sprengel
=*Boussingaultia cordifolia* Ten.
=*Boussingaultia gracilis* Miers
=*Boussingaultia gracilis* Miers var. *pseudobaselloides* (Hauman) L.H.Bailey

In South Africa the plant has been listed as *Anredera baselloides* (Wells, 1986; MacDonald *et al*., 2003), a name considered a synonym of *A. cordifolia* (Schatz *et al*., 2011).

Common names: bridal wreath, cascade creeper, lamb's tail, Madeira vine, mignonette vine (English); Madeiraranker (Afrikaans); indaba-ingehlele, madilika (Zulu).

A twining vine with glabrous stems, often producing aerial tubers; rootstock and stem base producing an irregularly lump-shaped caudex with smooth greenish to brownish bark; aerial stems annual, twining, to 6 m long, softly succulent. **Leaves** well spaced, petiole up to 2.5 cm long; blade ovate to cordate, 2.5–10 × 1.5–7.5 cm, with cordate base, sometimes truncate to rounded, apex acute (rarely obtuse), slightly fleshy, green. **Inflorescence** a usually lax and much-branched (sometimes unbranched) raceme up to 50 cm long; pedicels 0.5–3.5 mm long; bracteoles persistent, connate at the base forming a cup. **Flowers** bisexual, strongly sweet-scented. **Sepals** broadly ovate to broadly elliptic, patent, 1.5–3 × 1.5–2.5 mm, distinctly shorter than petals (rarely of almost equal length), white at anthesis, ± dark brown when in fruit. **Petals** uniform, patent, elliptic to obovate, 2–4 × 1.5–2.5 mm, whitish-yellow, turning ± dark brown after anthesis. **Stamens** opposite petals; filaments recurved in bud. **Style** 1, 3-partite, sometimes almost to the base. **Fruit** surrounded by persistent perianth. **Distribution**: L, S, SA. (Fig. 72).

References: Eggli (2002a), Eriksson (2007).

Anredera cordifolia is a very variable species but infraspecific taxa are not recognised. It is native to the southern and central parts of South America (South Brazil, Paraguay and northern Argentina). It grows well in tropical and subtropical areas of the world and is often naturalised outside its native distribution range (Eriksson, 2007).

In southern Africa the plant is grown as a garden ornamental (Wells, 1986; Glen, 2002) because of its large, branched inflorescences (Fig. 73) consisting of masses

of showy, pedicellate, fragrant flowers (Fig. 74). (Eriksson, 2007). It is also grown for its edible tubers (Fig. 75), which are said to be rather tasteless, while elsewhere the leaves are cooked like spinach (Fig. 76) (Eggli, 2002a). *Anredera cordifolia* has been recorded as having anti-inflammatory properties (Vincent, 2003) while in South Africa it is used medicinally as a general anti-microbial agent (Von Ahlefeldt *et al*., 2003; Singh, 2006) and specifically by the Vhavenda for the treatment of gonorrhoea and syphilis (Tshikalange, 2003). Aqueous extracts of the plant are, however, considered poisonous (Henderson, 2001).

It is considered a declared weed in the sub-region and is listed in South Africa as a category 1 invader, meaning it must be controlled or eradicated where possible (Henderson, 2001). The plant grows very quickly and along with its ability to reproduce vegetatively by way of the tubers, has become rather difficult to control (Eriksson, 2007). In addition seeds germinate profusely (Fig. 77).

While chemical control methods are available for the management of *Anredera cordifolia*, they are considered unsuitable due to the risk to non-target species growing beneath the smothering vines (Fig. 78). The South African and Australian Governments have done some initial research on the use of a South American, leaf feeding beetle, *Plectonycha correntina,* as a biological control agent (Cagnotti *et al*., 2007; Biosecurity Australia, 2010). The risk to non-target species is considered negligible and no other potential consequences of the release were identified (Biosecurity Australia, 2010). During initial trials, *Basella alba* and *Anredera cordifolia* were among four plants allowing complete larval development (Biosecurity Australia, 2010), making this a potential biocontrol agent for the future.

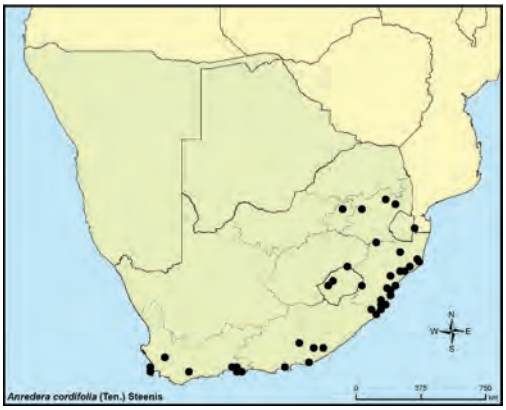

Fig. 72. Distribution map of *Anredera cordifolia* (Ten.) Steenis.

Fig. 73. Branched inflorescences of *Anredera cordifolia* (Ten.) Steenis.
(Picture by Geoff R. Nichols)

Fig. 74. Pedicellate, white flowers of *Anredera cordifolia* (Ten.) Steenis.
(Picture by Neil R. Crouch)

Fig. 75. Edible tubers of *Anredera cordifolia* (Ten.) Steenis. (Picture by Neil R. Crouch)

Fig. 76. Leaves of *Anredera cordifolia* (Ten.) Steenis. (Picture by Neil R. Crouch)

Fig. 77. Seedlings of *Anredera cordifolia* (Ten.) Steenis. (Picture by Neil R. Crouch)

Fig. 78. Vines of *Anredera cordifolia* (Ten.) Steenis smothering native plants. (Picture by Geoff R. Nichols)

Basella L.

Twining vines to procumbent or erect herbs with or without tuberous roots; stems glabrous or rarely puberulent when young, without tubers. **Leaves** alternate, slightly fleshy, with a short petiole; blade lanceolate to broadly elliptic or cordate, entire, apex obtuse to acuminate. **Inflorescence** a branched or unbranched spike, with or without peduncle; bracts ± triangular; bracteoles minute to distinct, subtending the flowers, triangular to ovate, free. **Flowers** sessile, bisexual, unscented and often chasmogamous or cleistogamous. **Sepals** ovate to elliptic, free or partly connate into a short tube, shorter than to equalling petal length, apex ± obtuse, greenish, whitish or reddish at anthesis, pale and ± dry or purple to black, thick and juicy in fruit. **Petals** uniform, ovate to elliptic, connate at the base or up to ⅔ of their length, apex ± obtuse, greenish, whitish or reddish at anthesis, pale and ± dry or purple to black, thick and juicy when in fruit. **Stamens** with filaments straight in bud (sometimes obscurely reflexed), connate and basally fused or fused into a short tube up to ¾ of their length; anthers dorsifixed and longitudinally dehiscent. **Styles** 3 or 1 that is 3-partite to the base or almost so. **Fruit** a globose to pyriform nutlet, at the base tightly enclosed (partly or completely) by the persistent perianth.

References: Sperling & Bittrich (1993), Eggli (2002a), Eriksson (2007).

The genus *Basella* comprises five species. Madagascar is home to three of these (*B. excavata* Scott-Elliot*, B. leandriana* H.Perrier and *B. madagascariensis* Boivin ex H.Perrier) with another, *B. paniculata* Volkens, being native to South and East Africa. *Basella alba* L. has a pantropical distribution which is probably a result of its widespread cultivation (Sperling & Bittrich, 1993; Eriksson, 2007).

The invasive *Basella alba* may be distinguished from the indigenous *B. paniculata* in the following way [adapted from Eriksson (2007)]:

1. Inflorescence usually unbranched, petals fused to form urceolate flower with petals usually longer than 3.5 mm, perianth whitish to reddish at anthesis . . . . . .***Basella alba***

1'. Inflorescence branched, petals almost free and usually shorter than 3.5 mm, perianth greenish at anthesis . . . . . .**(*Basella paniculata*)**

Basella alba L.

In: *Species Plantarum* 1: 272 (1753a).

=*Basella nigra* Lour.
=*Basella rubra* L.
=*Gandola alba* Rumph. ex L.
=*Gandola rubra* Rumph. ex L.

Common names: Ceylon spinach, Indian spinach, Malabar nightshade, Malabar spinach (English).

Stem twining vine to procumbent or erect herb up to 4–8 m long; stem slender, glabrous, green or purplish. **Leaves** alternate, simple, fleshy; petiole up to 9 cm long; blade cordate or sometimes ovate to broadly elliptic, 3–15 × 2.5–12 cm, base cordate to acuminate or obtuse, apex usually acute or somewhat acuminate or obtuse, dark green or purplish. **Inflorescence** an unbranched (sometimes with few branches) spike 1–20 cm long, hanging, with long peduncle; bracteoles distinct, ovate to triangular. **Flowers** bisexual, sessile, unscented, cleistogamous or sometimes chasmogamous, 5-merous. **Sepals** ovate to elliptic, ± erect, connate at base or up to ½ of their length, 3.5–5.5 × 2–2.5 mm, up to 7.5 mm long when fruiting, white to reddish at anthesis, purple to black in fruit, thick and juicy. **Petals** ovate to elliptic, ± erect, connate at base or up to ⅓–⅔ of their length, 3.5–5.5 × 1.5–2.5 mm at anthesis, up to 7.5 mm long when fruiting, white to reddish at anthesis, purple to black in fruit, very thick and juicy. **Stamens** 5, opposite petals; anthers pale. **Styles** 3 or 1 that is 3-partite to the base or almost so. Perianth persistent, fleshy, urceolate, tightly enveloping the fruit. **Fruit** a subglobose pseudo-berry, entire structure up to 7.5 × 10 mm, purplish black, containing a violet juice, 1-seeded. **Distribution**: SA. (Fig. 79).

References: Abukutsa-Onyango (2004), Eriksson (2007).

The native distribution of *Basella alba* is unknown though some consider it a native

of southern Asia (Abukutsa-Onyango, 2004), while others feel it is indigenous to Africa (Verdcourt, 1968). The plant is commonly grown as an ornamental (Fig. 80) and leafy vegetable throughout the tropics and subtropics which has lead to widespread naturalization following escape (Eriksson, 2007).

Fig. 79. Distribution map of *Basella alba* L.

Fig. 80. *Basella alba* L. grown as an ornamental in India. (Picture by Stefan Neser)

Apart from it being grown as a vegetable, *Basella alba* fruits (Fig. 81) have been used for dyeing, as ink and cosmetics and for colouring foods (Abukutsa-Onyango, 2004). While no medicinal use for the species is recorded from southern Africa, a number of medicinal applications have been reported from elsewhere in Africa (Neuwinger, 2000; Abukutsa-Onyango, 2004). These include treatment for constipation, conjunctivitis, snake bite and headaches, to name but a few (Neuwinger, 2000). Red forms of Malabar spinach are planted as ornamentals, and have become popular in Europe and North America as pot plants (Abukutsa-Onyango, 2004).

Fig. 81. Fruits of *Basella alba* L. (Picture by Stefan Neser)

BEGONIACEAE C.Agardh.

