A TAXONOMIC STUDY OF THE GENUS *CRYPTOLEPIS* (PERIPLOCOIDEAE: APOCYNACEAE)

by

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INTRODUCTION AND HISTORICAL REVIEW

1.1 Introduction to *Cryptolepis* R.Br. (Periplocoideae, Apocynaceae)

The generic name *Cryptolepis* is derived from *Kryptos* = ‘hidden’, and *Lepis* = ‘a scale’, which refers to the corona lobes that close off the corolla tube mouth and hide the anthers and stigma (Santapau and Irani, 1960; Stearn, 1991). *Cryptolepis* belongs to the family Apocynaceae *sensu lato*, subfamily Periplocoideae.

The Apocynaceae *sensu lato* comprises about 395 genera and around 5100 species (Endress et al., 2007). Meve (2002) showed that a significant number of new genera and species were described in the subfamilies Periplocoideae, Secamonoideae and Asclepiadoideae during the period from 1990 to 2000. As an increasing amount of data and resources become available to systematists, this trend is expected to persist and Meve (2002) predicts that in the asclepiads alone species numbers may rise to around 4000.

The Periplocoideae are represented by a relatively small proportion of Apocynaceae taxa, with 34 genera and about 190 species currently recognized in this subfamily. The majority of the periplocoid genera are small, consisting of one to 14 species, and only three genera contain more than 20 species (Venter and Verhoeven, 2001). *Cryptolepis* (31 spp.) is the second largest genus in the Periplocoideae, second only to *Raphionacme* Harv. with 36 species, while *Pentopetia* Decne. consists of 22 species (Klackenberg, 1999, 2007; Venter, 2009a; Venter and Verhoeven, 2001).

Cryptolepis is the most widely distributed genus of the Periplocoideae, growing throughout sub-Saharan Africa, the southern parts of Yemen, including the island archipelago of Socotra, and southern Asia ranging from India to southern China, Taiwan, the Philippines and Indonesia. By contrast *Raphionacme* is restricted to sub-Saharan Africa and southern Arabia (Venter, 2009a), while *Pentopetia* is restricted to Madagascar (Klackenberg, 1999). The only other widely distributed genus, *Periploca* L., grows in Africa, Europe and southern Asia and consists of 14 species (Venter and Verhoeven, 1997).

Cryptolepis is highly variable in vegetative morphology with the majority of species being slender, woody climbers, though a number of low growing shrubs and two tree species are also included. The majority of species grow in tropical forests or savannah, but about 13 species are adapted to semi-desert regions of the Mandeb Circle while one species grows in the Namib Desert. Since the rest of the Periplocoideae is represented in arid habitats by only three *Ectadium* E.Mey. species restricted to the Namib Desert (Venter et al., 1990a) and about five *Raphionacme* species growing in the Namib and Mandeb Circle (Venter, 2009a), *Cryptolepis* constitutes a significant number species adapted to arid conditions in the subfamily.

Many of the tropical and sub-tropical regions where *Cryptolepis* grows, are under-collected (Meve, 2002). As a consequence several *Cryptolepis* species are known from only one or two specimens resulting in poor understanding of their distribution and ecology (Joubert et al. 2008; Joubert and Venter, 2009; Venter and Verhoeven, 1999, 2007; Venter et al., 2006a). Further exploration of these regions may improve the scanty information on the ecology of such rare species and may also lead to the discovery of new *Cryptolepis* species.

Though *Cryptolepis,* and indeed the Periplocoideae, have little commercial value, some species are used widely as traditional remedies or food (Mendes and Jansen, 1984; Previati et al., 2007; Venter, 2009a). In China *C. sinensis* is used to make ropes and for the treatment of snake bites and other wounds while *C. dubia* [= *C. buchananii*] is used to treat edema (Ping-tao et al., 1995). In Mozambique *C. obtusa* is used to prevent abortion and to treat abdominal pains (Mendes and Jansen, 1984). However, the best known *Cryptolepis* species used for traditional remedies, is *C. sanguinolenta,* which is widely applied in Central and West Africa to treat a diversity of diseases, including malaria (Kerharo and Adam, 1974; Sofowora, 1982).

The wide use of *C. sanguinolenta* extracts for treatment of infectious diseases, amoebiasis and malaria has resulted in pharmaceutical interest in this species and prompted a series of phytochemical studies and pharmaceutical trials (Ansah and Gooderham, 2002; Ansah, et al., 2005; Bierrer et al., 1998; Bonjean et al., 1998; Chimanga et al., 1997; Frederich et al., 2008; Grellier et al., 1996; Lisgarten, et al., 2002; Paulo and Houghton, 2003). Clinqart (1929) first isolated cryptolepine, an indole alkaloid, from the roots of *C. sanguinolenta.* Since its discovery a number of semi-synthetic cryptolepine derivatives have been produced (Frederich et al., 2008).

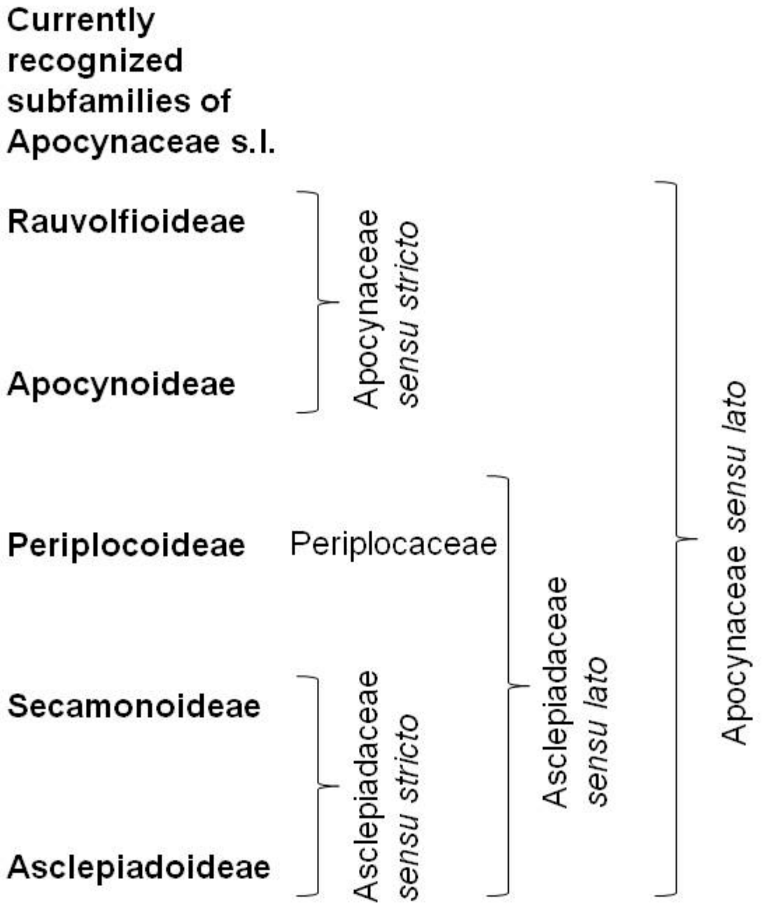
Pharmaceutical trials using cryptolepine have indicated that this compound is effective in treating malaria (Chimanga et al., 1997; Grellier et al., 1996), but its cytotoxic and genotoxic effect makes this compound potentially harmful to users (Ansah et al., 2005; Lisgarten et al., 2002). Though this lessens its potential as a commercial anti-malarial drug, the cytotoxic properties of cryptolepine show potential as chemotherapy in treating cancer. Several studies have shown that cryptolepine may be effectively used to treat a number of organ specific cancers (Ansah and Gooderham, 2002; Bonjean et al., 1998). Bierer et al. (1998) also showed that cryptolepine had anti-hyperglycemic properties and could possibly be used in the treatment of Type II diabetes.

A chemotaxonomic study of *Cryptolepis,* including seven African *Cryptolepis* species, showed that alkaloids were not common to all species in this genus. Phenolic compounds were present in the majority of investigated species, but were absent from one sample of *C. obtusa* and *C. hypoglauca*, and from all samples of *C. sanguinolenta.* In addition, *C. sanguinolenta* and *C. hypoglauca* were the only species containing alkaloids. *Cryptolepis sanguinolenta* is therefore chemically different from other African *Cryptolepis* species included in this analysis and it may be expected that these other species would not have medicinal value similar to that of *C. sanguinolenta*. Comparison with other Apocynaceae subfamilies and genera suggested that chemotaxonomy may be useful in the classification of the family, but biochemical data is currently too limited to be effectively used in the classification of the Apocynaceae *sensu lato* (Paulo and Houghton, 2003).

1.2 Taxonomic history of the Apocynaceae

The classification of the Apocynaceae and its subfamilies has varied considerably in the past. For the purpose of this discussion on the taxonomic history of the Apocynaceae, the family/subfamily name used by the cited author will be given in its original form, followed by the currently accepted name as depicted in Table 1.1.

Table 1.1. Concepts of families in the Apocynaceae *sensu lato*, following Schumann (1895a), Schlechter (1905), Endress and Bruyns (2000) and Endress (2004).



Jussieu (1789) first circumscribed the Apocineae (at present Apocynaceae *sensu lato*) and divided the 24 genera known at the time, most of which had been described by Linnaeus (1753, 1754) under his Pentandria Monogyna and Pentandria Digyna, into three groups. These groups were based on ovary, fruit and seed characters. Group 1 was defined by an ovary consisting of two free carpels, bifollicular fruit and non-comose seeds. Group 2 also had an ovary consisting of two free carpels and bifollicular fruit but was distinguished from Group 1 by its comose seeds. Group 3 in contrast, was defined by its syncarpous ovary, consisting of bicarpellate, baccate or capsular fruits and non-comose seeds (Jussieu, 1789).

Groups 1 and 3 of Jussieu (1978) were artificial and constituted genera which are included in the Rauvolfioideae in modern classifications. In these two groups corolla lobes are sinistrorsely contorted, anthers are free from the style-head and seeds are non-comose (Endress, 2004). Group 2 represented the only natural group defined by Jussieu (1978), characterised by dextrorsely contorted corolla lobes (with a few exceptions), a gynostegium formed by anthers which are postgenitally fused to the style-head and usually comose seeds (Endress, 2004).

The most influential work on the classification of the Apocineae (at present Apocynaceae *sensu lato*) was published by Brown (1810a, b). Brown (1810a) reported on the taxa collected and studied during the expedition of Matthew Flinders to Australia and described 14 new genera. Shortly after this first publication Brown's definitive account "On the Asclepiadeae" (Brown, 1810b) followed in which he described a further 26 new genera and gave detailed accounts of 53 genera and 169 species. Though recognizing that these genera all formed part of a natural series, Brown (1810a, b) split the Apocineae (at present Apocynaceae *sensu lato*) as circumscribed by Jussieu (1789) into two smaller, more manageable groups, the Asclepiadeae (at present Asclepiadaceae *sensu lato*) and the Apocineae *sensu stricto* (at present Apocynaceae *sensu stricto*). Brown (1810b) based his new classification on pollen characters, the Apocyneae *sensu stricto* having single pollen grains and no translators, whereas the Asclepiadeae were characterised by pollen coalesced into masses (pollen tetrads or pollinia) and the presence of translators.

Brown (1810b) further divided the Asclepiadeae (at present Asclepiadaceae *sensu lato*) into three subfamilies, namely Asclepiadeae *verae* (at present Asclepiadoideae), the Periploceae (at present Periplocoideae) and the genus *Secamone* R.Br. by itself in an unnamed category which Endlicher (1838) named Secamonoideae. These three subfamilies as defined by Brown (1810b) have been shown to be monophyletic and are still recognized in modern classifications (Endress, 2004).