(Begonia family; *Begoniafamilie*)

by

N.R. Crouch

Herbs or undershrubs, mostly fleshy, generally erect, sometimes creeping or climbing by means of adventitious roots, or acaulescent with a rhizome or tuber. **Leaves** alternate and spiralled, rarely distichous or subradical, petiolate, generally asymmetrical, digitately nerved, margins entire, toothed, lobed or dissected, sometimes peltate; stipules 2, conspicuous, persistent or caducous. **Inflorescences** axillary, cymose, bracteate, often long-pedunculate. **Flowers** unisexual but plants monoecious, regular or irregular, showy. **Male flowers**: tepals usually 2 or 4, rarely many or 0, petaloid; stamens numerous, filaments free or connate; anthers petaloid, 2-locular, opening with longitudinal slits or apical pores; staminodes 0 or rarely represented by glands. **Female flowers**: ovary inferior or rarely half-inferior, rarely 1-, 2-, or 5-locular, usually 3-locular and 3-winged or angled, ovules numerous on projecting simple or lobed axile placentas; styles (2)3(–5), free or connate at base, usually 2-fid, stigmas entire or branched, often twisted, papillose. **Fruit** usually a 3-winged or 3-angled loculicidal capsule, rarely a berry. **Seeds** numerous, minute, testa reticulate, endosperm scanty or absent, embryo straight.

References: Hilliard (1976), Bredenkamp (2000), Eggli (2002b).

The Begoniaceae consists of the monotypic *Hillebrandia* Oliv. from Hawaii and *Begonia* L., one of the largest genera of flowering plants, estimated variously to have roughly 1 400 (Smith *et al*., 1986) or as many as 1 600 species (Sands, 2001), which are distributed mainly throughout the world's tropical forests. Some authorities also recognise the genus *Symbegonia* Warburg as a small genus of 10 species endemic to New Guinea (Tebbitt, 1997). *Begonia* is comprised of mesophytic to somewhat succulent herbs or subshrubs and sometimes even climbers, with five representatives indigenous to the *Flora of Southern Africa* region (Hilliard, 1976). In this region they extend farther into the temperate zone than any other members of the genus, with the possible exception of some Chinese taxa (McLellan *et al*., 2009). Well over 200 begonias have been introduced to horticulture where they are variably employed as conservatory, window-garden and bedding subjects. Many are grown for their attractively marked foliage, others for their showy blooms, with many of the latter being treated as single pot subjects, although a few are used for bedding. More than ten thousand cultivars and hybrids have been developed (Tebbitt, 1997), including a range of hybrid tuberous pot-plant forms with double and triple blooms that display an enormous spectrum of bright colours.

Although many *Begonia* species possess stems that are succulent, or otherwise simply termed fleshy, they are essentially plants of mesic and sometimes very damp habitats, and so would suffer under conditions of drought stress, being poorly adapted to xeric conditions. Both species dealt with in the current account have succulent stems. Under drought conditions *Begonia hirtella* Link retires to seed until conditions become more mesic, whereas *B. cucullata* Willd. survives by virtue

of both seed and its persistent stolons. Only two *Begonia* species are naturalised in southern Africa. Both taxa fit into the Semperflorens category, an artificial rather than natural system of classification for the genus, which groups species in terms of cultivation requirements and appearance.

Begonia L.

Caulescent or acaulescent herbs or undershrubs with succulent stems and leaves, generally erect, sometimes creeping or climbing, sometimes with rhizomes or tubers; stems aerial, often swollen and conspicuously jointed. **Leaves** alternate, rarely subradical, petiolate, usually asymmetrical, entire, lobed or partite, irregularly toothed, green or sometimes richly multicoloured or spotted. Small axillary bulbs sometimes present. **Male flowers**: tepals 2 or 4, rarely many or 0, petaloid; stamens numerous, filaments free or connate at the base. **Female flowers**: tepals often 5 or 6, sometimes 4, petaloid; ovary usually 3-, rarely 2-, 4- or 5-locular; ovules numerous, placentas axile, projecting, simple or lobed; styles usually as many as the loculi, free or connate at the base, 2-fid; stigmas entire or branched, often twisted, papillose. **Fruit** usually a capsule, 3-winged or 3-angled, rarely terete or 4-angled, or a berry. **Seeds** numerous, minute, without endosperm.

References: Hilllard (1976), Tebbitt (1997).

As only five native species occur in southern Africa (*Begonia dregei* Otto & A.Dietr., *B. geranioides* Hook.f., *B. homonyma* Steud., *B. sonderiana* Irmsch. and *B. sutherlandii* Hook.f.), both locally naturalised and indigenous species are included in the following key [adapted from Hilliard (1976)]:

1. Placentas bilamellate (appearing bifurcate in transverse section) **2**
1'. Placentas entire **4**

2. Stems hairy when young, leaf margin toothed but not, or scarcely, lobed . . . . . .**2. *Begonia hirtella***
2'. Stems glabrous when young; leaf margin lobed or not **3**

3. Leaf flat, margin lobed . . . . . **(*Begonia sonderiana*)**
3'. Leaf hooded (cucullate) due to slightly inrolled base, margin not lobed . . . . . .**1. *Begonia cucullata***

4. Leaves nearly symmetrical, suborbicular, nearly all arising from the stem base . . . . . **(*Begonia geranioides*)**
4'. Leaves mostly asymmetrical, arising along the aerial stem **5**

5. Flowers dark yellow, orange or orange-red, male tepals generally four . . . . . **(*Begonia sutherlandii*)**
5'. Flowers white or pink, male tepals usually two **6**

6. Primary leaves up to 13 × 7 cm, seldom less than 7 × 3 cm, caudex up to 25 cm diameter . . . . . .**(*Begonia homonyma*)**
6'. Primary leaves up to 8 × 3.5 cm, usually 5 × 2 cm or less, caudex up to 8 cm diameter . . . . . **(*Begonia dregei*)**

1. *Begonia cucullata* Willd.

In: *Species plantarum* 4(1): 414 (1805) **var. *cucullata***.

=*Begonia cucullata* Willd. var. *hookeri* (A.DC.) L.B.Sm. & B.G.Schub.
=*Begonia nervosa* Humboldt
=*Begonia semperflorens* Link & Otto

Common names: clubed begonia, wax begonia (English).

Tuberous, stoloniferous, perennial herb; stems erect or ascending, glabrous, 10–100 cm tall. **Leaves** with petiole up to 2.5 cm long; blade slightly asymmetric, broadly ovate, up to 8 × 7 cm, base truncate and inrolled, obtuse, scalloped to sharply toothed (crenate-serrate), ciliate, palminerved, glossy, fleshy; stipules oblong, obtuse, 2–3 cm long, persistent, margins denticulate. **Inflorescence** an axillary, few- to many-flowered cyme, peduncle 3–5 cm long, pedicels slender; bracts persistent, ovate, 5 mm long, serrulate. **Male flowers:** tepals 4, outer pair suborbicular to reniform, 8–13 mm long, inner pair smaller and narrowly obovate, white or pink; stamens free, numerous; filaments short; anthers linear. **Female flowers**: bracteoles deciduous, elliptic to almost spathulate, 3.5–4 mm long, margin ciliate; tepals 4–5, obovate, 6–9 mm long, white or pink; ovary 3-locular, placentas axile, bifid; styles 3, partite; stigmas linear, spiral, continuous. **Fruit** a capsule, 24–30 mm long, unequally 3-winged, the largest wing triangular, subacute, wings acute in the typical variety; placentas split, appearing bifurcate in transverse section. **Seeds** numerous, minute. **Distribution**: SA. (Fig. 82).

References: Golding (1982), Tebbitt (1997), PIER (2010).

Fig. 82. Distribution map of *Begonia cucullata* Willd.

This species has in the past been confused in herbaria with the indigenous *Begonia homonyma* but this last mentioned species can be readily distinguished on account of its non-bilamellate ovary, and its large caudex (see also key above) (Fig. 83). Additionally, *B. homonyma* leaves are not cucullate or hooded as are those of this invader. Further distinguishing vein and leaf shape characters (Fig. 84) are provided by McLellan *et al*. (1996). At sites such as that on the Mzimvubu River on the Transkei coast these two species may be found co-occurring, the invasive species spreading by seeds dispersed from brown, 3-winged fruit (Fig. 85).

Fig. 83. *Begonia cucullata* Willd. lacks a large caudex. (Picture by Neil R. Crouch)

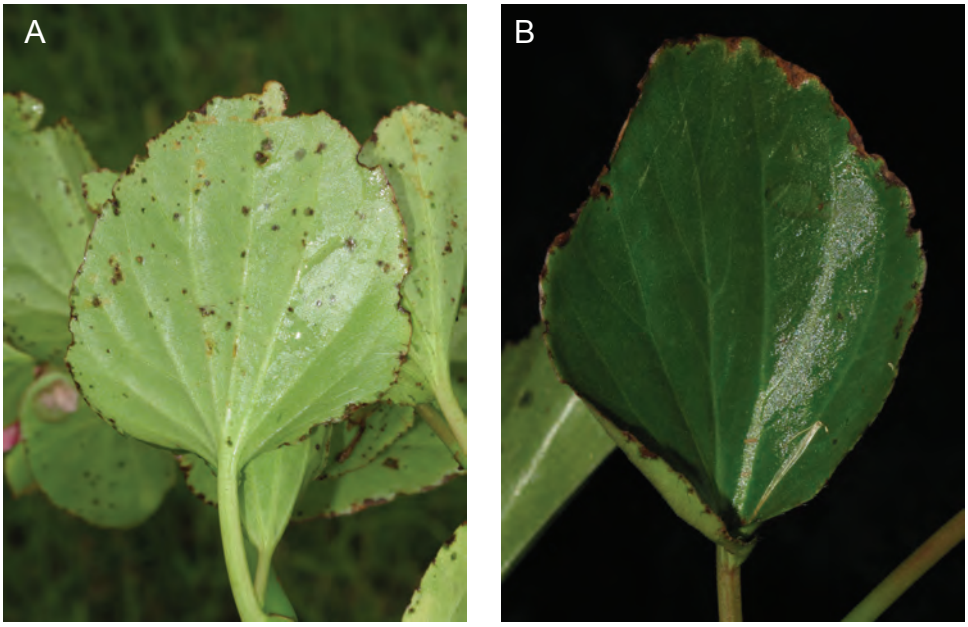

Fig. 84 . *Begonia cucullata* Willd. – A. Leaf venation; B. Cucullate leaf shape (Pictures by Neil R. Crouch)

Fig. 85. Winged capsules of *Begonia cucullata* Willd. (Picture by Neil R. Crouch)

Begonia cucullata is regionally a potential emerging invader, which due to its high seed set and persistent and stoloniferous rootstock has the potential to multiply rapidly under suitable conditions. Elsewhere it has been recognised as control-worthy when noted to have escaped from cultivation, such as in Australia (Randall, 2007) and the USA (Florida Invasive Plant Education Initiative, 2010).