Brown's subfamilial classification was based on his "essential characters", namely characters of pollen and translators. At present the Asclepiadoideae are characterised by individual pollen grains agglutinated into two pollinia per anther, each of these pollinia enclosed by a thick wall. Two pollinia, one from each of two neighbouring anthers, are attached to a clip-like corpuscule via two caudicles. In the Secamonoideae each anther carries four pollinia consisting of pollen tetrads, these enclosed by a thin pollinium wall. Consequently four pollinia, two from two neighbouring anthers, are attached to a single clip-like corpuscule (Civeyrel et al., 1998). The Periplocoideae are distinguished from the former two groups by pollen grouped into tetrads which are shed at anthesis onto spoon-shaped translators. A few genera in the Periplocoideae also produce pollinia, but Verhoeven and Venter (2001) showed that these differ from those of the Asclepiadoideae in consisting of tetrads, and not of monads.

Schumann (1895a) subdivided Brown's Apocyneae *sensu stricto* (at present Apocynaceae *sensu stricto*) into two subfamilies, namely Plumerioideae (at present Rauvolfioideae) and Echitoideae (at present Apocynoideae). Endress and Bruyns (2000) changed the name Plumerioideae to Rauvolfioideae in accordance with the rule of priority of names. Schlechter (1905a) proposed that the Asclepiadeae (at present Asclepiadaceae *sensu lato*), as described by Brown (1810b), be subdivided into two families, namely Asclepiadaceae *sensu stricto* (consisting of the Asclepiadoideae and Secamonoideae) and Periplocaceae (at present Periplocoideae). This classification was supported by later authors such as Arekal and Ramakrishna (1980), Bullock (1956), Dave and Kriachen (1991), Dyer (1975), Huber (1973), Hutchinson (1973), Kunze (1990, 1993, 1996), Liede and Kunze (1993), Nilsson et al. (1993), Omlor (1996), Schlechter (1914, 1924), Swarupanandan et al. (1996) and Venter et al. (1990a).

Schlechter (1914, 1924) separated the Asclepiadaceae *sensu stricto* and Periplocaceae on the basis of pollen characteristics. The Periplocaceae were characterized by pollen arranged in tetrads, these loosely deposited on spoon-like translators with a soft, sticky, amorphous viscidium (or sticky disc). The Asclepiadaceae, in contrast, were characterized by pollen grouped into pollinia, these attached via two caudicles to a clip-like corpuscule (Endress and Bruyns, 2000).

Despite this subdivision of the group, morphological studies also emphasized Brown's (1810b) observation that the Apocynaceae *sensu lato* represented a natural series and several characters overlap among the families and subfamilies in this group (Endress, 2001). Such overlap may be found even in the "essential characters" used for the subdivision of the families and subfamilies. Translator characters show a gradual transition from simple spoon-shaped translators in the Periplocoideae (Schlechter's Periplocaceae) to clip-like corpuscula in the Secamonoideae and Asclepiadoideae (Schlechter's Asclepiadaceae *sensu stricto*). Endress (2001) suggested that, in cross section, the translator stalk in the Periplocoideae was structurally similar to the clip-like corpuscule of the Secamonoideae and Asclepiadoideae, indicating a close relationship between these families. Indeed, Kunze (1993) regarded the upper part of the adhesive disc and the stalk of the periplocoid translator as homologous with the corpuscule of the Secamonoideae and Asclepiadoideae.

In addition, members of the Apocynaceae *sensu stricto* (Rauvolfioideae and Apocynoideae) secrete a sticky adhesive on the style-head in areas between adjacent anthers, corresponding to the position of translators in the Periplocoideae, Secamonoideae and Asclepiadoideae. In *Apocynum* L. and *Forsteronia* G.Mey. (Apocynoideae) this sticky adhesive hardens to form a sticky band which functions in the same way as the spoon-shaped translator of the Periplocoideae (Demeter, 1922; Nilsson et al., 1993). Chemical analysis of the sticky adhesive of the Apocynoideae and the translators of the Periplocoideae and Asclepiadoideae showed that these structures consist of the same compounds, supporting homology of the structures (Schick, 1982).

A similar gradual transition in pollen characters may be observed from the Apocynaceae *sensu stricto* to the Asclepiadaceae *sensu lato* (Endress, 2001). The Apocynoideae are generally characterised by single pollen grains, but in *Apocynum* pollen grains are released as tetrads onto the sticky adhesive of the style-head. This is similar to the Periplocoideae, where pollen tetrads are released onto the spoon-shaped translator (Verhoeven and Venter, 1998). Studies by Schill and Jäkel (1978) and Verhoeven and Venter (1998) further revealed that several periplocoid genera have pollinia, consisting of agglutinated tetrads, but not enclosed by a thick pollinium wall. These pollinia, four per anther, are freely shed onto spoon-shaped translators (Verhoeven and Venter, 2001).

Pollinia in the Periplocoideae are similar to those in the Secamonoideae in which pollen tetrads are also agglutinated in pollinia, but without a pollinium wall. However, in the Secamonoideae four pollinia are attached to each corpuscule. From the Secamonoideae to the Asclepiadoideae there is also an intermediate form in that *Fockea* Endl. (Asclepiadoideae) has only two pollinia per anther like the rest of the Asclepiadoideae, but it is similar to the Secamonoideae in that its pollinia lack distinct pollinium walls and caudicles (Verhoeven and Venter, 2001).

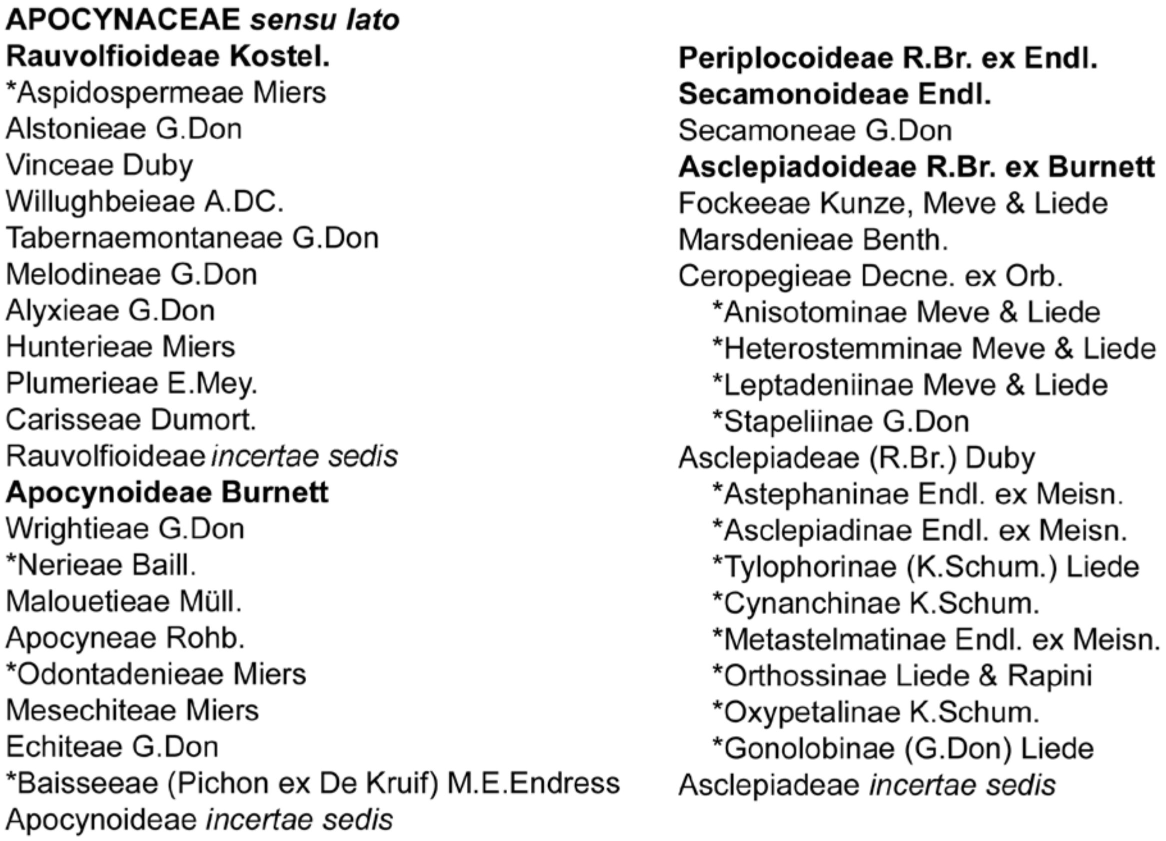
Detailed morphological investigations of a large number of taxa have led some authors to suggest a linear evolution in characters from the Rauvolfioideae and Apocynoideae to the Secamonoideae and Asclepiadoideae with Periplocoideae occupying an intermediate position (Arekal and Ramakrishna, 1980; Demeter, 1922; Safwat, 1962; Cronquist, 1981; Rosatti, 1989; Endress, 1994; Endress, 2001). Others have suggested that both Asclepiadoideae and Periplocoideae evolved from the Apocynoideae independently and that similarities in their pollen transport apparatus are the result of parallel evolution or convergence (Huber, 1973; Nilsson et al., 1993; Schumann, 1895a; Wanntorp, 1988).

Molecular phylogenetic investigations shed new light on this topic and resulted in substantial changes in the general concept of natural groups and character evolution in the Apocynaceae *sensu lato*. The first of these was a phylogenetic analysis of 23 Apocynaceae genera based on the chloroplast gene region, *rbcL* (Sennblad and Bremer, 1996). This study was followed by similar phylogenetic analyses including more taxa and based on additional chloroplast gene regions (*matK, ndhF, rpl16* intron, *rps16* intron, *3' trnK* intron, *trnL* intron, *trnL-F* spacer) and morphological data (Civeyrel et al., 1998; Livshultz et al., 2007; Potgieter and Albert, 2001; Sennblad and Bremer, 2000, 2002).

Phylogenetic analyses which included a substantial number of taxa showed that the Apocynaceae *sensu stricto* as delimited by Brown (1810b) is paraphyletic since the Periplocoideae and milkweeds (Secamonoideae and Asclepiadoideae) are nested within the Apocynoideae (Civeyrel et al., 1998; Potgieter and Albert, 2001).

Based on their wide morphological survey of the Apocynaceae *sensu stricto* and Asclepiadaceae *sensu lato,* as well as molecular phylogenetic information available at the time, Endress and Bruyns (2000) proposed that the two families originally recognized by Brown (1810b) be united into a single family, the Apocynaceae *sensu lato.* This classification would ensure the circumscription of a monophyletic family, as suggested by earlier taxonomists (Hallier, 1905; Safwat, 1962; Thorne, 1992; Judd et al*.,* 1994; Takhtajan, 1997). Endress and Bruyns (2000) further maintained the subfamilial classification proposed by Brown (1810b) in maintaining the Asclepiadoideae, Secamonoideae and Periplocoideae, in addition to the Apocynoideae and Rauvolfioideae. Endress and Stevens (2001) suggested several tribal additions to the classification of Endress and Bruyns (2000), while the classification was further updated by Endress et al. (2007), resulting in a tribal and sub-tribal classification based on extensive morphological and molecular evidence (Table 1.2.).

Table 1.2. Classification of the Apocynaceae *sensu lato* following Endress et al. (2007). Tribes and sub-tribes not previously recognized by Endress and Bruyns (2000) and Endress and Stevens (2001) are preceded by an asterisk.



APOCYNACEAE *sensu lato*
Rauvolfioideae Kostel.
*Aspidospermeae Miers
Alstonieae G.Don
Vinceae Duby
Willughbeieae A.DC.
Tabernaemontaneae G.Don
Melodineae G.Don
Alyxieae G.Don
Hunterieae Miers
Plumerieae E.Mey.
Carisseae Dumort.
Rauvolfioideae *incertae sedis*
Apocynoideae Burnett
Wrightieae G.Don
*Nerieae Baill.
Malouetieae Müll.
Apocyneae Rohb.
*Odontadenieae Miers
Mesechiteae Miers
Echiteae G.Don
*Baisseeae (Pichon ex De Kruif) M.E.Endress
Apocynoideae *incertae sedis*

Periplocoideae R.Br. ex Endl.
Secamonoideae Endl.
Secamoneae G.Don
Asclepiadoideae R.Br. ex Burnett
Fockeeae Kunze, Meve & Liede
Marsdenieae Benth.
Ceropegieae Decne. ex Orb.
  *Anisotominae Meve & Liede
  *Heterostemminae Meve & Liede
  *Leptadeniinae Meve & Liede
  *Stapeliinae G.Don
Asclepiadeae (R.Br.) Duby
  *Astephaninae Endl. ex Meisn.
  *Asclepiadinae Endl. ex Meisn.
  *Tylophorinae (K.Schum.) Liede
  *Cynanchinae K.Schum.
  *Metastelmatinae Endl. ex Meisn.
  *Orthossinae Liede & Rapini
  *Oxypetalinae K.Schum.
  *Gonolobinae (G.Don) Liede
Asclepiadeae *incertae sedis*

The Rauvolfioideae and basal Apocynoideae form a grade (Endress, 2004) while relationships among the higher Apocynoideae tribes and the three subfamilies, Periplocoideae, Secamonoideae and Asclepiadoideae (termed the "crown clade") remain poorly resolved (Livshultz et al., 2007). Livshultz (2010) combined the nuclear gene *Phytochrome-A* with a number of the above mentioned chloroplast genes to produce a comprehensive analysis of the Apocynaceae *sensu lato* crown clade. The Asclepiadaceae *sensu lato* is either paraphyletic or polyphyletic since the tribe, Baisseeae (Apocynoideae), is resolved as the sister group to the Secamonoideae and Asclepiadoideae (Asclepiadaceae *sensu stricto*), while the position of the Periplocoideae among the higher Apocynoideae tribes is unresolved (Livshultz et al., 2007; Livshultz, 2010). These results contradict the assumption by earlier authors that character evolution in the Apocynaceae *sensu lato* shows a linear progression from the Rauvolfioideae, through the Apocynoideae and Periplocoideae to the Secamonoideae and Asclepiadoideae.

1.3 Taxonomic history of the Periplocoideae and *Cryptolepis*

The number of genera and species in the Periplocoideae has varied considerably in the past. Ionta and Judd (2007) proposed the great diversity of this subfamily, morphological variability of closely related taxa, lack of information on several poorly collected taxa and the small, complex flowers which are difficult to interpret from herbarium material, as probable causes for the instability of classification in the subfamily.

The type genus of the Periplocoideae, *Periploca*, was first described in 1753 by Linnaeus, who placed it in the Order Pentandria Digynia. This genus was classified under the Asclepiadeae (at present Asclepiadaceae *sensu lato*) when Brown (1810b) split this family from the Apocyneae *sensu stricto* (at present Apocynaceae *sensu stricto*). Brown (1810b) also described the genus *Cryptolepis* from a specimen collected in India by Buchanan-Hamilton (Fig. 1.1.). Though Brown (1810b) did not assign a type species, the specimen on which he based the genus description was later named *Crytolepis buchananii* by Roemer and Schultes (1819). This species was considered to be the type species of the genus (Santapau and Irani, 1960). Almeida (2001) synonymised *C. buchananii* with *C. dubia* and, consequently, the latter should now be regarded as the type species of *Cryptolepis.*

Brown (1810b) placed *Cryptolepis* in the family Apocyneae *sensu stricto* (at present Apocynaceae *sensu stricto*) since he overlooked the minute translators found in *Cryptolepis,* a character that should have placed this genus in the Asclepiadeae (at present Asclepiadaceae *sensu lato*). Later Bentham (1876) and Hooker (1883) correctly classified *Cryptolepis* under the Asclepiadeae (at present Asclepiadaceae *sensu lato*) and when Schlechter (1905) split the Periplocaceae from the Asclepiadaceae *sensu stricto, Cryptolepis* was placed in the former family.

Brown (1902) reviewed the tropical African members of the Asclepiadaceae *sensu lato* and added several new genera and species. This revision was followed by several papers on the African Asclepiadaceae (*sensu lato*) by Bullock (1952, 1953a, 1953b, 1954a,1954b, 1955, 1956, 1957, 1961, 1963) wherein he provided an in depth revision of the group, synonymising several genera, making new combinations and describing a number of new species. Forster (1990, 1993) again reviewed the Asclepiadaceae *sensu lato*. He synonymised several genera, including *Phyllanthera*

Blume and *Batesanthus* N.E.Br., with *Cryptolepis* and then divided the latter genus into two subgenera. The first of these subgenera, *Cryptolepis* subgenus *Cryptolepis,* included all previously described *Cryptolepis* species with discrete corolla lobes while the second subgenus, *Cryptolepis* subgenus *Phyllanthera,* included species without discrete corona lobes (Forster, 1993).

Venter and Verhoeven (1997, 2001) reviewed the Periplocoideae (Periplocaceae) and reinstated *Phyllanthera* and *Batesanthus* as genera separate from *Cryptolepis.* The subgeneric classification of *Cryptolepis* by Forster (1993) was consequently rejected. Venter and Verhoeven (1997) synonymised 12 periplocoid genera, but subsequently one of these was reinstated and a further 11 genera were synonymised (Venter and Verhoeven, 2001). Klackenberg (1997, 1998) placed two more genera in synonymy resulting in a total of 31 genera and 181 species in the Periplocaceae (at present Periplocoideae) (Venter and Verhoeven, 2001). During the last decade a number of genera were reinstated or newly described resulting in the current number of 34 accepted genera (Venter, 2009b; Venter et al., 2006a).

Venter and Verhoeven (1997) were the first to attempt a tribal classification of the Periplocoideae. This classification was based on a large number of morphological characters with strong reference to characters used for generic delimitation by earlier taxonomists. Such characters included the distinctness of the corolla tube, shape and position of the corona lobes in relation to the corolla tube and stamens, as well as hairiness of the anthers (Brown, 1810b; Brown, 1902; Blume, 1825–1826; Venter and Verhoeven, 1997).

Phylogenetic analysis of 33 Periplocoideae genera, based on 39 morphological characters by Venter and Verhoeven (2001), resulted in a poorly resolved tree which did not support the tribal classification of Venter and Verhoeven (1997). Venter and Verhoeven (2001) showed that distinctness of the upper corolla tube was more variable than had previously been supposed and proposed that this character was not sufficient for delimiting genera within the Periplocoideae. Based on this phylogeny and palynological data, Venter and Verhoeven (2001) and Verhoeven and Venter (2001) suggested that pollinia evolved multiple times within the Periplocoideae and questioned the homology of the pollinia in Secamonoideae and Asclepiadoideae.

The first large scale molecular phylogenetic investigation in the Periplocoideae was undertaken by Ionta and Judd (2007), who used a combination of chloroplast (*trnD-T, trnT-L, trnL* intron, *trnL-F*) and nuclear (ITS) genes in a phylogenetic investigation of 29 of the 32 periplocoid genera recognized at the time. Their resultant phylogeny did not support the tribal classification of Venter and Verhoeven (1997) nor the morphology based phylogeny of Venter and Verhoeven (2001). However, the phylogeny obtained did support the hypothesis that pollinia evolved multiple times within the Periplocoideae (Ionta and Judd, 2007; Venter and Verhoeven, 2001; Verhoeven and Venter, 2001).

Other than the raised central groove on the translators of genera in the "grooved translator clade", no other morphological characters correspond to the Periplocoideae phylogeny of Ionta and Judd (2007). Poor correlation between morphological and molecular data in addition to the poorly resolved morphology based phylogeny of Venter and Verhoeven (2001) suggest that morphological characters within this group are subject to parallelism and convergence. As a consequence interpretation of homology in the Periplocoideae is still problematic and hampers the circumscription of natural taxa.

Though many authors have reviewed *Cryptolepis* as part of a broad revision of the Periplocoideae, all literature on the taxonomy of *Cryptolepis* is based on a regional perspective and no treatment includes all species. In addition, several recent changes in the number and names of species occurred since several genera such as *Curroria* Planch. ex Benth. (Brown, 1902; Venter and Verhoeven, 1997), *Ectadiopsis* Benth. (Schlechter, 1896), *Mitolepis* Balf.f. (Venter and Verhoeven, 1997) and *Socotranthus* Kuntze (Venter and Verhoeven, 1997) have been declared synonymous with *Cryptolepis*. A number of new species, *C. yemenensis* (Venter and Verhoeven, 1999), *C. nugaalensis* (Venter et al., 2006b), *C. somaliensis* (Venter et al., 2006b) and *C. ibayana* (Joubert and Venter, 2009), have also been described in recent years. Others, such as *C. albicans* Jum. & H.Perrier of Madagascar (now *Pentopetia albicans* (Jum. & H.Perrier) Klack.) have been transferred to other genera (Klackenberg, 1999).

In terms of species diversity, distribution and potential pharmaceutical and economic value *Cryptolepis* is one of the most significant genera in the Periplocoideae. The aim of this study is to determine the number of *Cryptolepis* species found worldwide and to produce an identification key, descriptions and distribution maps for all species. In addition, suitable morphological characters for identification and classification of the genus and species will be determined. All nomenclature regarding this genus will be reviewed, corrected and synonyms designated, while types will be confirmed and lecto- and neotypes designated where necessary. Molecular phylogenetics will be used to assess the monophyly of *Cryptolepis,* to investigate the relationships among *Cryptolepis* species in a biogeographical context and to identify possible driving forces in speciation and evolution in this genus.

Fig. 1.1. Type specimen of *Cryptolepis* collected by Dr. Buchanan-Hamilton.

CHAPTER 2

MATERIALS AND METHODS

2.1 Taxon sampling for taxonomic treatment

Fresh material was collected throughout the distribution range of *Cryptolepis* in Southern Africa. Detailed observations of the habitat, associated species as well as vegetative and floral characteristics of the specimens were made. Vouchers were prepared and these are housed at the Herbaria BLFU and PRE.

Herbarium specimens from all geographical regions to which *Cryptolepis* is native, were investigated during a visit to some major European herbaria. Material was examined from herbaria listed in Table 2.1. Type specimens were examined and scans of type material available on JSTOR Plant Science (http://plants.jstor.org/) were reviewed. Where type material was only seen on JSTOR these are indicated as "scan!". Type literature was confirmed and synonyms were designated. Typification was done according to the guidelines of the International Code of Botanical Nomenclature (McNeill et al., 2006). Where holotypes were missing, such as those destroyed in the bombing of Berlin (B) during the Second World War, isotypes or syntypes were located and lectotypes were selected from these. Where no types could be found neotypes were designated.

All collectors' data, morphological measurements and observations were recorded using BRAHMS V6.50 (Filer, 2009). Voucher information for all specimens investigated is shown in Appendix 1.

General terminology used in the description of taxa follows Beentje (2010). Spelling of author names follows Brummitt and Powell (1992) and taxonomic literature is cited as in Stafleu and Cowan (1976). Spelling of associated species names and author names follows The International Plant Names Index (2012) and Jackson (1893).