This species, native to Brazil, Peru, Argentina, Paraguay and Uruguay, is noteworthy as a founding parent (together with *B. schmidtiana* Regel) of the immensely popular Semperflorens or wax begonias, used primarily as half-hardy bedding plants for landscaping. It is also known to have naturalised in Hawaii (Wagner *et al*., 2005), La Réunion (MacDonald *et al*., 1991), Puerto Rico, and both Florida and Georgia in the USA (Florida Invasive Plant Education Initiative, 2010). It has doubtless escaped from cultivation at several sites in South Africa, most prominently at Port St John's (Eastern Cape) (McLellan *et al*., 1996) and Gilletts near Durban (KwaZulu-Natal). It prefers exposed situations on moist banks (Fig. 86); both pink and white colour forms are invariably found growing together (Fig. 87). *Begonia cucullata* does naturalise though in forest situations under a partially open canopy (McLellan *et al*., 1996).

In Florida (USA) steps have been taken to limit the impact of this species on the environment, through the use of cultural, mechanical and chemical control measures. Authorities in that state have recommended that this species - likely the most widely known *Begonia* in cultivation - be removed from the landscape and not replanted (Florida Invasive Plant Education Initiative, 2010). A management plan for this species in Florida is available as a downloadable PDF (http://plants.ifas.ufl.edu/node/65).

Fig. 86. *Begonia cucullata* Willd. typically inhabits moist banks. (Picture by Neil R. Crouch)

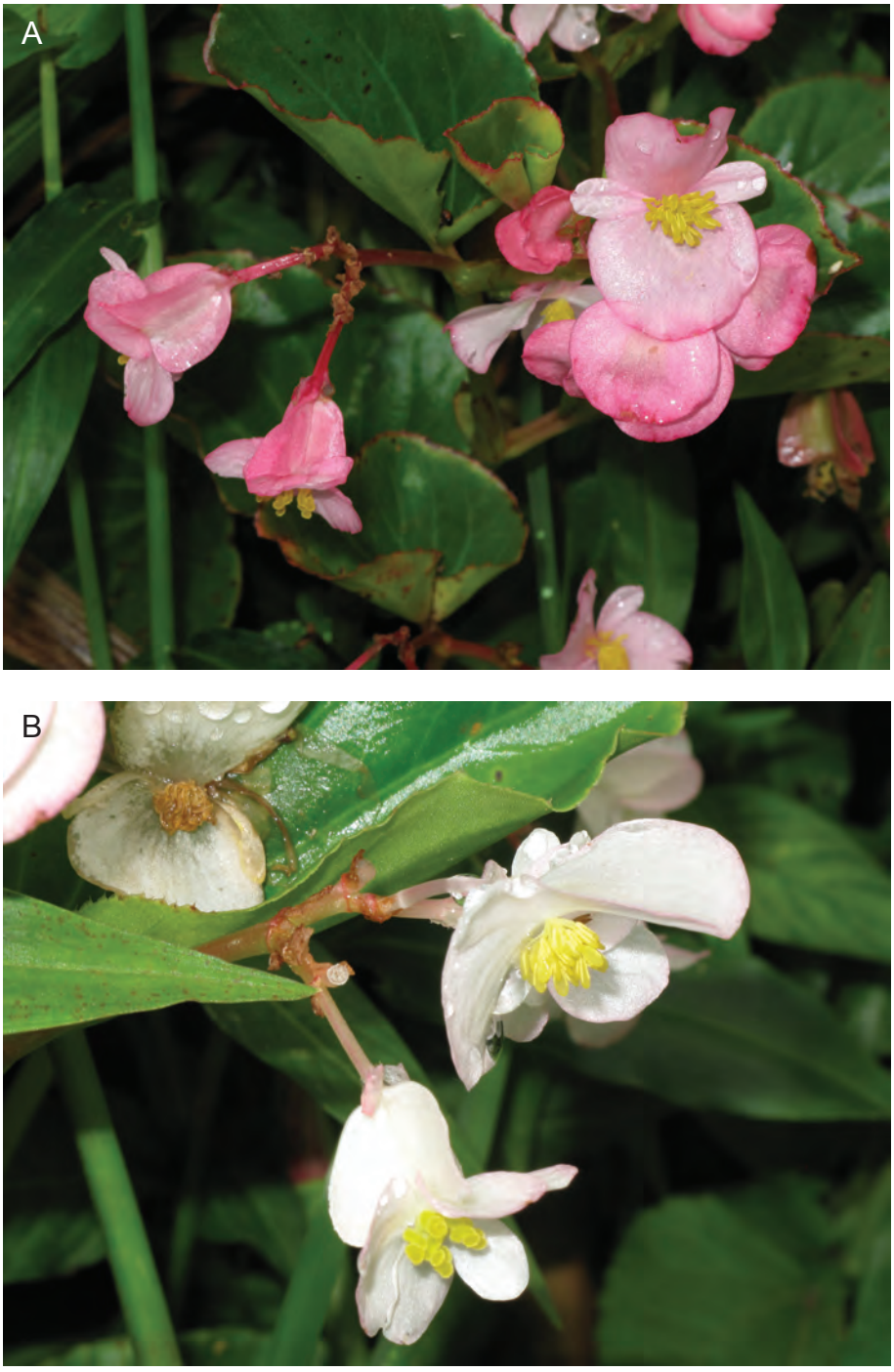

Fig. 87. *Begonia cucullata* Willd. – A. Pink flowers; B. White flowers.
(Pictures by Neil R. Crouch)

2. *Begonia hirtella* Link

In: *Enum. Hort. Berol*. 2: 396 (1822).

=*Begonia villlosa* Lindl.

Common names: bearded begonia, Brazilian begonia (English).

Erect, robust, branched, fibrous-rooted, annual herb; stems several from the base, up to 2 cm diameter, there branched, up to 75 cm tall, green or red-tinged, fleshy, thickly clothed in long coarse, white hairs, becoming glabrous or nearly so. **Leaves** widely spaced; petiole up to 9 cm long, pink, fleshy, villous; blade membranous, obliquely ovate, up to 10 × 8 cm, base shallowly cordate to truncate or nearly so, apex acute, margins irregularly crenate-serrate, not or scarcely lobed, green above, thinly villous, paler below, there hairs nearly confined to the main veins, with a red spot above where petiole joins the blade, palminerved; stipules ovate-lanceolate, c. 1 × 0.5 cm, membranous, apex acuminate, margin fimbriate-ciliate, whitish, eventually deciduous. **Inflorescences** in the upper leaf axils, few-flowered, pendent, in branched cymes; peduncles up to c. 5 cm long, usually shorter than the petiole; bracts persistent. **Male flowers**: tepals 4, outer pair ovate to almost circular, 2–8 × 2–6 mm, inner pair linear-oblong, 1–4 × 0.5–2 mm, white; stamens 10–15, arranged symmetrically, anther connectives projecting. **Female flowers**: bracteoles deciduous, elliptic to almost spathulate, 3.5–4 mm long, margin ciliate; tepals 5, unequal, ovate to ovate-oblong, 2–4 × 1–2 mm, white; ovary ovoid to ellipsoid, 4–8 × 2–5 mm, unequally 3-winged, whitish green, 3-locular, placentas axile, bifid; styles 3, partite; stigmas in a spiraled band. **Fruit** capsular, 3-winged, rounded-oblong to cuneiform in outline, 0.8 cm × c. 2 cm at the broadest part of the wings, placentas split, appearing bifurcate in transverse section. **Seeds** numerous, minute, without endosperm. **Distribution**: SA. (Fig. 88).

References: Hilliard (1976), Wagner *et al*. (1999), Tebbitt (2005).

This species is unlikely to be confused with any other in South Africa, because of its hairy leaves (Fig. 89), hairy petioles (Fig. 90) and the presence of aerial stems (Fig. 91). Although some forms of *Begonia sutherlandii* possess hairy leaves they produce orange rather than white flowers (Fig. 92). Fruit of *B. hirtella* are light brown in colour and unequally 3-winged (Fig. 93). The only other hairy begonia with

Fig. 88. Distribution map of *Begonia hirtella* Link.

white flowers is *B. geranioides* which is stemless or usually so, normally producing its leaves so close to the base of the stem as to make them appear to come from the root; it is also tuberous, unlike *B. hirtella*. The leaves of *B. geranioides* are additionally suborbicular rather than obliquely ovate.

Fig. 89. Hairy leaves of *Begonia hirtella* Link. (Picture by Neil R. Crouch)

Fig. 90. Hairy petiole of *Begonia hirtella* Link. (Picture by Neil R. Crouch)

Fig. 91. Aerial stem of *Begonia hirtella* Link. (Picture by Neil R. Crouch)

Fig. 92. White flowers of *Begonia hirtella* Link. (Picture by Neil R. Crouch)

This species has not previously been listed as an invasive in South Africa, although it has been recognised as exotic (Bredenkamp, 2006).

The occurrence of *Begonia hirtella* in two Zululand forests remains unexplained and somewhat enigmatic, for although it appears natural when encountered, it has most likely escaped from cultivation. This species, a native of Brazil, Colombia, Peru and some Caribbean islands, has long been cultivated in North America and Europe, despite the fact that it is of little decorative value (Bailey & Bailey, 1976; Hillard, 1976). It has been collected from both Gwalaweni forest in the Lebombo mountains of northern KwaZulu-Natal—well away from sites of amenity horticulture—and in Dlinza forest situated in very close proximity to Eshowe, a town where it may at one time have been cultivated and have escaped. Notably though, Glen (2002) does not list it as a species known to have been grown previously in southern Africa. However, the species is known to have naturalised elsewhere in the world, including Hawaii (Wagner *et al*., 2005), and Sri Lanka where it is so invasive that it is now the most common *Begonia* species on that island (Tebbitt, 2005). Within the genus *Begonia*, *B. hirtella* belongs to section *Doratometra* from Central and South America: it is in the Semperflorens group. Although an annual, this species produces masses of fine seed which has resulted in it becoming a common weed of greenhouses in north temperate regions, as well as a colonist of disturbed habitats throughout the tropics (Tebbitt, 2005). Unusual for a begonia, this species is not only self fertile but also self-pollinating: the male flowers are positioned directly above the female flowers (Fig. 92) so allowing pollen to drop on to the stigmas and for seed to be set (Tebbitt, 2005). Little information is available for its ecological preferences in the two South African forest sites where it has been found so far; elsewhere (Hawaii) where it has invaded it has been recorded locally common in disturbed, wet, shaded sites, especially on moist banks at altitudes of between 450 and 940 m (Wagner *et al*., 1999).

Fig. 93. Mid-brown and unequally 3-winged fruit of *Begonia hirtella* Link. (Picture by Neil R. Crouch)

CACTACEAE Juss.

(Cactus family; *Kaktusfamilie*)

by

P.J.D Winter, H.G. Zimmerman and B.K. Mashope

Perennial herbs, shrubs, trees or climbers with variously modified, mostly succulent stems, often spiny; spines, branches, flowers and often glochidia (in subfamily Opuntioideae) arise from raised or sunken cushions (areoles). **Leaves** rudimentary or absent, rarely well-developed, persistent (*Pereskia*), succulent, those of the brachyblasts (short shoots/areoles) mostly modified into bristles, spines or glochidia. **Flowers** bisexual, actinomorphic, or rarely zygomorphic, axillary, sessile or rarely pedunculate (*Pereskia*), one or rarely more per areole. **Tepals** numerous, in a graded series from scale-like, through foliaceous to petaloid, free. **Stamens** usually numerous, in several rows, arising in calyx throat, sometimes adnate to base of tepals; anthers 2-locular. **Ovary** mostly submerged in a pericarpel of peduncular origin that often extends above the ovary into a hypanthium, inferior (except in some *Pereskia* spp.), 1-locular; ovules many on 3–20 parietal placentas; style terminal, simple; stigmas as many as placentas. **Fruit** a berry, rarely dry, naked, scaly, hairy, bristly or spiny, indehiscent or variously dehiscent. **Seeds** many, sometimes strophiolate, in subfamily *Opuntioideae* entirely encased by an often pale bone-coloured aril (funicular envelope); testa smooth, shiny, or tuberculate, often black-brown (virtually black).