Table 2.1. Herbaria that provided specimens on loan or specimen records and scans. (Herbarium acronyms according to Holmgren et al. (1990).)

B	Herbarium, Botanischer Garten und Botanisches Museum Berlin-Dahlem, Zentraleinrichtung der Freie Universität, Berlin, Germany.
BLFU	Geo Potts Herbarium, Department of Plant Sciences, University of the Free State, Bloemfontein, Free State Province, South Africa.
BOL	Bolus Herbarium, Botany Department, University of Cape Town, Rondebosch, Western Cape Province, South Africa.
BM	Herbarium, Department of Botany, The Natural History Museum, London, England.
BR	Herbarium, National Botanic Garden of Belgium, Domein van Bouchout, Meise, Belgium.
COI	Herbarium, Botany Department, University of Coimbra, Coimbra, Portugal.
E	Herbarium, Royal Botanic Garden, Edinburgh, Scotland.
EA	East African Herbarium, National Museum of Kenya, Nairobi, Kenya.
FT	Centro Studi Erbario Tropicale, Università degli Studi di Firenze, Italy.
G (G-DC)	Herbarium, Conservatoire et Jardin botaniques de la Ville de Genève, Genève, Switzerland.
GRA	Selmar Schonland Herbarium, Albany Museum, Grahamstown, Eastern Cape Province, South Africa.
HBG	Biozentrum Klein-Flottbek, Hamburg, Germany.
J	C.E. Moss Herbarium, School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, Gauteng Province, South Africa.
K	Herbarium, Royal Botanic Gardens, Kew, Richmond, England.
KMG	Herbarium, McGregor Museum, Kimberley, Northern Cape Province, South Africa.
KTUH	Herbarium, Botany and Microbiology Department, Kuwait University, Kuwait.
L	Nationaal Herbarium Nederland, Leiden University, Leiden, Netherlands.
LISC	Herbàrio, Centro de Botânica, Jardim Bôtanico Tropical, Instituto de Investigaçâo Científica Tropical, Lisboa, Portugal.

LISU	Museu Nacional de História Natural, Lisboa, Portugal.
M	Herbarium, Botanische Staatssammlung, München, Germany.
MO	Herbarium, Missouri Botanical Garden, Saint Louis, Missouri, U.S.A.
NBG	Compton Herbarium, South African National Biodiversity Institute, Claremont, Western Cape Province, South Africa.
NH	KwaZulu-Natal Herbarium, South African National Biodiversity Institute, Durban, KwaZulu-Natal Province, South Africa.
NU	Bews Herbarium, School of Biological and Conservation Sciences, University of KwaZulu-Natal, Pietermaritzburg, KwaZulu-Natal Province, South Africa.
PRE	National Herbarium, South African National Biodiversity Institute, Pretoria, Gauteng Province, South Africa.
PRU	H.G.W.J. Schweickerdt Herbarium, Botany Department, University of Pretoria, Pretoria, Gauteng Province, South Africa.
S	Swedish Museum of Natural History, Stockholm, Sweden.
SRGH	National Herbarium, Botanic Garden, Harare, Zimbabwe.
UPS	Botanical Museum of Evolution, Uppsala University, Uppsala, Sweden.
W	Herbarium, Department of Botany, Naturhistorisches Museum Wien, Vienna, Austria.
WIND	National Herbarium of Namibia, National Botanical Research Institute, Windhoek, Namibia.
Z	Herbarium, Institut für Systematische Botanik, Universität Zürich, Zürich, Switzerland.

2.2 Biogeography and mapping

Distribution data on specimen labels were recorded using BRAHMS V.6.50. Georeferencing was done using coordinates provided on specimen labels or by using Google Earth version 6.2.2.6613 (http://www.google.com/earth/index.html) and Reader's Digest Atlas (Walton, 1984). In cases where old or alternative spelling of names of countries or towns are recorded on specimen labels, the current or more commonly used name is given in square brackets.

Distribution data were exported as data base files (.dbf) from BRAHMS and imported into DIVA V.5.2.0.2 (Hijmans et al., 2005) where it was used to draw distribution maps of all species. Country names are indicated on all maps, except 1:45 000 000 scale maps of Africa. Fig. 2.1. shows all country names for this Africa map.

Spatial analysis of *Cryptolepis* species diversity was done using point to grid analysis in DIVA. The study area was defined as 19°W to 129°E, 30°S to 31°N. A circular neighbourhood analysis was conducted using cell size of 30', and map units set at 2°.

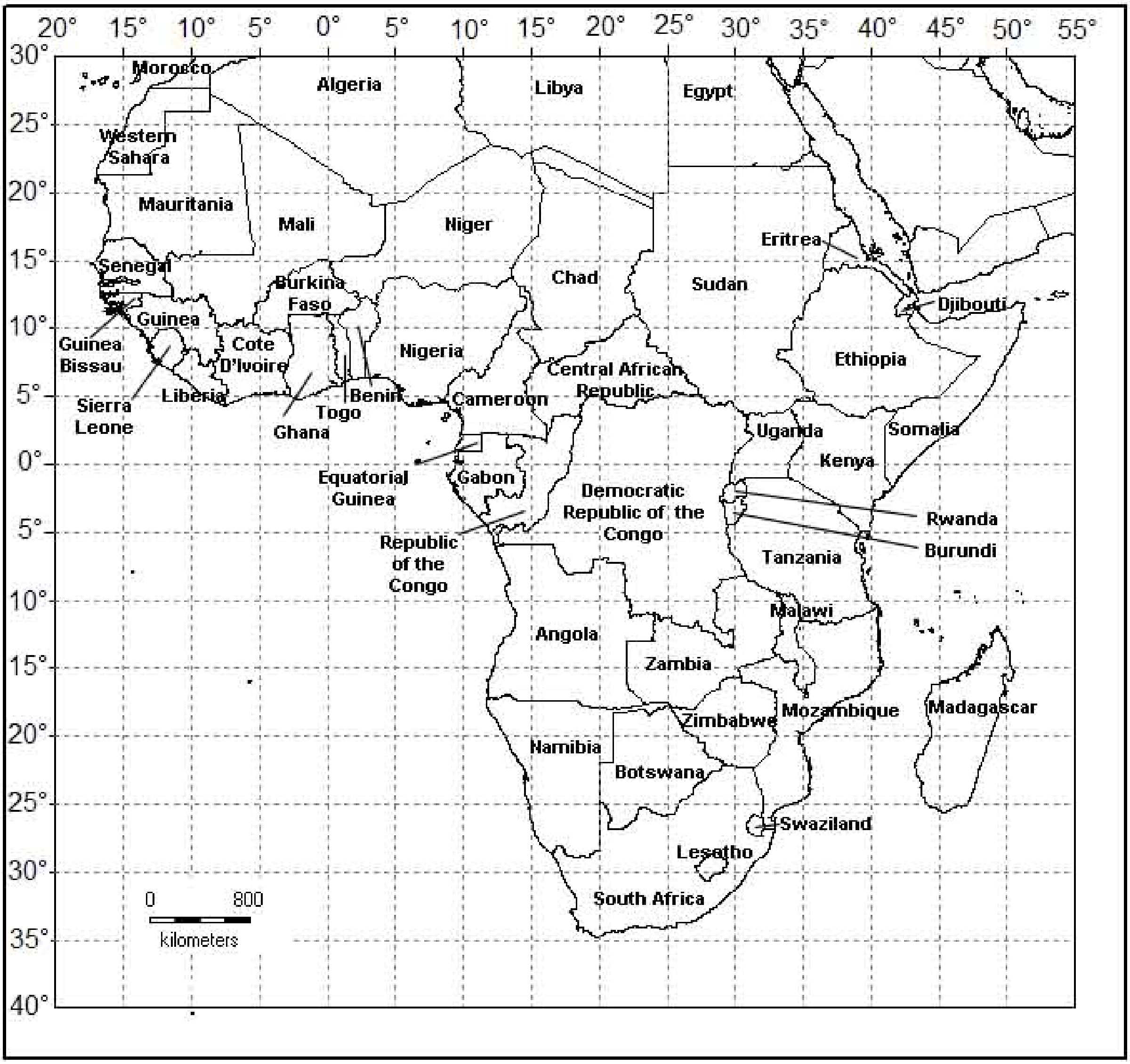


Fig. 2.1. African countries (Map scale 1:45 000 000).

2.3 Leaf epidermal surfaces

Fresh leaves, preserved in 3% phosphate-buffered glutaraldehyde, or leaves collected from herbarium vouchers, rehydrated for 48 hours in 3% phosphate-buffered glutaraldehyde, were used for studying the epidermal surface with a scanning electron microscope (SEM). These leaf samples were cut into 5 x 5 mm pieces and dehydrated in an alcohol series. The dehydrated leaf samples were critical point dried, mounted on stubs with epoxy glue and painted at the corners with silver paint to improve conductivity. The samples were then sputter coated with gold and studied with the Jeol Winsem 6400 or Shimadzu Superscan SSX-550 scanning electron microscope at 10 kV and a working distance of 17 mm. Description of leaf surface morphology follows the terminology of Wilkinson (1979).

2.4 Seed coat surfaces

Dry seeds, from mature fruit on herbarium specimens, were mounted on stubs with epoxy glue and the tips painted with silver. These seeds were sputter coated and photographed using a Jeol Winsem 6400 scanning electron microscope at 10 kV and a working distance of 25 mm. Seed coat surface description follows the terminology of Barthlott (1981) and Boesewinkel and Bouman (1984).

2.5 Floral morphology and anatomy

SEM studies were carried out on fresh flowers preserved in 3% phosphate-buffered glutaraldehyde or flowers collected from herbarium vouchers, rehydrated in 3% phosphate-buffered glutaraldehyde for 48 hours and dissected. The dissected flowers were dehydrated in an alcohol series and critical point dried. Dried specimens were mounted on stubs with epoxy glue, painted at the corners with silver paint and sputter coated. These specimens were then examined and photographed using a Jeol Winsem 6400 scanning electron microscope at 10 kV and a working distance of 25 mm.

Floral sections were prepared by fixing flowers in 3% phosphate-buffered glutaraldehyde, after which they were postfixed in 2% osmium tetroxide, dehydrated in an alcohol series and embedded in Spurr’s low-viscosity resin. Sections were made using a LKB Ultrotome III microtome and glass knives. Sections (3–5 µm) were affixed to microscope slides by heating at 100°C until the water evaporated, and stained for three minutes with 1% toluidine blue in 1% borax. Sections were rinsed with distilled water, and air dried before the cover slips were mounted, where after they were photographed with an Olympus AX70 photomicroscope.

For investigation with a stereomicroscope, flower samples were collected from herbarium vouchers and rehydrated by heating in a diluted soapy solution. The flowers were dissected and mounted on specimen cards using herbarium glue. Translators were removed from flowers and mounted separately on specimen cards. These samples were studied and floral parts measured using a Nikon SMZ645 stereomicroscope.

2.6 Micromorphology of pollen and translators

Fresh flowers, preserved in 3% phosphate-buffered glutaraldehyde, or flowers collected from herbarium vouchers, rehydrated in 3% phosphate-buffered glutaraldehyde for 48 hours, were used to obtain pollen and translators.

In order to study pollen wall ultrastructure anthers were postfixed in 2% osmium tetroxide, dehydrated in an alcohol series and embedded in Spurr’s low-viscosity resin. Sections were cut using a LKB Ultrotome III microtome and glass knives, stained with uranyl acetate followed by lead citrate, and examined with a Philips CM 100 transmission electron microscope (TEM) at 60 kV.

For scanning electron microscopy (SEM) pollen was removed from the thecae in 100% alcohol and the rest of the anther material discarded. Pollen was washed into centrifuge tubes with glacial acetic acid and prepared according to the acetolysis method of Erdtman (1960) and Hesse and Waha (1989). The acetolysed pollen was prepared according to the method of Reitsma (1969) by rinsing in acetic acid, washing twice with water and once in alcohol, before being mounted on stubs, air-dried and sputter coated. The pollen samples were studied and photographed using a Jeol Winsem 6400 or Shimadzu Superscan SSX-550 scanning electron microscope at 10 kV and a working distance of 17 mm.

The remainder of the acetolysed pollen material was mounted in glycerine jelly and sealed with paraffin wax for light microscopy studies. Samples were examined with an Olympus AX70 photo-microscope. Translators were mounted on stubs using double sided tape and sputter coated, then photographed with the Jeol Winsem 6400 or Shimadzu Superscan SSX-550 scanning electron microscope at 10 kV and a working distance of 17 mm.

2.7 Molecular sequencing and phylogenetic analysis

2.7.1 Sampling

Since the Periplocoideae were found to be nested within the Apocynoideae (Livschultz et al., 2007), with the Rauvolfioideae occupying a basal position relative to the Apocynoideae, sequences of *Forsteronia leptocarpa* A.DC. (Apocynoideae) and *Rhabdadenia biflora* Müll. Arg. (Apocynoideae) were downloaded from GenBank and, together with sequences obtained from *Apocynum venetum* A.DC., *Nerium oleander* L. (Apocynoideae) and *Rhazya stricta* Decne. of the Rauvolfioideae, were used as outgroups from outside the Periplocoideae. From within the Periplocoideae 42 species from outside *Cryptolepis*, including *Parquetina calophylla* (Baill.) Venter and *P. nigrescens* (Afzel.) Bullock, the two sisters of *Cryptolepis* (Ionta and Judd, 2007), were chosen as outgroups.

For the ingroup 22 species of *Cryptolepis* were included, represented by 38 accessions. Voucher information for all taxa sampled and all sequences obtained from GenBank is given in Appendix 2. Nine *Cryptolepis* species, namely *C. africana* (Kenya), *C. gillettii* (Somalia), *C. gossweileri* (Angola), *C. grandiflora* (India), *C. ibayana* (Kenya and Tanzania), *C. microphylla* (Angola, DRC and CAR), *C. orbicularis* (Somalia), *C. thulinii* (Somalia) and *C. villosa* (Tanzania), were excluded because DNA could not be extracted from the available material.

Several authors have shown that increased taxon sampling for phylogenetic analysis results in increased accuracy in phylogenetic representation of evolutionary events through reducing artefacts such as long-branch attraction (LBA) and node-density effect (NDE) (Heath et al., 2008; Pollock et al., 2002; Rannala et al., 1998). Poe (1998) has shown that taxon sampling is not a problem for small clades of closely-related taxa while Yang and Goldman (1997) and Hillis (1998) have suggested that the percentage of taxa sampled from the taxonomic group of interest is of more importance than the total number of taxa sampled. Since this analysis includes 70% of known *Cryptolepis* species, the missing taxa are not expected to have an adverse effect on the accuracy of the phylogeny obtained. In addition, sampling of *Cryptolepis* species is geographically unbiased since the missing species represent all geographical regions where this genus is found and no region is not represented. At least 50% of species from each geographical region was included in the sample.

2.7.2 DNA extraction, amplification and sequencing

Leaf tissue was obtained from herbarium specimens or from field-collected specimens dried in silica. DNA was isolated using a modification of the CTAB extraction protocol (Doyle and Doyle, 1987). All primer sequences used for PCR amplification and sequencing are given in Table 2.2.

The ITS region (Fig 2.2.) was amplified by using the primers ITS-A and ITS-B as described by Blattner (1999). In old or poorly preserved herbarium specimens where amplification proved to be problematic, ITS-1 and ITS-2 with 5.8S were amplified separately using internal primer combinations ITS-A with ITS-C and ITS-B with ITS-D (Blattner, 1999).
For amplification of the *trnT-L* region (Fig 2.3. A) primer B of Taberlet et al. (1991) was used in combination with primer trnT2F of Shaw et al. (2005). The *trnL-F* region (Fig. 2.3. A) was amplified by using the primers C and F of Taberlet et al. (1991). For poorly preserved herbarium samples the *trnL-F* region was amplified by using the primers E and F and the *trnL* intron by using the primers C and D of Taberlet et al. (1991). The *trnD-T* intergenic spacer (Fig 2.3. B) was amplified using the primers trnD and trnT (Demesure et al., 1995).

PCR amplification was performed in 39.02 µl volumes consisting of 27.68 µl sterilized PCR water, 3.6 µl NH_4 buffer, 0.72 µl $MgCl_2$ of 50 mM, 1.44 µl dNTP of 2.5 mM, 1.19 µl of each primer at 10 mM strength and 0.2 µl Biotaq DNA Polymerase, with 3 µl of diluted (1:5) unquantified DNA template. Thermocycling was carried out on a Hybaid Sprint set to the following thermal conditions: initial denaturation at 94°C for 2 mins., followed by 30 cycles of 94°C for 30 seconds, annealing at 52°C for 1 min., extention at 72°C for 2 mins., and a final polymerisation step of 72°C for 7 mins. The above-mentioned PCR protocol was adapted with a lower annealing temperature of 51°C for amplification of *trnD-T*. PCR products were purified and sequenced by MACROGEN Inc. using the same primers as were used in the PCR reactions.

Sequences were manually aligned and edited using GeneDoc version 2.7.000 (Nicholas and Nicholas, 1997). Ambiguous positions were coded according to the IUPAC ambiguity symbols and gaps were coded according to the simple coding method of Simmons and Ochoterena (2000).

Table 2.2. Primer sequences used for PCR amplification and sequencing of DNA extracted from leaf samples.

Primers for ITS-1 and ITS-2 described by Blattner (1999):	
ITS-A	5'-GGAAGGAGAAGTCGTAACAAGG-3'
ITS-B	5'-CTTTTCCTCCGCTTATTGATATG-3'
ITS-C	5'-GCAATTCACACCAAGTATCGC-3'
ITS-D	5'-CTCTCGGCAACGGATATCTCG-3'
Primers for *trnT-F* described by Shaw et al. (2005) and Taberlet et al. (1991):	
trnT2F	5'-CAAATGCGATGCTCTAACCT-3'
trnB	5'-TCTACCGATTTCGCCATATC-3'
trnC	5'-CGAAATCGGTAGACGCTACG-3'
trnD	5'-GGGGATAGAGGGACTTGAAC-3'
trnE	5'-GGTTCAAGTCCCTCTATCCC-3'
trnF	5'-ATTTGAACTGGTGACACGAG-3'
Primers for *trnD-T* described by Demesure et al. (1995):	
trnD	5'-ACCAATTGAAGTACAATCCC-3'
trnT	5'-CTACCACTGAGTTAAAAGGG-3'

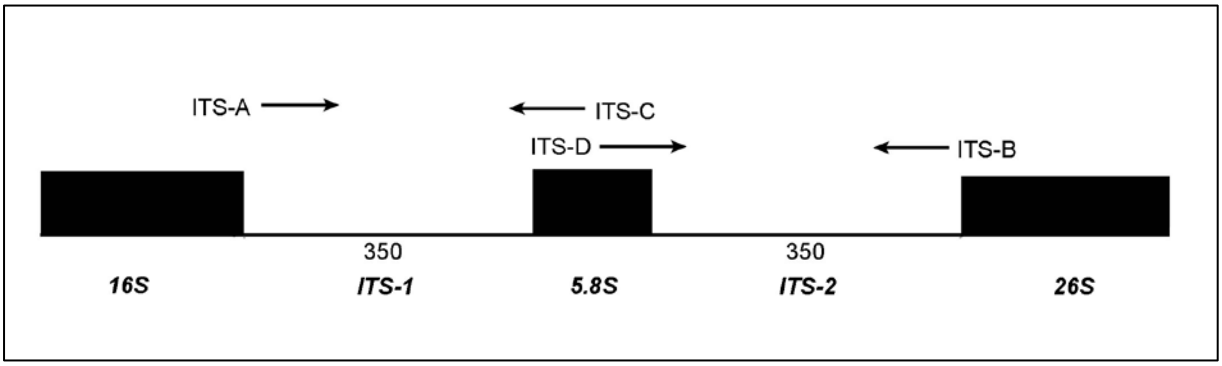


Fig. 2.2. Schematic representation of the ITS-1 and ITS-2 non-coding regions, separated by 5.8S. Gene names are italicized and printed in Bold below while amplification and sequencing primer names are above with arrows indicating 3' ends of the primers. The expected PCR product size is ±700 bp with primers ITS-A and ITS-B; ±350 bp with primers ITS-A and ITS-C; ±350 bp with primers ITS-B and ITS-D. (Adapted from Blattner (1999)).

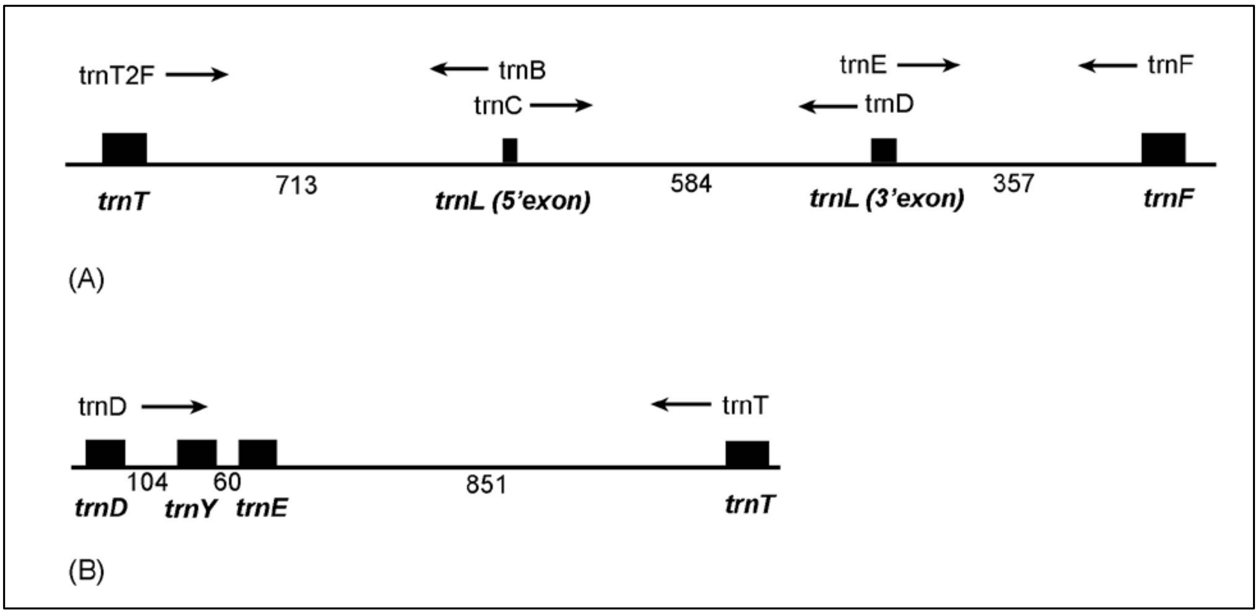


Fig. 2.3. Schematic representation of the non-coding regions of cpDNA used in this study: (A) *trnT-F,* (B) *trnD-T.* Gene names are italicized and printed in Bold below while amplification and sequencing primer names are above with arrows indicating 3' ends of the primers. The expected PCR product size of each non-coding region is cantered below each intergenic spacer and intron. (Adapted from Taberlet et al. (1991) and Shaw et al. (2005)).