References: Barthlott & Hunt (1993), Anderson (2001), N.P. Taylor (*pers. comm.*).

Members of Cactaceae are primarily characterised by the presence of areoles, and all except the most primitive members have the ovary enveloped in a pericarpel. They typically have fleshy, leafless, often spiny, photosynthetic stems (long shoots), and showy, sessile flowers. *Pereskia* Mill. is an exception, with well-developed leaves along non-fleshy stems, and a branching inflorescence with ‘pedicellate’ flowers (Barthlott & Hunt, 1993; Anderson, 2001). The roots can be fibrous or tuberous, e.g. *Peniocereus* (A.Berger) Britton & Rose. Fleshy stems have diversified into a wide spectrum of forms, branched or unbranched. The branches are cylindric or columnar, often ribbed, sometimes winged or flattened, often segmented and variously adorned with hairs and/or (more usually) spines. Where leaves are present, e.g. in *Austrocylindropuntia subulata* (Muehlenpf.) Backeb., (Fig. 94), they are spirally arranged, simple, entire and without stipules. Leaves, scales, calyx and corolla often form a more or less continuous gradation of organs from ± foliar to petaloid. The flowers are zoophilous.

Fig. 94. Leaves of *Austrocylindropuntia subulata* (Muehlenpf.) Backeb.
(Picture by Helmuth G. Zimmermann)

In response to extreme habitats, the Cactaceae have also evolved special physiological traits which relate to nocturnal stomatal opening and a Crassulacean Acid Metabolism (CAM) photosynthetic pathway (as well as CAM-cycling), leading to efficient use of limited soil water. Special water storage cells are found in the inner cortex or in the pith of most species. They act as water reservoirs and release water when the plants are water stressed. In addition, the photosynthetic stems of many species contain large quantities of mucilage (a hydrophilic carbohydrate) found in the inner cortex and pith which also affects water relations. The thick layer of white spines found in several species e.g. *Cylindropuntia fulgida* (Engelm.) F.M.Knuth (Fig. 95) reflects incident sunlight and has a cooling effect. Many Cactaceae have a high tolerance for high temperatures. Of several species that have been assessed quantitatively, the tolerated high temperature averaged 68°C. Metabolic processes are severely curtailed in most plants at temperatures of 55 to 60°C. (Nobel, 1988). The roots of most cacti living in xerophytic conditions are shallow, no deeper than 15-30 cm below the soil surface but often extending laterally for considerable distances (Rundel & Nobel, 1991). This allows the plants to take full advantage of the limited precipitation typical for desert and desert-like climates. Combined with the morphological traits described above, these adaptations have allowed cacti to grow and survive in extreme hot and dry conditions (Nobel, 2002).

Fig. 95. Dense white spines of *Cylindropuntia fulgida* (Engelm.) F.M.Knuth.
(Picture by Helmuth G. Zimmermann)

The approximately 1 438 species in 124 genera (Hunt, 2006) occur in North and South America, with a single species of *Rhipsalis* Gaertn. which is widespread in tropical America, extending to Africa, Madagascar and Sri Lanka (Obermeyer, 1976; Barthlott, 1983; Smith & Steyn, 1997; Smith *et al*., 1999). Various species, in the *Opuntioideae* in particular, are widely naturalised in warmer regions of the Old World (Parfitt & Gibson, 2003).

Cactaceae is closely related to families Anacampserotaceae and Portulacaceae *sensu stricto* (Nyffeler & Eggli, 2010). The fact that several taxa in the family appear to be of hybrid origin (Parfitt & Gibson, 2003) provides a challenge to attempts at improving its classification. Nomenclatural instability as a result of the general poor quality, or often total absence, of type material, is another obstacle that needs to be overcome by any student of this family. Cactaceae are generally poorly represented in herbarium collections, due to the extraordinary care required in preparing pressed and dried specimens. Spines and glochidia pose a hazard to those handling specimens. Ideally, stem parenchyma needs to be removed to speed up drying, since it contains a substance that releases water only with radical treatment e.g. microwave methods.

There are several species in the Cactaceae that are cultivated for fruit, fodder, 'nopalitos' (a green vegetable) and for cochineal production. The ornamental cactus trade has also developed into a formidable industry and is responsible for the inter-continental spread of many ornamental and useful cactus species. However, invasive or potentially invasive cactus species have been spread in this way (Fig. 96). In some countries spiny species are widely used as living fences (Fig. 97) which has also led to several species becoming invasive.

Economically, *Opuntia ficus-indica* (L.) Mill. is by far the most important species and it is widely cultivated as a drought tolerant crop for arid and semi-arid regions. Fruit production from many selected spineless cultivars is a fast growing industry. It is grown commercially for this purpose in at least 16 countries (Barbera *et al*., 1995). Their role in fodder production is regarded as even more important though. Globally, there are already c. 687 000 ha under cultivation exclusively for this purpose with Brazil the leading country (Mondragon-Jacobo & Perez-Gonzalez, 2001). Many thousands of hectares are also cultivated for cochineal (carmine) production based on the insect *Dactylopius coccus*. Peru, the Canary Islands, Chile, Bolivia and lately also Ethiopia are leading producers. Special cultivars have been developed in Mexico for the production of young leaf-pads, from which 'nopalitos' are produced. This product is consumed as a green vegetable in Mexico. For example, the consumption of 'nopalitos' is now also well established in Ethiopia and beyond. More than 10000 ha are cultivated for this purpose (Flores-Valdez, 1995).

New exotic, cactus-derived fruit crops are emerging which include the pitayas (pitahayas) from several columnar or vine cacti including the genera *Cereus* Mill., *Hylocereus* (A.Berger) Britton & Rose, *Selenicereus* (A.Berger) Britton & Rose and *Stenocereus* (A.Berger) Riccob. (Nerd *et al*., 2002). Some of these are now also seen on South African markets.

With global warming, land degradation and the need for food security in developing countries, cactus cultivation has been widely promoted by the FAO because of the ease of cultivation, drought tolerance and general resilience of the plants, making them some of the more promising new emerging crops.

A total of 29 species, with two infraspecific taxa, from 11 genera of the Cactaceae are known to be naturalised in South Africa. However, this list is expected to expand as soon as more people are able to identify cacti in the field and bring them to the attention of scientists. Obermeyer (1976) reported only 12 species for the same area 35 years ago. Glen (2002) has listed more than 200 species as being cultivated in southern Africa. In these works, some of the names are applied tentatively due to several sources of nomenclatural uncertainty. Though resolution of all these issues is beyond the scope of this treatise, we have attempted to highlight such problems, so that they can eventually be systematically dealt with. The listed taxa have been recorded in natural vegetation in southern Africa.

Fig. 96. Cacti are popular in the commercial horticultural trade.
(Picture by Helmuth G. Zimmermann)

Fig. 97. Plants of the spiny *Echinopsis schickendantzii* F.A.C.Weber established as a living fence. (Picture by PPRI)

Key to the genera:

Notes: (1) Where only one species has been recorded for the region, the species name is given in full. (2) The indigenous *Rhipsalis baccifera* (J.Mill.) Stearn subsp. *mauritiana* (DC.) Barthlott is included for comparison. (3) *Cleistocactus* Lem. has been recorded as persisting in abandoned gardens in Lekgalameetse Nature Reserve and Zebediela. As older stems of *C. samaipatanus* (Cárdenas) D.Hunt can appear similar to those of *Peniocereus serpentinus*, and as there was an unconfirmed report of invasion around Graaff-Reinet, it has been included in the key.

1. Woody climber; stems not modified to cylindrical or flattened cladodes; more vigorous shoots with paired recurved spines specially adapted for climbing; leaves conspicuous in growing season, flat, more than 1.5 cm broad; glochidia absent (Pereskioideae). . . . . ***Pereskia aculeata***

1'. Shrublets, shrubs or small trees, or climbers with cladodes; shoots never with paired, recurved spines; leaves usually inconspicuous and caducous (except in *Austrocylindropuntia*), subulate or terete, less than 8 mm broad (Opuntioideae) or absent (Cactoideae); glochidia present or absent **2**

2. Glochidia absent; flowers either large (> 6 cm in diameter), white and often nocturnal, or narrower than 4 cm, red or white, and diurnal (Cactoideae) . **3**

2'. Glochidia present in areoles; flowers 3–7(–10.5) cm in diameter, coloured (rarely white) and diurnal (Opuntioideae) **10**

3. Branches cylindric, less than 7 mm wide, not ribbed; flowers usually 4 –10 mm across; fruit up to 8 mm wide, cream-coloured or somewhat translucent, smooth . . . . . .***Rhipsalis baccifera* subsp. *mauritiana***

3'. Branches winged, ribbed, or tubercled, more than 1 cm wide; flowers more than 2 cm across; fruit more than 8 mm wide, red, bearing scales (though these may be inconspicuous in *Myrtillocactus*) **4**

4. Branches scrambling or pendent (never erect or columnar), slender, often segmented, sometimes emitting aerial roots, 3–4(–7)-winged or angled, or 4–5-ribbed **5**

4'. Branches erect (sometimes columnar) or ascending, not scrambling, slender to very stout, not producing aerial roots, 3–4-winged or angled, or few- to many-ribbed, or tubercled **6**

5. Climbers; branches often emitting aerial roots; stem wings acute; spines absent or few, up to 7 mm long . . . . . ***Hylocereus***

5'. Shrubs, usually scandent or clambering; branches not rooting aerially (except occasionally at tip); ribs obtuse or rounded; spines present, more than 1 cm long . . . . . .***Harrisia***

6. Stems columnar or arching, only rarely branched above 0.5 m from base; ribs usually 9–15; troughs between ridges obscured by radial spines extending over them and interlacing; pericarpel with many hair-spines or hairs; scales conspicuous to obsolete **7**

6'. Stems erect, columnar when young, later usually with at least some branching above 0.5 m from base; ribs usually 5–8; troughs between ribs exposed, radial spines not extending over them, not interlacing; pericarpel (at anthesis) nearly naked, or with scales only **9**

7. Stems less than 6 cm in diameter; flowers appearing over a considerable length of the stem **8**

7'. Stems (6–)8–10(–13) cm in diameter; flowers restricted to the top 10 cm of the stem; pericarpel and hypanthium with long, blackish hairs . . . . . .***Echinopsis schickendantzii***

8. Stems up to 1.5 m tall; rib margins virtually entire; spines pale yellow on active growth; pericarpel with dark hairs; perianth red, narrow (< 40 mm) . . . . . ***Cleistocactus samaipatanus***