2.7.3 Phylogenetic analyses

Analyses were carried out on three sets of data: (1) nuclear data, (2) combined chloroplast data and (3) 'total data', i.e. nuclear and combined chloroplast data. Since no strongly supported conflicts between the data were detected, no further tests of congruence were performed before combining the data, since such tests can fail and also cannot be considered proof of incongruence (Yoder et al., 2001).

Parsimony analyses of all three data sets were carried out with PAUP* version 4.0b4 (Swofford, 2000). For each analysis characters were equally weighted and states were unordered. Each data matrix was analysed using 1000 replicates of random taxon-addition, TBR branch swapping, with MULPARS on and all character transformations treated as equally likely (Fitch, 1971). At most two trees were saved on each replicate. All trees found in the initial 1000 replicates were used as starting trees for the second round of TBR branch swapping. Nodal support was evaluated by use of the jackknife (10000 replicates with 36.79% of characters deleted at each replicate, emulate "Jac" resampling, "Fast" stepwise-addition) as implemented in PAUP*. Only groups with jackknife support percentages (JK) > 50 were retained. Clades with JK ≥ 63 are regarded as supported by the data, as they are supported by at least one un-contradicted character (Farris et al., 1996).

Bayesian analyses of all three data sets were carried out with MrBayes Version 3.1.2 (Ronquist and Huelsenbeck, 2003). A total of 2 000 000 trees were sampled from the tree-space with two sets each of four Markov chains running simultaneously (i.e. 8 chains). Every 100th tree was sampled and printed. The first 5000 of these trees were discarded as burnin and the consensus tree was calculated from the remaining 15 001 trees. Posterior probabilities (PP) were calculated from this consensus tree and clades with a value of PP ≥ 95 are regarded as supported by the data (Erixon et al., 2003).

2.6 Format of references

References are given according to the specifications of the South African Journal of Botany, except in the case of literature cited in the protologue of the taxonomic treatment, where the referencing style as described below is used. The list of references is arranged alphabetically and chronologically, making use of a, b, c etc.

if an author published more than one publication during a given year. If the same author has published both on his own and as senior author with others the solo publications are listed first, followed by publications with one co-author. Thereafter publications with more than one co-author are listed. These are not arranged alphabetically, but chronologically to facilitate comparison with references in the text, in which only the name of the first author, followed by et al. and the publication date are given (e.g. Jones et al., 2000). Journal titles are given according to Alkire (2005).

All literature cited in the protologue of the taxonomic treatment is included in the reference list. For the first valid publication of a taxon name the reference includes the author abbreviation, followed by the full journal title, volume number, page number and date of publication. For all other literature only the author abbreviation, page number and date of publication are cited in the protologue.

CHAPTER 3

DIAGNOSTICALLY IMPORTANT CHARACTERISTICS AND TERMINOLOGY

Cryptolepis, the second largest genus in the Periplocoideae, comprises numerous morphologically similar species. Many species have small flowers in which the floral structures are difficult to interpret in the field. In addition, the complex flowers of the Apocynaceae *sensu lato* has led to the development of a large number of specialized terms, many of which are conflicting or synonymous (Liede and Kunze, 1993; Endress and Bruyns 2000; Kunze, 2005). The aim of this chapter is to clarify the terminology and structural features of the vegetative and floral diagnostic characters used in the delimitation of *Cryptolepis* and its species.

3.1 Growth form

Growth form is an important diagnostic character used to delimit morphologically similar groups in *Cryptolepis*. Most of the species growing in forest or woodland in tropical and sub-tropical regions are climbers with twining stems which are dependent on other plants for support. In more open habitats in savannah, grassland, semi-desert and desert *Cryptolepis* species may occur as dwarf shrubs with occasional twining stems. However, erect, multi-stemmed shrubs and dwarf-shrubs without twining branches are more common growth forms of *Cryptolepis* in open, arid habitats and two of the *Cryptolepis* species endemic to Socotra are trees, one of which also occasionally grows as a large, multi-stemmed shrub.

3.2 Leaf venation

Venation constitutes a combination of various characters, such as venation type, orders of venation, angle of divergence between veins, intramarginal veins, intersecondary veins, pattern of tertiary veins, structure of higher order venation, veinlets and areole development. Many of these characters are informative in differentiating the species of *Cryptolepis*. The following definitions of certain venation characteristics are quoted from Hickey (1979).

3.2.1 Venation type

Venation in *Cryptolepis* is either hyphodromous or camptodromous (Fig. 3.1.). Hyphodromous venation is the venation pattern in which all but the primary vein is absent, rudimentary or concealed within a coriaceous or fleshy mesophyll. Camptodromous venation is that in which secondary veins do not terminate at the leaf margin, and includes brochidodromous, cladodromous, eucamptodromous and reticulodromous venation. Brochidodromous venation is the most common venation type in *Cryptolepis* and is defined by the secondary veins being joined together in a series of prominent arches. Eucamptodromous venation, where the secondary veins are upturned and gradually diminish apically inside the margin, connected to the superadjacent secondary veins by a series of cross veins, is less common in *Cryptolepis* (Fig. 3.1.).

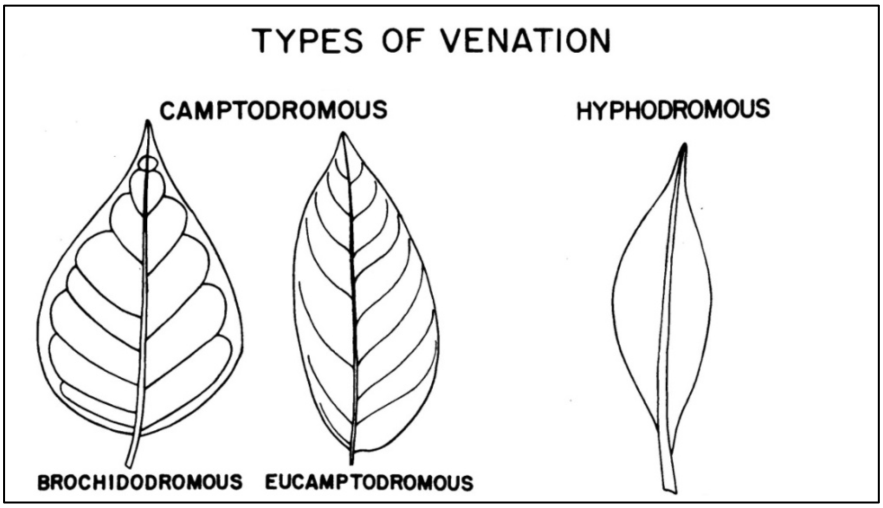


Fig. 3.1. Venation types found in *Cryptolepis*. (Adapted from Hickey (1979)).

3.2.2 Orders of venation

Veins are differentiated into a series of size classes. In *Cryptolepis* the primary veins (1°) are the thickest veins of the leaf, here referred to as the midrib. Secondary veins (2°) are the next smaller size class that arise from the midrib (Fig. 3.2. A). According to Hickey (1979) intersecondary veins have a "thickness intermediate between that of the second and third order veins, generally originating from the medial primary vein, interspersed among the secondary veins, and having a course more or less parallel to them. Two types of intersecondary veins may be discerned: simple intersecondary which consist of a single vein segment" (Fig. 3.2. A(e)), found in *C. dubia* and *C. cryptolepioides,* "and composite intersecondary which consist of coalesced tertiary vein segments for over 50% of its length" (Fig. 3.2. I), found in *C. africana, C. apiculata, C. ibayana, C. socotrana* and *C. villosa*.

Hickey (1979) states that "An intramarginal vein is a vein closely paralleling the leaf margins and into which the secondary veins merge. This may be formed as a result of straightening of the extramedial brochidodromous secondary arch segments to form what appears to be an independent vein" (Fig. 3.2. B). Such intramarginal veins are often seen in *Cryptolepis* species with coriaceous leaves and prominent brochidodromous venation such as *C. ibayana* and *C. oblongifolia.*

Tertiary veins (3°) are the next smaller sized branches of the secondary veins and those branches of equal thickness from the primaries. Tertiary veins may be reticulate, anastomosing with other tertiary veins or with secondary veins. In *Cryptolepis* random reticulate tertiary veins are the most common arrangement, with angles of anastomoses varying (Fig. 3.2. J). Tertiary veins may also be orthogonal reticulate, with angles of anastomoses at right angles (Fig. 3.2. L). Arrangement of the tertiary veins is termed percurrent if the tertiaries from opposite secondaries join (Fig. 3.2. H). The variation in orientation of percurrent tertiary veins in relation to the main vein is shown in Fig. 3.2. M. Ramified tertiary veins, which branch into higher orders without rejoining the secondary veins (Fig. 3.2. F, G, K) are not found in *Cryptolepis.*

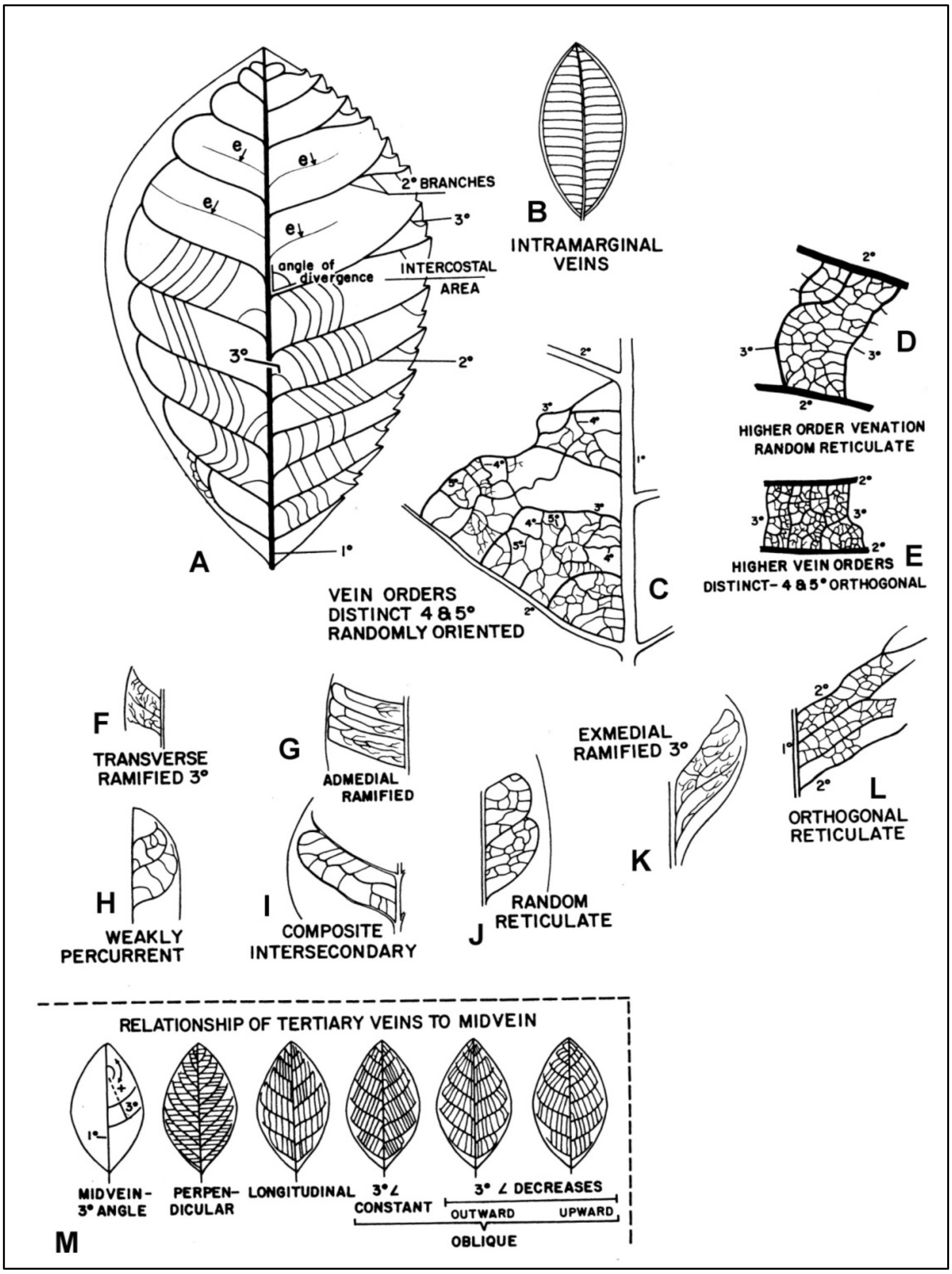


Fig. 3.2. Leaf architectural features: orders of venation and vein configuration. (Adapted from Hickey (1979)).

Veinlets are the freely ending ultimate veins of the leaf and veins of the same order which occasionally cross areoles to become connected distally. Areoles are the smallest areas of the leaf tissue which are delimited by veins of any order, except freely ending veinlets (Fig. 3.3.). Veinlets may cross, or branch into areoles, but do not divide them into smaller units. Areole development is an important diagnostic character at species level in *Cryptolepis*. Figure 3.3. shows the four main types of areole development. Where all areoles on the leaf surface are of more or less the same size and shape, the areole development is referred to as 'perfect'.

Areole development is known as 'imperfect' when areoles are irregular in shape and slightly variable in size. Where areoles are not completely closed and very irregular in shape and size areole development is incomplete and in hyphodromous or succulent leaves areoleation is completely lacking (Hickey, 1979).

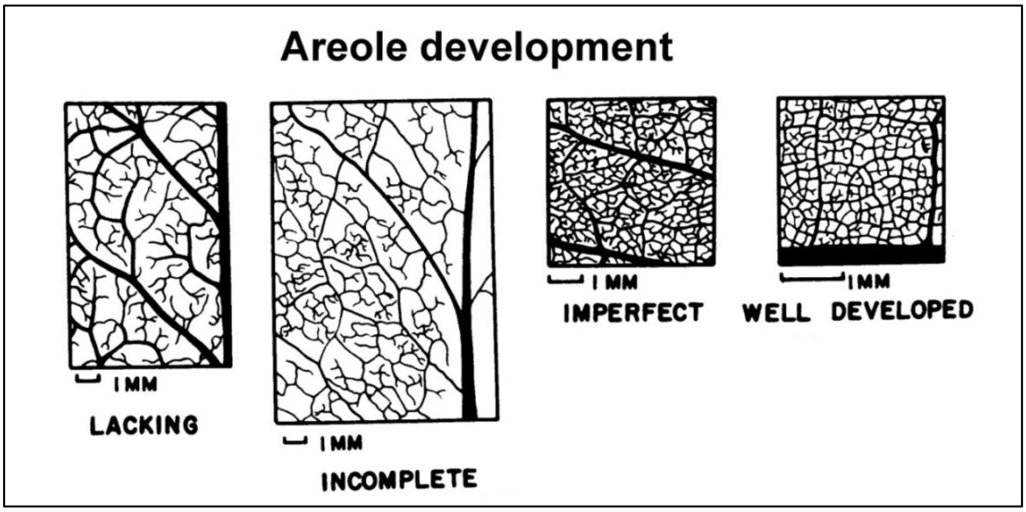


Fig. 3.3. Leaf architectural features: areole development. (Adapted from Hickey (1979)).

3.3 Micromorphology of leaf epidermal surfaces

Leaf epidermal characteristics form an important part of the plant's micromorphology. These characteristics are under strong gene control and are influenced little by environmental factors (Barthlott, 1981). For this reason they are reliable in taxonomic studies, but different epidermal characteristics are of value at different taxonomic levels. Barthlott (1981) regarded cuticular striation, epicuticular wax and cell shape as mainly useful at lower taxonomic levels, while secondary wall thickenings are used in determining relationships at higher taxonomic levels.

Leaf micromorphological characters with diagnostic value include primary sculpture of epidermal cells or cell shape, secondary sculpture which refers to the relief of the cell wall and tertiary structure, which refers to epicuticular secretions (Barthlott, 1981). To this must be added stomatal characteristics which have systematic value in several families (Wilkinson, 1979).

Primary sculpture of epidermal cells is a combination of several characteristics. These include the cell outline, anticlinal wall patterns, relief of cell boundaries and curvature of periclinal walls (Barthlott, 1981). Secondary sculpture can be caused by striation, filigree folding, reticulate folding, ridges and wrinkles. Striation alone is also a combination of various characteristics which include length, orientation, pattern and distribution of striations (Wilkinson, 1979). Tertiary sculpture includes a great variety of structures, for instance epicuticular secretions such as waxes (Fig. 3.4. C), some of which are family or genus specific and are therefore of great taxonomic and systematic value (Barthlott, 1981). Stomatal characteristics include the distribution and arrangement of stomata, shape and arrangement of subsidiary cells, shape of the guard cells and stomatal ledge and stomatal size (Wilkinson, 1979).

In *Cryptolepis* a combination of leaf micromorphological characters may be used to identify groups of similar species, but accurate species identification, based exclusively on leaf micromorphology is only rarely possible where leaves have unique characteristics such as the finger-shaped papillae of *C. intricata* (Fig. 4.3.15.4. D–F). Globular micropapillae on the abaxial epidermal surface are characteristic of *C. dubia* (Fig. 4.3.4.3. D–F), *C. delagoensis* (Fig. 4.3.8.3. D–F), *C. eburnea* (Fig. 4.3.9.3. D–F), *C. microphylla* (Fig. 4.3.17.3. D–F) and *C. villosa* (Fig. 4.3.29.3. E–F). Trichome characteristics may also be of value in differentiating species, such as the broadly ovate trichomes of *C. arbuscula* (Fig. 4.3.3.3. A–F), short, triangular trichomes of *C. orbicularis* (Fig. 4.3.22.3. C, F) and crispate trichomes of *C. thulinii* (Fig. 4.3.28.3. B, E).

A combination of striation patterns (Fig. 3.4. A–B) and the presence and distribution of wax platelets (Fig. 3.4. C) may also be of value in differentiating certain species. In *Cryptolepis* the leaves may be hypostomatic or amphistomatic, but in the former a few stomata may be situated directly next to the main vein on the adaxial leaf surface. Stomatal structure is relatively constant in the genus, with paracytic stomata where guard cells are covered by a broad (Fig. 3.4. A) or narrow (Fig. 3.4. B–C) stomatal ledge. The cuticle covering the guard cells may be smooth (Fig. 3.4. A) to slightly or heavily striated (Fig. 3.4. B), with striations orientated perpendicular or parallel to, or radiating from, the stomatal pore. *Cryptolepis stefaninii* is distinct from other *Cryptolepis species* in having subsidiary cells covered by a heavily striated, raised cuticle, which obscures the guard cells and stomatal ledge (Fig. 3.4. D). In *C. macrophylla* and *C. socotorana* the stomata are deeply sunken with narrow stomatal ledges (Fig. 3.4. C). Leaf micromorphology is of significant taxonomic value in distinguishing species of *Cryptolepis.*

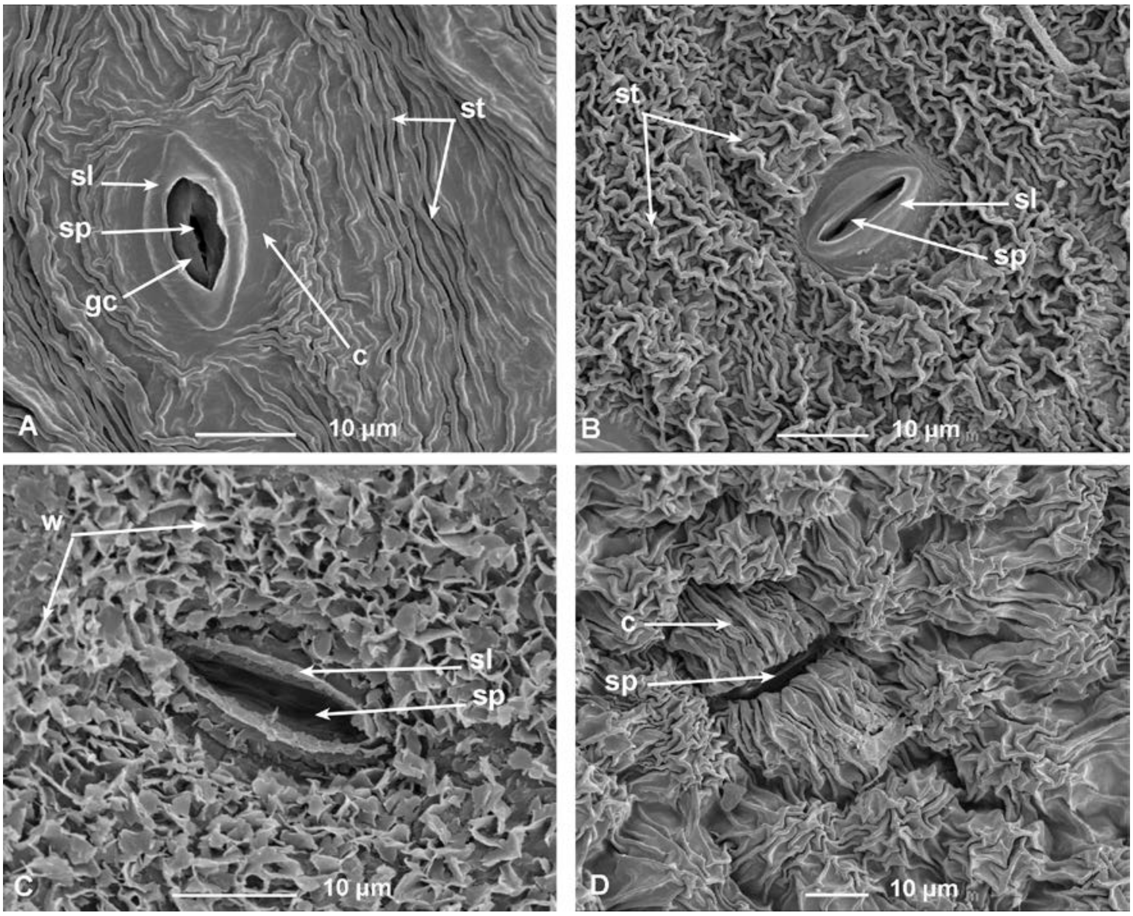


Fig. 3.4. Stomatal characteristics of *Cryptolepis:* (A) leaf epidermis of *C. migiurtina* with broad stomatal ledge and guard cells covered by a smooth cuticle. Cuticular striations straight and parallel, (B) leaf epidermis of *C. sinensis* with narrow stomatal ledge, cuticular striations wavy and randomly orientated, (C) leaf epidermis of *C. socotrana* with sunken stoma and a narrow stomatal ledge, epidermis covered by wax platelets, (D) leaf epidermis of *C. stefaninii* with stomatal pore and stomatal ledge obscured by raised, heavily striated cuticle covering the guard cells. Legend: (c) = cuticle covering guard cells, (gc) = guard cells, (sl) = stomatal ledge, (sp) = stomatal pore, (st) = cuticular striations, (w) = wax platelets. Magnification: A = x2000; B = x1800; C = x2500; D = x650. Specimens: (A) *Lavranos & Carter 24945* (K); (B) *C.h. 400* (K); (C) *Popov GP/So/275* (BM); (D) *Gillett 23935* (K).