8'. Stems up to 3.0 m tall; rib margin ± tuberculate; spines white, purplish on active growth; pericarpel with white bristles; perianth white, broad (8–15 cm) . . . . . .***Peniocereus serpentinus***

9. Ribs 5–6, low; central spine 10–70 mm long, 3–6 mm broad at base; flowers diurnal, very small (c. 20 × 25 mm), up to 9 per areole; fruit 10–20 mm in diameter, dark purple . . . . . .***Myrtillocactus geometrizans***

9'. Ribs (3–)6–8(–12), prominent (irregularly broken and wavy in 'monstrous' forms); central spines 1–4, 1–5(–8) cm long, 1(–3) mm broad at base; flowers open from 20h00 to 10h00, large (15–29 cm long, 10–20 cm in diameter), solitary in each areole; fruit more than 4 cm in diameter, red, pink or orange . . . . . .***Cereus***

10. Spines with the epidermis separating either completely, or only at spine apex, as a deciduous papery sheath . . . . . ***Cylindropuntia***

10'. Spines without a papery sheath **11**

11. Branches, including terminal ones, cylindric or globose; > 1.5 cm in diameter; flowers scarlet, orange, or white to pale pink 12

11'. Branches compressed, i.e. modified to cladodes (at least the terminal ones), or, if all branches cylindric, then only up to 1 cm in diameter; flowers yellow to orange . . . . . ***Opuntia***

12. Arborescent; branches not segmented, growth indefinite, cylindric; areoles not sunken; flowers (5–)6–7 cm long, scarlet to orange; fruit more than 5 cm long . . . . . ***Austrocylindropuntia***

12'. Low shrub; branches segmented, moniliform, segments with determinate growth, globose or cylindric, up to 5 cm long; areoles sunken; flowers up to 4.5 cm long, white or pale pink; fruit less than 2 cm long . . . . . ***Tephrocactus articulatus***

Austrocylindropuntia Backeb.

Shrubs or small trees. Branches cylindric, growth indefinite, sometimes divided into segments; furrow delimiting each tubercle sharply defined; roots more or less tuberous. **Leaves** 4–40(–120) mm long, succulent, terete, rather persistent, finally deciduous. Areoles with hairs, spines and glochidia. Glochidia flattened at the base, spines smooth, not sheathed. **Flowers** 5–7 cm long; tepals orange-red (scarlet), typically ¼–⅓ flower length. **Fruit** thick-walled, ellipsoidal (without pulp between the seeds in South Africa, often without seeds). **Seed** globose to pyriform, (3.5–)7(–c.10) mm long, laterally compressed, or with lateral ridges in some species, with smooth to slightly rugose funicular envelopes covered with fine hairs; funicular girdle rudimentary.

References: Anderson (2001), Hunt *et al.* (2006).

The genus consists of eight species from the Andes mountain range in South America (Argentina, Bolivia, Ecuador and Peru). It is distinguished from *Cylindropuntia* by shoots with indefinite growth, unsheathed spines, rhomboid to ovate tubercles with sharply defined delimiting furrows, and the typically large, isodiametric seeds. Of all southern African naturalised Cactaceae, the two *Austrocylindropuntia* species are the most conventionally tree-like when fully grown. Tepals are typically scarlet and ¼–⅓ flower length.

Fruit encountered in South Africa for *Austrocylindropuntia subulata* lacks pulp and is often also devoid of seeds. Individuals in South Africa may represent sterile clones derived from a minimal number of introductions. Lack of pulp renders fruit unattractive to birds. This also explains why this species is not spreading as effectively as similar, but seeding species, or those with seeds embedded in pulp. Fruits in South Africa are thick-walled and act as vegetative propagules.

Key to the two species of *Austrocylindropuntia* naturalised in southern Africa:

1. Leaves up to 1.5 cm long and tepals up to 1.7 cm long . . . . . **1. *Austrocylindropuntia cylindrica***

1'. Leaves 4–8 cm long and tepals 2–3 cm long . . . . . **2. *Austrocylindropuntia subulata***

Incomplete specimens may be difficult to distinguish from species of *Cylindropuntia* if spine sheaths are not well-developed in the latter. In *Austrocylindropuntia* stem tubercles are sharply defined, whereas in *Cylindropuntia* they are undulating.

1. *Austrocylindropuntia cylindrica* (Lam.) Backeb.

In: *Jahrbuch der Deutsche Kakteengesellschaft* 2: 12 (1942).

=*Opuntia cylindrica* (Lam.) DC

Shrub or small tree up to c. 2 m tall; trunk woody; branch segments distinctly rhomboid-tuberculate, c. 25 cm long, arising laterally from previous segments, not fragile, dark or bluish green. **Leaves** up to 1.1(–1.5) cm long, rather persistent, finally deciduous. Spines 2–5(–8), 10(–30) mm long, sometimes with later accruals on older growth, porrect, straight, terete or slightly flattened, yellowish; a few long hairs sometimes present. **Flowers** up to 7 cm long; pericarpel elongate-urceolate; areoles numerous, glochidiate; spines occasional, bristly. **Tepals** hardly spreading, c. ¼ flower length, scarlet. **Fruit** ellipsoid to oblong-urceolate, up to 9 cm long. **Seed** subglobose, 4–6(– c. 10) mm across, girdle narrow, not prominent. **Distribution**: SA. (Fig. 98).

References: Backeberg (1958), Anderson (2001), Hunt *et al.* (2006).

Fig. 98. Historical distribution of *Austrocylindropuntia cylindrica* (Lam.) Backeb.

The species with its snake-like, tuberculate stems (Fig. 99) is originally known from Ecuador (Pinchincha, Chimborazo and Cañar). In South Africa there are historical records from the Free State (Bloemfontein), KwaZulu-Natal (Black Umfolozi, Pietermaritzburg) and Eastern Cape (Katrivier catchment). Although most of these probably merely represent adventives, one herbarium specimen label records that it was becoming invasive in the Pietermaritzburg area in 1965. It is not a declared weed in South Africa.

Austrocylindropuntia cylindrica is also naturalised in Australia (Telford, 1984).

Fig. 99. Snake-like, tuberculate stems of *Austrocylindropuntia cylindrica* (Lam.) Backeb. (Picture by Helmuth G. Zimmermann)

2. *Austrocylindropuntia subulata* (Muehlenpf.) Backeb.

In: *Jahrbuch der Deutsche Kakteengesellschaft* 2: 12 (1942).

=*Austrocylindropuntia subulata* (Muehlenpf.) Backeb. subsp. *exaltata* (A.Berger) D.R.Hunt
=*Opuntia exaltata* A.Berger
=*Opuntia subulata* (Muehlenpf.) Engelm.

Common names: devil's rope, long-spine cactus (English); langdoringkaktus (Afrikaans).

Arborescent, 3–4(–5) m tall, abundantly branched, sometimes from below; branches elongate, tuberculate, up to 0.5 m long, green or somewhat glaucous. Tubercles in a few spirals, sharply defined, vertically rhomboid to decurrent-obovate. **Leaves** subulate, 4–8 cm long, persistent, with areoles at the upper extremities of tubercles. Spines (1–)2–4, strong, straight, up to 8 (–13) cm long, greyish-white (white or yellowish-brown when young). **Flowers** up to 6 cm long; pericarpel relatively long,

tuberculate, with porrect, subulate bract-scales resembling small leaves. **Perianth** not widely flaring, a third of the flower length; tepals 2–3 cm long, scarlet, orange or yellowish. **Fruit** elongate, obovoid-oblong to clavate or ± spherical, ± spiny, sometimes successively proliferous (mostly sterile in South Africa). **Seeds** (1–)19, globose or isodiametric, 8–10 mm across. **Distribution**: N, SA. (Fig. 100).

References: Backeberg (1958), Obermeyer (1976), Anderson (2001), Henderson (2001), Hunt *et al*. (2006).

In parts of its natural distribution range (La Paz, Bolivia, to Junín, Peru), and elsewhere, this shrub or small tree is widely cultivated as a hedge. In South Africa it is known from Limpopo (Phalaborwa), North-West (Potchefstroom), Gauteng (Pretoria), Free State (Ficksburg, Bloemfontein), KwaZulu-Natal (Pietermaritzburg), Eastern Cape (Umzimkulu) and Western Cape (near Stellenbosch). It also occurs around Windhoek, in Namibia. This species has been proposed for classification as a category 1b species under NEMBA (National Environmental Management: Biodiversity Act) and CARA (Conservation of Agricultural Resources Act) (Anonymous, 2009). It is often cultivated as a barrier plant (living fence) in Namibia (Fig. 101), and has been recorded as an invader in Kenya, forming dense stands, impenetrable hedges or thickets, often around abandoned homesteads. It is also expected to be cultivated in other African countries. In ancient Peru, its spines (Fig. 102) were once used as needles (Anderson, 2001).

Seeds are usually sterile (Backeberg, 1958), and reproduction is mostly vegetative by means of proliferating fruit. Each fruit is capable of rooting on contact with the soil, and forming several plantlets. This may explain why the species is not spreading as fast as similar species with fertile seeds. Infestations are mainly clumpy and localised (Fig. 103).

Fig. 100. Distribution map of *Austrocylindropuntia subulata* (Muehlenpf.) Backeb., mostly as casual aliens.

Fig. 101. Living fence of *Austrocylindropuntia subulata* (Muehlenpf.) Backeb. (Picture by Helmuth G. Zimmermann)

Fig. 102. Flowering branch of *Austrocylindropuntia subulata* (Muehlenpf.) Backeb., showing needle-like spines and furrows framing each tubercle (Picture by Helmuth G. Zimmermann)

Fig. 103. Localised infestation of *Austrocylindropuntia subulata* (Muehlenpf.) Backeb. (Picture by by Helmuth G. Zimmermann)

Cereus Mill.

Tree-like or shrubby, usually much branched; branches erect or ascending, strongly ribbed, often with annual constrictions, often glaucous; ribs 3–14, usually pronounced**.** Spines often numerous, acicular. **Flowers** medium to large, funnelform, nocturnal; pericarpel and hypanthium elongate, thick, naked or nearly so below, with scattered small scales above. Pericarpel areoles absent. **Perianth** broad, or moderately so, usually white. **Fruit** fleshy, globose, ovoid or oblong, usually red, sometimes orange, naked, splitting along one or more sides when mature to reveal white fruit pulp and small black-brown (virtually black) seeds, perianth remnant sometimes persistent (at least the style), blackening. **Seed** broadly ovoid, 1.8–4.0 × 1.1–3.0 mm, black-brown or brown, shiny or dull; smooth to tuberculate.

References: Taylor & Zappi (2004, 2006).

This genus consists of 25 species, from the Caribbean and South America (Taylor & Zappi, 2006). One or two members of subgenus *Cereus,* the largest subgenus with 13 species (Taylor & Zappi, 2006), are naturalised in southern Africa.

The extremely tall habit, mostly few-ribbed, cylindric or columnar stems with visible troughs between ribs, relatively large nocturnal flowers with virtually naked or merely scaly, spineless and glabrous pericarpel and hypanthium, and dehiscent fruit characterise locally naturalised representatives of this genus.

Species of *Cereus* have a history of cultivation spanning centuries, since they are popular garden plants with their attractive flowers, their popular fruit and their cylindric or columnar branches. This growth form sometimes leads to confusion with the indigenous and unrelated *Euphorbia ingens* E.Mey. ex Boiss. which can be found in many areas interspersed with *Cereus*. Cultivation almost inevitably leads to infestation of nearby savanna vegetation due to their attractive edible fruits, which are eagerly consumed by frugivorous birds. Seedlings are often found under fence lines and under trees and shrubs as a result of seed dispersal by birds.

In South Africa all naturalised populations belong to a group of five currently recognised species or subspecies (Taylor & Zappi, 2006), that appear closely related to, and include, *Cereus hexagonus* (L.) Mill., the type species of the genus. The other species in this group are: *C. jamacaru* DC. (two subspecies) and *C. hildmannianus* K.Schum. (two subspecies). Note that the image used to illustrate *C. hexagonus* in Anderson (2001) appears to be a species of *Stenocereus* (A.Berger) Riccob., judging by the densely areolate pericarpel, and rounded flowerbud apex.

Taylor & Zappi (1992) retained the name *Cereus jamacaru* so that it could be used in the usual sense, in case the entity was considered conspecific with *C. hexagonus*. Later they stated (Taylor & Zappi, 2006) that *C. jamacaru* appears to be closely related to *C. hexagonus*, which is said to usually have fewer branches and much shorter spines (the cultivated form being virtually spineless). The classification of Taylor & Zappi (2004, 2006) is followed in the present work.

As these taxa are difficult to distinguish from one another, particularly in the absence of dehiscing fruit, the group can be collectively referred to as the *Cereus hexagonus* species complex. Its known natural distribution range can be regarded as a geographical taxon replacement series, starting with *C. hexagonus* to the north of the Amazon River, from Venezuela, Trinidad and Tobago, to northern Brazil (Pará), in moist woodland (Taylor & Zappi, 2006). To the south and east of the Amazon, *C. hexagonus* is replaced by *C. jamacaru* (Taylor & Zappi, 2004). Continuing south- and westward, *C. hildmannianus* completes the series (Kiesling, 1982; Taylor & Zappi, 2004, 2006).

For many years the South African populations have been referred to the misapplied name *C. peruvianus* (Taylor & Walker, 1984), and more recently to *C. jamacaru* (Henderson, 1995). In the present work, two taxa (*Cereus hildmannianus* subsp. *uruguayanus* and *C. jamacaru* subsp. *jamacaru*) are considered naturalised or merely as casual aliens in South Africa.

A key to some taxa of the *Cereus hexagonus* complex is presented here as an aid to future interpretation of the variation in or among the populations that are naturalised in southern Africa [based on information in Anderson (2001) and Taylor & Zappi (2004, 2006)]:

Note: floral dimensions are as expected for fresh flowers.

Key to the *Cereus hexagonus* complex:

1. Flowers up to 18 cm long; fruit splitting along 3 lines . . . . . **1. *Cereus hildmannianus* subsp. *uruguayanus***

1'. Flowers 20–29 cm long; fruit splitting along 1–3 lines **2**

2 Flowers 10–15 cm wide **3**

2'. Flowers 15–20 cm wide **4**

3. Mostly spineless; fruit splitting along 3 lines from apex . . . . . **(*Cereus hildmannianus* subsp. *hildmannianus*)**

3'. Always spiny; fruit splitting from base along 1 line on the underside . . . . . **(*Cereus jamacaru* subsp. *calcirupicola* (F.Ritter) N.P.Taylor & Zappi)**

4. Areoles 1.5–4 cm apart; tree with dense branching; dry woodland habitat; fruit dehiscence along 1 line on the underside . . . . . **2. *Cereus jamacaru* subsp. *jamacaru***

4'. Areoles 1–2 cm apart; tree with few branches; moist woodland habitat; fruit dehiscence unknown . . . . . **(*Cereus hexagonus*)**

1. *Cereus hildmannianus* K.Schum. subsp. *uruguayanus* (R.Kiesling) N.P.Taylor

In: *Cactaceae Consensus Initiatives* 6: 15 (1998).

=*Cereus peruvianus* sensu auctt. non L. (Mill.) var. *monstrosus* DC.

Common names: pitaya, queen of the night (English); nagblom (Afrikaans).

Treelike or shrubby, c. 15 m tall, with or without a well-developed trunk; branches 8–12 cm in diameter, glaucous when young; branch tissue highly mucilaginous; ribs very variable in number, (5–)6–9(–12), (3–)3.5–5(–7) × 1–3 cm; juveniles only 3–5-ribbed; areoles 1–2 cm apart, c. 6 mm in diameter. Spines 5–10, (1–) 1.5–2 cm long, reddish-brown to black. **Flowers** 15–18 × 10–14 cm; outer tepals brownish or olive green, inner tepals white. **Style** 10–11 cm long**. Fruit** 5–12 × 7–12 cm, yellow, orange or reddish, splitting open from apex along c. 3 lines; pulp white. **Seed** c. 3 × 2.8 mm. **Distribution**: SA. (Fig. 104)

References: Anderson (2001), Taylor & Zappi (2004, 2006).

Cereus hildmannianus occurs from Rio de Janeiro and southwestern Minas Gerais to Paraguay, Uruguay and eastern Argentina (Entre Ríos and Buenos Aires) (Taylor & Zappi, 2004). The subspecies *uruguayanus* has a natural range from southern Brazil (Santa Catarina and Rio Grande do Sul), through Uruguay to the Rio de la Plata estuary in Argentina (Kiesling, 1982; Taylor & Zappi, 2006). It is cultivated in South Africa, and should be treated at least as potentially invasive.

This taxon differs from *Cereus hildmannianus* subsp. *hildmannianus* and also from the other two species in the complex by its shorter flowers (Anderson, 2001; Taylor & Zappi, 2004, 2006). The flowers (Fig. 105) are furthermore narrower (10–14 cm wide) than those of *C. hexagonus* or *C. jamacaru* subsp. *jamacaru* (15–20 cm wide), presumably due to shorter tepals. The collecting of additional material from South Africa is required to confirm the identification of the taxon present in the country.

The name *Cereus uruguayanus* was first applied as a replacement name for the occasional monstrose form (Fig. 106) with interrupted and/or contorted ribs (Kiesling, 1982). Such forms seem to occur in *C. jamacaru* as well.

Fig. 104. Distribution map of *Cereus hildmannianus* K.Schum. subsp. *uruguayanus* (R.Kiesling) N.P.Taylor.

Anderson (2001) lists *Cactus peruvianus* as a synonym of *Cereus hildmannianus.* However, this is a misapplied name as *Cactus peruvianus* L. (which is the basionym of *Cereus peruvianus* (L.) Mill.) is a synonym of *Cereus repandus* (L.) Mill, a species in a different subgenus of *Cereus* (Hunt & Taylor, 1992; Taylor & Zappi, 2004, 2006).

Fig. 105. Flower of *Cereus hildmannianus* K.Schum. subsp. *uruguayanus* (R.Kiesling) N.P.Taylor. (Picture by Geoff R. Nichols)

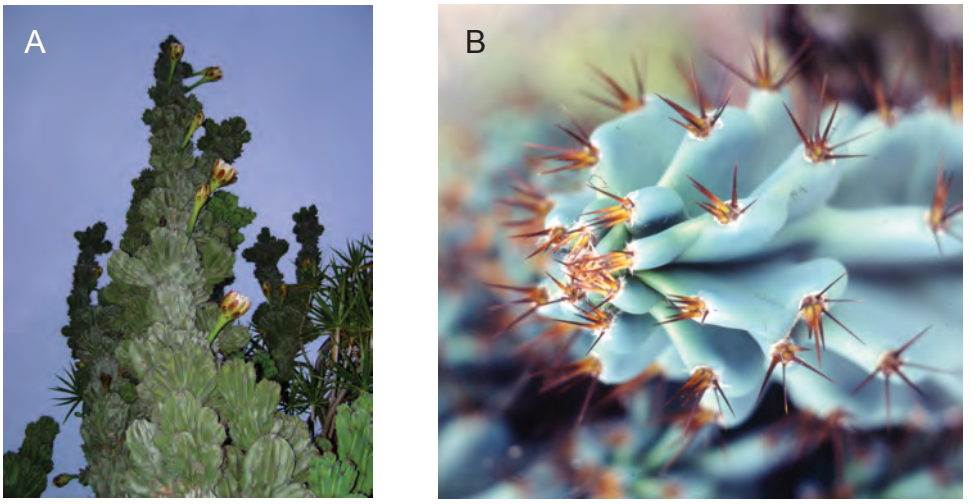

Fig. 106. *Cereus hildmannianus* K.Schum. subsp. *uruguayanus* (R.Kiesling) N.P.Taylor – A. Monstrose form; B. Spines. (Pictures by Geoff R. Nichols (A); Gideon F. Smith (B))

2. *Cereus jamacaru* DC.

In: *Prodromus Systematis Naturalis Regni Vegetabilis* 3: 467 (1828a), nom. cons., **subsp. jamacaru**.

Common names: Peruvian apple cactus, pitaya, queen of the night (English); bobbejaanpaal, môrester, nagblom (Afrikaans).

Tree-like, 3–10(–18) m high, up to 10 m across, often with a short (0.5–2 × 0.3–1 m) trunk; densely branched; branches 7–20 cm in diameter, often strongly glaucous when young, later dark blue-green, tissue scarcely mucilaginous; ribs (3–)6–8(–10), up to 6 × 1.8–4.5 cm; margins weakly to strongly crenate; areoles 4–8 mm at first, enlarging greatly on trunk and older branches, grey-felted, 1.5–4 cm apart. Spines few to many, sometimes absent on upper branches, yellow or brown when young, eventually turning grey to blackish; central spines 1–4 or more, 1–2(–6) cm long, up to 3 mm broad at base; radial spines (4–)7–8(–12), up to 3.5 cm long. **Flowers** funnelform, 21–30 × 15–20 cm**. Pericarpel** and hypanthium up to 16 cm long; green, bearing small, red or reddish scales. **Tepals** 8–10 × 2–2.7 cm, outer tepals greenish, sometimes tinged crimson, inner tepals white. **Stigmas** 12–16(–20), 1.1–1.9 cm long, greenish. **Stamens** oblique in mature flower. **Fruit** ellipsoid, 6–10 × 4–8 cm, crimson to pinkish red, dehiscent by a longitudinal slit from the base on the underside; pulp white. **Seed** black-brown (virtually black). **Distribution**: N, SA. (Fig. 107)

References: Anderson (2001), Henderson (2001), Taylor & Zappi (2004, 2006).

Cereus jamacaru ranges from northern Brazil (Maranhão and perhaps Pará, where records could not be determined unambiguously) and throughout eastern Brazil to central Minas Gerais, mainly in drier thorn savanna (‘caatinga’) (Taylor & Zappi, 2004). The southern periphery of this range in Bahia and Minas Gerais is occupied by subsp. *calcirupicola* (F.Ritter) N.P.Taylor & Zappi, which has not been recorded in South Africa but should be watched for. It differs from subsp. *jamacaru* in the following characters (Taylor & Zappi, 2004, 2006): ribs 5–8 (in young plants 0.1–1.0 m tall); branch segments broadest immediately above the constrictions; spines uniformly short, dark red–brown; flowers 10–15 cm diameter, pericarpel and hypanthium up to 21 cm long, with green to brownish scales; tepals 5–7 cm long.

Fig. 107. Distribution map of *Cereus jamacaru* DC. subsp. *jamacaru*.

Cereus jamacaru subsp. *jamacaru* is naturalised across a large part of the savanna biome of South Africa (Henderson, 2007), and is a declared weed due to the transformation of woodland by rendering it impenetrable to livestock (Fig. 108). It has also been recorded in other biomes, e.g. some in the Western and Eastern Cape Provinces (Henderson, 2007) and has been proposed for classification as a category 1b invader under NEMBA and CARA (Anonymous, 2009). The species is often confused with the indigenous *Euphorbia ingens* (Fig. 109) but easily distinguished on account of the large fragrant flowers (Fig. 110, 111).

Control of isolated plants is best using registered stem-injected herbicides (Anonymous, 2004). Large infestations should be manually infested with the South American mealybug, *Hypogeococcus pungens* (also known as *H. festerianus*) which causes gall-like distortions, arresting growth and fruiting and eventually results in the death of the plants. This natural enemy is host-specific to several genera in the Cactoideae. The second biological control agent is a longhorn beetle, *Alcideon cereicola,* introduced from Argentina in 1990. It is very localised and a poor disperser, but effective in killing large and small plants once infected (Klein, 1999). *H. pungens* is most damaging, and the growth distortions are conspicuous, mainly at the growth tips. The insects may take a few years to suppress the infestations to acceptable levels (Klein, 1999).

This species is known for its delicious and attractive red fruit (Fig. 112), referred to variously as jamacaru, mandacaru or pitaya. It is now being developed as a new fruit for commercial cultivation in Israel, mainly for export to Europe (Nerd *et al*., 2002).

Fig. 108. Impenetrable woodland with *Cereus jamacaru* DC. subsp. *jamacaru.*
(Picture by PPRI)

Fig. 109. *Cereus jamacaru* DC. subsp. *jamacaru* (foreground) is often confused with *Euphorbia ingens* E.Mey. ex Boiss. (background). (Picture by Geoff R. Nichols)

Fig. 110. Flowers of *Cereus jamacaru* DC. subsp. *jamacaru.*
(Picture by Geoff R. Nichols)

Fig. 111. Flowers of *Cereus jamacaru* DC.
subsp. *jamacaru.*
(Picture by Geoff R. Nichols)

Fig. 112. Fruit of *Cereus jamacaru* DC. subsp. *jamacaru* is known as 'pitaya'. (Picture by Lesley Henderson)

Cylindropuntia Mill.

Trees or shrubs, erect, much branched; branches articulate on ramification; branch segments cylindric to somewhat placate, glabrous, firmly attached to easily detached, distinctly to hardly tuberculate, furrow delimiting each tubercle broadly rounded, tubercles more or less elongated. Glochidia present, flattened at base. Spines with entire, papery, deciduous, epidermal sheaths. **Flowers** variously coloured, pink to dark purple. **Inner tepals** ligulate to spathulate**. Fruit** cylindric to subglobose or clavate, variously coloured, fleshy or dry, mostly sterile and/or proliferous. **Seed** usually thick-discoid or lenticular, 2.5–5 mm long, white to pale yellow or beige; funicular envelope glabrous or with thin unicellular trichomes; girdle well-developed.

References: Anderson (2001), Pinkava (2003a), Hunt *et al*. (2006).

This genus consists of 33 species, distributed in Central America and the Caribbean, extending into the southwestern USA and northwestern South America (Anderson, 2001; Pinkava, 2003a; Hunt, 2006).

Species of *Cylindropuntia* always have cylindrical, segmented branches, and sheathed spines. As in *Harrisia martinii*, most species have elongated, prominent tubercles that give the branch segments a 'plaited rope' look. The inner tepals are never orange or scarlet as they are in the *Austrocylindropuntia* species treated here, and the tubercles are not so clearly delimited.

The frequent occurrence of hybrids, polyploid series, and taxa of hybrid origin in its native range (Parfitt & Gibson, 2003; Pinkava, 2003a) complicates the taxonomy of this genus (Hunt, 2006).

Key to the species of *Cylindropuntia* in South Africa [based partly on Pinkava (2003a)]:

1. Terminal stem segments usually alternate, narrow, 0.7–1.4 cm in diameter; tubercles hardly apparent, never obscured by dense spines; large spines 0–4(–6) per areole . . . . . **4. *Cylindropuntia leptocaulis***

1'. Terminal stem segments commonly whorled or subwhorled, thicker, usually 1.5–5.5 cm in diameter; tubercles distinct, in some species obscured by densely interlacing spines; large spines (0–)6–30 or more per areole **2**

2. Fruits smooth to shallowly tuberculate, green to yellow-green, sometimes tinged red to purple at maturity, usually forming long chains in large plants, sometimes simple . . . . . **1 & 2. *Cylindropuntia fulgida***

2'. Fruits strongly tuberculate, yellow-green to yellow (sometimes tinged red to purple) or orange-yellow at maturity, simple (rarely with a secondary fruit produced in *C. imbricata*), clustered at end of terminal cladodes, but not proliferating in chains **3**

3. Distal stem segments easily detached from next segment; spines crowded, obscuring stem; flowers always rose coloured . . . . . **5. *Cylindropuntia pallida***

3'. Distal stem segments firmly attached to next segment; spines scattered, not or little obscuring stem; flowers usually dark pink to magenta or purple-red **4**

4. Tubercles of stems usually 0.5–1.5 cm high, crowded; fruits with 28–50 or more areoles, tubercles longer in distal portion of fruit . . . . . **6. *Cylindropuntia spinosior***

4'. Tubercles of stems usually 2–5 cm high, widely spaced; fruits with 18–30 areoles, tubercles nearly equal in length, or longer in proximal portion of fruit . . . . . **3. *Cylindropuntia imbricata***

1. *Cylindropuntia fulgida* (Engelm.) F.M.Knuth

In: Backeberg & Knuth *Kaktus-ABC*: 126 (1936) **var. *fulgida***.

Common names: chain-fruit cholla (English) (previously wrongly identified as rosea cactus, *Cylindropuntia pallida*, in South Africa).

Shrub to small tree 1–3 m tall; trunk well developed; branching divaricate; branch segments ovoid to narrowly ovoid-cylindric, 6–23 × 2–3.5 cm, glaucescent, terminal segments easily detached; tubercles salient, 8–13(–19) mm tall, broadly ovoid, strongly mamillate, obscured by longer and denser spines than in var. *mamillata*, that are interlaced with spines from adjacent tubercles; areoles with gold or brown wool; glochidia 1–3 mm long, yellow. Spines (0–)c.12(–18), 2.5–3(–3.5) cm long, yellow, sheaths baggy, whitish to yellowish. **Flowers** opening late afternoon.

Tepals obovate to ligulate, usually recurved, pink to magenta. **Fruit** obconical, 2–5.5 × 1.3–4.5 cm, obscurely tuberculate, mostly spineless, fleshy, grey-green, proliferous. **Seed** aborted (sterile). **Distribution**: B, SA. (Fig. 113).

References: Henderson (2001), Pinkava (2003a), Hunt *et al*. (2006).

This species is centred on the Gulf of California and the Sonoran Desert of northwestern Mexico and southwestern USA. The type variety (var. *fulgida*) occupies the northeastern portion of the range from Arizona (USA) to Sonora (Mexico), at 300–1100 m above sea level (Pinkava, 2003a). In South Africa infestations are known near Douglas (Northern Cape), Beit Bridge (near Musina, Limpopo Province) and also from adjacent Zimbabwe (Henderson and Zimmerman, 2003). It is thought to have been introduced into South Africa for horticultural purposes, and was previously used as a protective hedge around many homesteads.

It is often confused with *Cylindropuntia pallida* and *C. tunicata* (Lehm) Knuth, especially during the juvenile stage, when it has densely interlacing spines. This species can be differentiated from those two species by its indistinctly tuberculate fruit proliferating in chains (particularly long chains in larger plants) (Fig. 114), and showy darker pink to magenta tepals that curve backwards with age (Fig. 115). In South Africa it has been confusingly named rosea cactus and roseakaktus (Afrikaans). This resulted from its initial incorrect identification as *C. pallida*.

The name ‘chain-fruit cholla’ (Pinkava, 2003a) emphasises the formation of proliferating or ‘chain’ fruits, an important feature that distinguishes it from *C. pallida* and other naturalised chollas (Henderson & Zimmerman, 2003).

Alongside *Opuntia aurantiaca* this is probably the most dangerous cactus invader (Fig. 116) because of its formidable thorns which can cause severe injuries and even death to animals. It is not uncommon to find dead birds, reptiles and small mammals impaled on the thorns (Fig. 117). Livestock get the joints on their mouths or groins which prevent feeding and result in death if not removed. It is understandable why humans used it as a living fence.

This cactus is a declared a category 1 weed in South Africa which is prohibited and must be controlled. It has also been proposed for classification as a category 1b invasive alien plant under NEMBA and CARA (Anonymous, 2009). A registered herbicide is available for its control in South Africa (Anonymous, 2004). An effective biological control agent, a virtually host specific cochineal biotype of *Dactylopius tomentosus*, was collected in Mexico on *Cylindropuntia cholla* (F.A.C.Weber) F.M.Knuth, and released at a number of sites in Limpopo in October and November in 2008. This cochineal has been found to be very damaging to the chain-fruit cholla and is proving to be very successful in controlling this weed (Klein & Zimmerman, 2009). Shown are healthy (Fig. 118) and infected (Fig. 119) plants which clearly demonstrate the effectiveness of this biological control agent.

Fig. 113. Distribution map of *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *fulgida.*

Fig. 114A. *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *fulgida*. Chain fruit shown against healthy spiny plant (Picture by Helmuth G. Zimmermann)

Fig. 114B. *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *fulgida*. Fruit and large plant showing scale. (Picture by Helmuth G. Zimmermann)

Fig. 115. Flower of *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *fulgida.*
(Picture by Helmuth G. Zimmermann)

Fig. 116. *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *fulgida* is an aggressive invader.
(Picture by Helmuth G. Zimmermann)

Fig. 117. Reptile impaled in *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *fulgida.*
(Picture by Helmuth G. Zimmermann)

Fig. 118. Healthy plant of *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *fulgida*. (Picture by Helmuth G. Zimmermann)

Fig. 119. Plant of *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *fulgida* damaged by biological control agent. (Picture by Helmuth G. Zimmermann)

2. *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *mamillata* (A.Schott ex Engelm.) Backeb.

In: *Die Cactaceae, Handbuch der kakteenkunde* 1: 204 (1958).

=*Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *mamillata* (A.Schott ex Engelm.) Backeb. forma *monstrosa* (J.M.Coult) P.V.Heath

Common names: boxing glove cactus (applied only to the crested morphotype, forma *monstrosa*), coral cactus (English).

In comparison to the type variety that appears very spiny from afar due to its dense, longer (2.5–3.5 cm long) spinescence, strongly interlacing with that of adjacent areoles, that obscures the strongly mamillate tubercles beneath, var. *mamillata* appears spineless or nearly so from afar, exposing the strongly mamillate tubercles, due to the sparse, short (1–2 cm long) spines, not or only slightly interlacing with those from adjacent areoles [note that the photograph in Anderson (2001) labelled *C. fulgida* var. *fulgida*, shows these features of *C. fulgida* var. *mamillata*]. The spine sheaths are tightly fitting in var. *mamillata*, while they are baggy in var. *fulgida* (Pinkava 2003a). **Distribution**: SA. (Fig. 120)

Reference: Pinkava (2003a).

Its strongly tuberculate fruit distinguishes *Cylindropuntia fulgida* var. *mamillata* from *C. imbricata* and from the rose to reddish purple-flowered forms of *C. spinosior*, in which proliferation is rare or absent. Fruits are strongly tuberculate. Hybrids of *C. fulgida* with *C. leptocaulis* and *C. spinosior* are known in North America (Pinkava, 2003a).

This variety has a wider range, extending further southwest than *Cylindropuntia fulgida* var. *fulgida*. It occupies both sides of the Gulf of California, in Baja California and the Sonoran Desert in Sonora and Sinaloa (Mexico), as well as the northern extension of the Sonoran Desert in Arizona (USA), where the two varieties occur sympatrically and intermediates can be found (Pinkava, 2003a). The variety is not recognised by some authors (e.g. Hunt, 2006).

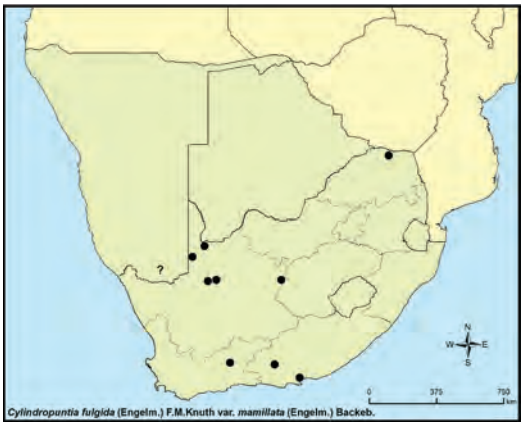

Fig. 120. Distribution map of *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *mamillata* (A.Schott ex Engelm.) Backeb.

The widely cultivated crested morph (Fig. 121) is native to south-central Arizona in the USA (Pinkava, 2003a). This form lacks strong, barbed spines and fertile seed and has been assumed therefore to be less aggressive than var. *fulgida*. Although the boxing glove cactus does not appear related to *C. fulgida* at first sight, there is a population near Hopetown (Northern Cape Province), showing all the features of *C. fulgida* var. *fulgida*, with several individuals showing characteristics of both varieties on one plant. It would appear as if var. *mamillata* can revert back to the much more aggressive var. *fulgida*. This justifies the control envisaged for var. *mamillata*, despite the fact that it otherwise appears to be less invasive.

Fig. 121. Crested form of *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *mamillata* (A.Schott ex Engelm.) Backeb. (Picture by Debbie Sharp)

In southern Africa the crested morph has invaded arid vegetation at a fairly local scale in southern Namibia, Limpopo Province (around Musina), the Northern Cape Province (near Upington, Askham and Noenieput) (Fig. 122), and in the Eastern Cape (near Port Elizabeth). A small population has also been detected in the Western Cape (near Beaufort West, including in the Karoo National Park). It is naturalised in Australia in Queensland, South Australia and Western Australia, and recently also in New South Wales. As in Australia, it is estimated that this species has spread from original plantings, since it is a popular succulent ornamental suitable for planting in semi-arid areas. Its characteristic boxing glove-like cladodes seem to have made it a popular seller. It is thought that it is the ability of these cladodes to persist for months after they have been discarded that has caused

them to start growing where discarded, e.g. at municipal refuse dumping sites. Localised dispersal is via movements of dislodged segments, especially by flood water. As it is the same species as *C. fulgida* var. *fulgida*, it is legally subject to the same control obligations as mentioned above.

Fig. 122. *Cylindropuntia fulgida* (Engelm.) F.M.Knuth var. *mamillata* (A.Schott ex Engelm.) Backeb. invasion. (Picture by Barbara K. Mashope)

3. *Cylindropuntia imbricata* (Haw.) F.M.Knuth

In: Backeberg & Knuth *Kaktus-ABC*: 125 (1936).

=*Cylindropuntia rosea* (DC.) Backeb.
=*Opuntia imbricata* (Haw.) DC.
=*Opuntia rosea* DC.

Common names: devil's rope pear, imbricate cactus (English); kabelturksvy, toukaktus (Afrikaans).

Shrub, often treelike, 1–3 m tall, often with short trunks; branch segments whorled or subwhorled, cylindric to subclavate, 8–25 × 1.5–4 cm, dull grey-green; tubercles prominent, giving the effect of a woven rope, 40 × 5 cm; widely spaced; areoles elliptic, with yellow to tan wool; glochidia 0.5–3 mm long, pale yellow. Spines 5–30, stout, up to 3 cm long, silver-grey to yellow to reddish or brown, sheaths silver-grey to yellow. **Leaves** subulate, 1–2 cm long, caducous. **Flowers** from Nov. to

Jan. **Tepals** obovate to spathulate, dark pink, magenta or reddish magenta. **Fruit** obovoid, 2.4–4.5 × 2–4 cm, fleshy, spineless, yellow, sometimes proliferous and mostly sterile. **Distribution**: B, N, S, SA. (Fig. 123)

References: Obermeyer (1976), Zimmerman (1983), Henderson (2001), Pinkava (2003a), Hunt *et al*. (2006), Scheinvar *et al*. (2009).

Cylindropuntia imbricata is similar to *C. spinosior*, which differs by its rose, reddish purple, bronze purple, whitish, yellow or salmon tepals (in *C. imbricata* usually dark pink to magenta, or rarely, only in its native range, white) (Pinkava, 2003a). Other characters are mentioned in the key to species of the genus.

The name *Opuntia rosea* has for a long time been incorrectly applied to *Cylindropuntia pallida*, following the Mexican usage, e.g. Bravo-Hollis (1978). Judging by the illustrations (Rowley, 1994) that were cited by De Candolle in his original description of the species, we follow Britton & Rose (1963) in placing it under *C. imbricata*. The illustration depicts sparse, short spines, a crimson flower with most tepals slightly recurved (Fig. 124), and a proliferating fruit (Fig. 125).

Cylindropuntia imbricata has a naturally wide distribution range in the Rio Grande catchment at (800–)1 100–1 800(–2 200) m above sea level, often dominant in the Chihuahuan Desert, spanning northern Mexico and the south-central United States, crossing over into the Mississippi catchment in southwestern Kansas and western Oklahoma (Pinkava, 2003a). In central Mexico it responds to overgrazing, forming dense and weedy populations. It is naturalised in Australia (Telford, 1984). In South Africa, it is a transformer of karoo, dry savanna (Fig. 126) and grassland vegetation.

This is a declared category 1 weed in South Africa, and the registered herbicide available for control can be found in the latest update of 'A guide to the use of herbicides' published by the Dept of Agriculture (2004). It has also been proposed for classification as a category 1b invasive alien plant under NEMBA and CARA (Anonymous, 2009).

Cochineal, *Dactylopius tomentosus*, was originally introduced from the USA in 1970. It provides reasonable control in hot and dry regions. Best results are achieved if well-infested plants are felled and heaped. The insect needs to be hand-dispersed to create new infestations. Isolated plants are best controlled chemically (Moran & Zimmermann, 1991b).

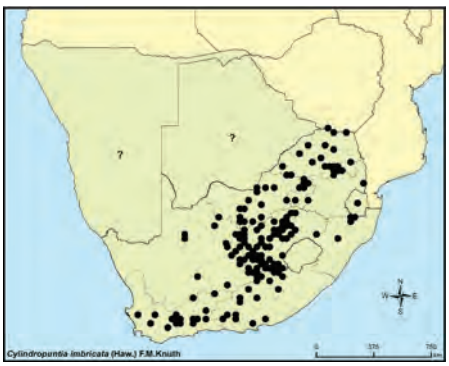

Fig. 123. Distribution map of *Cylindropuntia imbricata* (Haw.) F.M.Knuth.

Fig. 124. Flower of *Cylindropuntia imbricata* (Haw.) F.M.Knuth.
(Picture by Barbara K. Mashope)

Fig. 125. Proliferating fruit of *Cylindropuntia imbricata* (Haw.) F.M.Knuth.
(Picture by Gideon F. Smith)

Fig. 126. *Cylindropuntia imbricata* (Haw.) F.M.Knuth is a transformer of dry savanna. (Picture by Arrie Klopper)

4. *Cylindropuntia leptocaulis* (DC.) F.M.Knuth

In: Backeberg & Knuth *Kaktus-ABC*: 122 (1936).

Common names: desert Christmas cactus, desert Christmas cholla, pencil cactus (English); potloodkaktus (Afrikaans).

Shrubby or treelike, variously branched, 0.5–1.8 m, usually with numerous short, spineless stems along major axes; branch segments very slender, 20–80 × 3–5 mm, scarcely tuberculate, grey-green to purplish; areoles broadly elliptic, with white to yellow wool, becoming grey with age; glochidia 1.5 mm long, yellow to reddish brown. Spines 0–1(–3), 14–45 mm long, mainly at apical areoles, porrect, flattish at base, acicular above; sheaths grey, purplish grey, or yellow. **Flowers** pale to greenish yellow, sometimes with reddish tips. **Fruit** occasionally proliferating, obovoid, c. 15 × 6–7 mm, fleshy, spineless, yellow to red when ripe. **Distribution**: N, SA. (Fig. 127)

References: Pinkava (2003a), Hunt *et al*. (2006).

This species is widespread in the deserts, grasslands, shrublands and woodlands of the southern USA from Arizona to coastal Texas, and in Mexico from Sonora to Zacatecas and Tamaulipas (Pinkava, 2003a).

It is readily distinguished from the other naturalised *Cylindropuntia* species by its thin stems and indistinct tubercles (Fig. 128). *Cylindropuntia leptocaulis* superficially resembles *Opuntia salmiana*, from which it can be distinguished by sheathed, hard spines and short (5–8 mm long) pale to greenish yellow tepals (flowers 2–3.5 cm across and whitish in *O. salmiana*). Hybrids with *Cylindropuntia fulgida* and *C. spinosior* are known in North America (Pinkava, 2003a).

The pencil cholla became established in the Oudtshoorn district where it was spreading at an alarming rate during the seventies. The imbricate cactus cochineal, *Dactylopius tomentosus,* proved to be a very efficient biological control agent which has successfully controlled practically all known infestations. Isolated plants are still found around Oudtshoorn (Fig. 129) and beyond. No additional control measures are necessary.

Fig. 127. Distribution map of *Cylindropuntia leptocaulis* (DC.) F.M.Knuth.

Fig. 128. Fruits of *Cylindropuntia leptocaulis* (DC.) F.M.Knuth. (Picture by Helmuth G. Zimmermann)

Fig. 129. *Cylindropuntia leptocaulis* (DC.) F.M.Knuth.
(Picture by Helmuth G. Zimmermann)