3.4 The inflorescence

Inflorescence morphology, though highly variable in different plant families, is usually the result of modification or progression of a single basal type (Troll, 1959, 1969, 1972; Weberling, 1999). This variation and progression in inflorescence morphology may be phylogenetically informative in certain taxa but should be used with caution and in combination with other phylogenetically informative characters (Weberling, 1999). Liede and Weberling (1995) proposed a system of classification and evolutionary interpretation of the inflorescences of the Asclepiadaceae *sensu lato* (Periplocoideae, Secamonoideae, Asclepiadoideae) based on the typology developed by Troll (1959, 1969, 1972).

According to Liede and Weberling (1995) all inflorescences in the Apocynaceae *sensu lato* are primarily monotelic, terminal thyrsoidal systems. In the majority of the Periplocoideae, the apical bud of the main axis or apical buds of the main and lateral axes develop into inflorescences. A similar developmental pattern is found in the Apocynoideae and Secamonoideae and this inflorescence type is considered to be the primitive condition in the family (Liede and Weberling, 1995).

The extra-axillary inflorescences of the Asclepiadoideae are considered to be a synapomorphy for that subfamily. This inflorescence type develops from a terminal inflorescence which is displaced laterally by a vegetatively developing axillary bud, which takes over longitudinal growth of the stem system (Liede and Weberling, 1995). This type of inflorescence was, however, observed in live specimens of *Cryptolepis cryptolepioides* and *C. oblongifolia,* where terminal inflorescences are also displaced into lateral positions by the development of an axillary bud. Extra-axillary inflorescences are consequently not exclusive to the Asclepiadoideae.

In *Cryptolepis* inflorescences are usually cymes composed either of monochasia or dichasia with branches terminating in monochasia. In *C. cryptolepioides* and *C. oblongifolia*, both with dichasial inflorescences, the primary (apical) bud of each inflorescence aborts before opening. This developmental pattern was also reported for *Cynanchum pachycaulon* Choux and is considered to be a derived character state (Liede and Weberling, 1995).

Klackenberg (1999) showed that a variety of inflorescence types may develop in *Pentopetia* and *Ischnolepis* Jum. & H.Perrier due to variation in the extent of suppression of internodes. This variation was also observed in *Cryptolepis,* where little or no suppression of internodes results in lax inflorescences (Fig. 3.5. A), while suppression of the majority of internodes results in compact inflorescences (Fig. 3.5. E). Many intermediate forms may be observed (Fig. 3.5. C). The inflorescences may be robust, with a primary peduncle diameter of ± 2 mm, or slender, with a primary peduncle diameter of ± 1 mm.

The general inflorescence display is further influenced by reduction in flower numbers. In Asclepiadoideae the number of flowers per inflorescence is inversely correlated with floral size (Liede and Weberling, 1995). Though this is true for most *Cryptolepis* species, exceptions occur. *Cryptolepis delagoensis*, for example, has small flowers in few-flowered inflorescences, whereas *C. sinensis* has relatively large flowers in many-flowered inflorescences. Liede and Weberling (1995) propose an evolutionary trend towards reduction in flower number in the Asclepiadiodeae. In *Cryptolepis* extreme cases of such reduction can be observed in *C. decidua* (Fig. 3.5. D)*, C. orbicularis* and *C. intricata,* where the inflorescence is reduced to a single flower which is carried apically on a short lateral shoot. In *Cryptolepis* this reduction is correlated with environmental aridity.

All *Cryptolepis* inflorescences are characterized by paired bracts with colleters at their inner bases at every branching point of the inflorescence. The bracts are of diagnostic value in a number of species, but should always be used in combination with other characters. Bracts may be sparsely or densely arranged, depending on the length of internodes on the peduncles. Bract shape usually ranges from acicular to triangular, but those of *C. sanguinolenta* are unique in being oblanceolate to spatulate. Bract length may also be of diagnostic value in a small number of species, such as *C. macrophylla, C. sanguinolenta* and *C. villosa* where bract length exceeds 2.5 mm, as opposed to bracts shorter than 2 mm in all other *Cryptolepis* species.

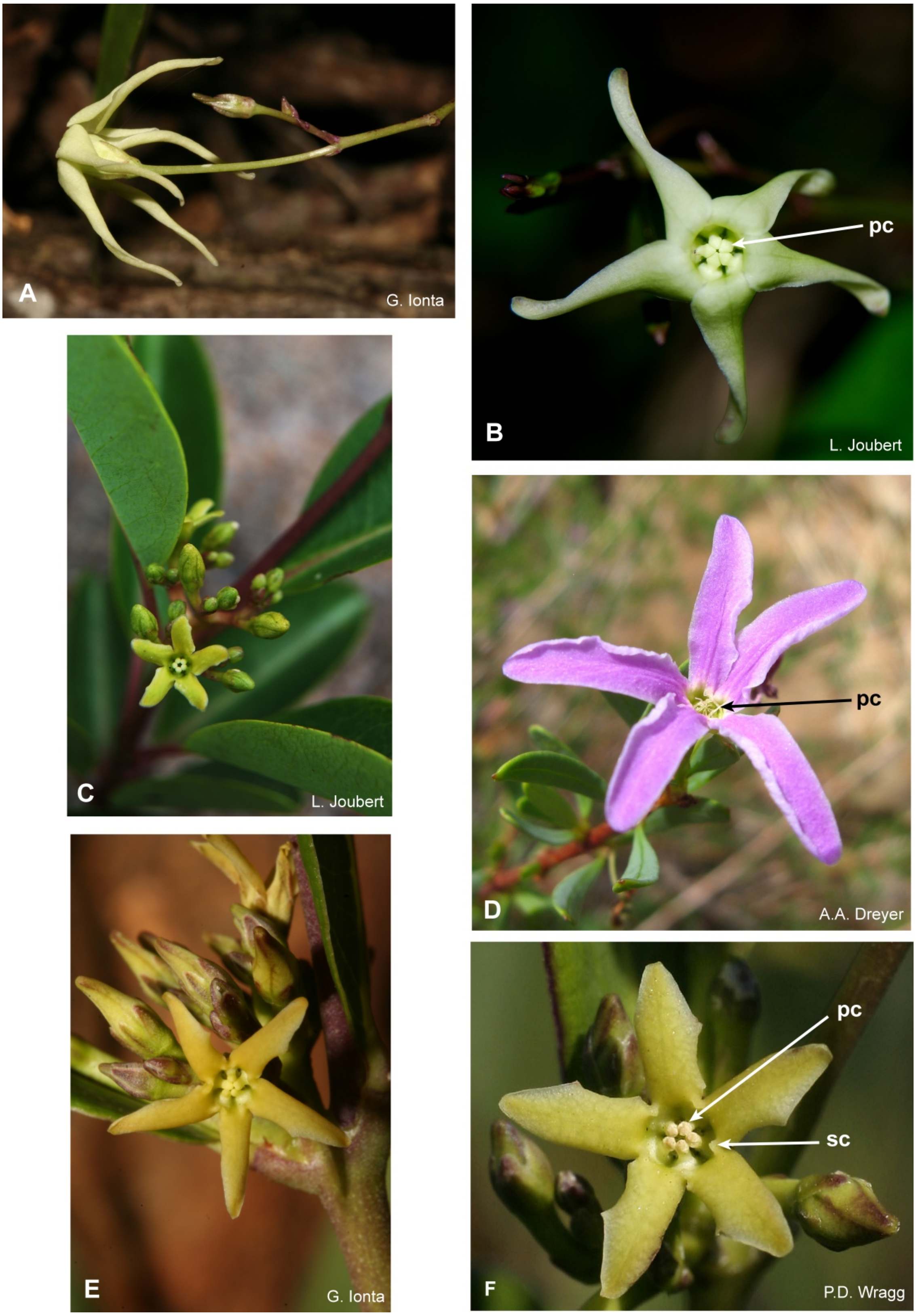


Fig. 3.5. *Cryptolepis* inflorescences and flowers: (A–B) *C. capensis,* (C) *C. cryptolepioides,* (D) *C. decidua,* (E–F) *C. oblongifolia,* Legend: (pc) = primary corona, (sc) = secondary corona.

3.5 Colleters

Colleters are taxonomically important in many Angiosperm families, including the Apocynaceae (Thomas, 1991; Thomas and Dave, 1991). Several types of colleters have been described (Thomas, 1991), but those occurring in the Apocynoideae are usually of the standard type, having a conical or finger-shaped head, carried on a short stalk (Thomas and Dave, 1991). The colleter originates from a primordium, consisting of protodermal and subprotodermal cells which elongate to form the conical head of the colleter.

Anatomically the colleter consists of a central core of parenchyma cells, ensheathed by radially elongated epithelial cells and covered by a thin cuticle (Fig. 3.6. D). Thomas (1991) reports on the presence of laticifers associated with colleters in several species belonging to the Apocynoideae, including *Allamanda cathartica* Schrad.*, A. violaceae* Gardner & Fielding*, Nerium* L., *Plumeria* L. and *Vallaris* Burm.f*.* In *Aganosma* G.Don*, Funtumia* Stapf*, Holarrhena* R.Br.*, Nerium, Strophanthus* DC.*, Vallaris, Wattakaka* Hassk. and *Wrightia* R.Br. colleters are vascularised with vascular tissue arising from the vasculature of the organ on which the colleter is carried. In the Apocynaceae colleters are often associated with simple, unicellular trichomes (Thomas, 1991).

Colleters perform a secretory function with the secretion containing resin, proteins and carbohydrates with different sugars present in the secretion of different genera. No amino acids are found in the secretion and since it is not water soluble, the secretion cannot be regarded as nectar. Thomas (1991) proposes that colleters function in protecting developing meristems. The resinous secretion could deter herbivores and pathogens, but may also limit transpiration from developing meristems and can therefore be considered as a xeromorphic adaptation (Thomas, 1991).

Actively secreting colleters are usually pale-yellow but turn brown once secretion has ended and necrosis sets in. The colleters of the Apocynaceae are borne on interpetiolar ridges, petioles, bracts and sepals and are persistent after secretion has ended as long as the organ to which they are attached remains on the plant (Thomas, 1991).

Characters of calycine colleters have been used in tribal classification of the Apocynaceae (Fallen, 1983; Woodson and Moore, 1938). Woodson and Moore (1938) describe three types of colleter arrangement in Apocynoideae, namely squamellae alternating with calyx lobes and attached to calyx lobe margins singly or in groups, colleters may also be attached opposite the lobes or indefinitely arranged, forming a fringe around the base of the calyx.

In *Cryptolepis* standard type colleters occur in the leaf axils, at the bases of bracts on the inflorescences and at the inner margins of sepal bases. The colleters at the sepal bases may be conical and occur in pairs (Fig. 3.6. A), or ovate with dentate apices, occurring singly (Fig. 3.6. B). It is likely that the single, ovate colleters result from the fusion of a pair of colleters from two adjoining sepal bases. Colleters are often associated with simple, unicellular trichomes and in one of the southern African species, *C. decidua* (Planch. ex Benth.) N.E.Br., the colleters at the sepal bases are obscured by dense tufts of trichomes (Fig. 3.6. C).

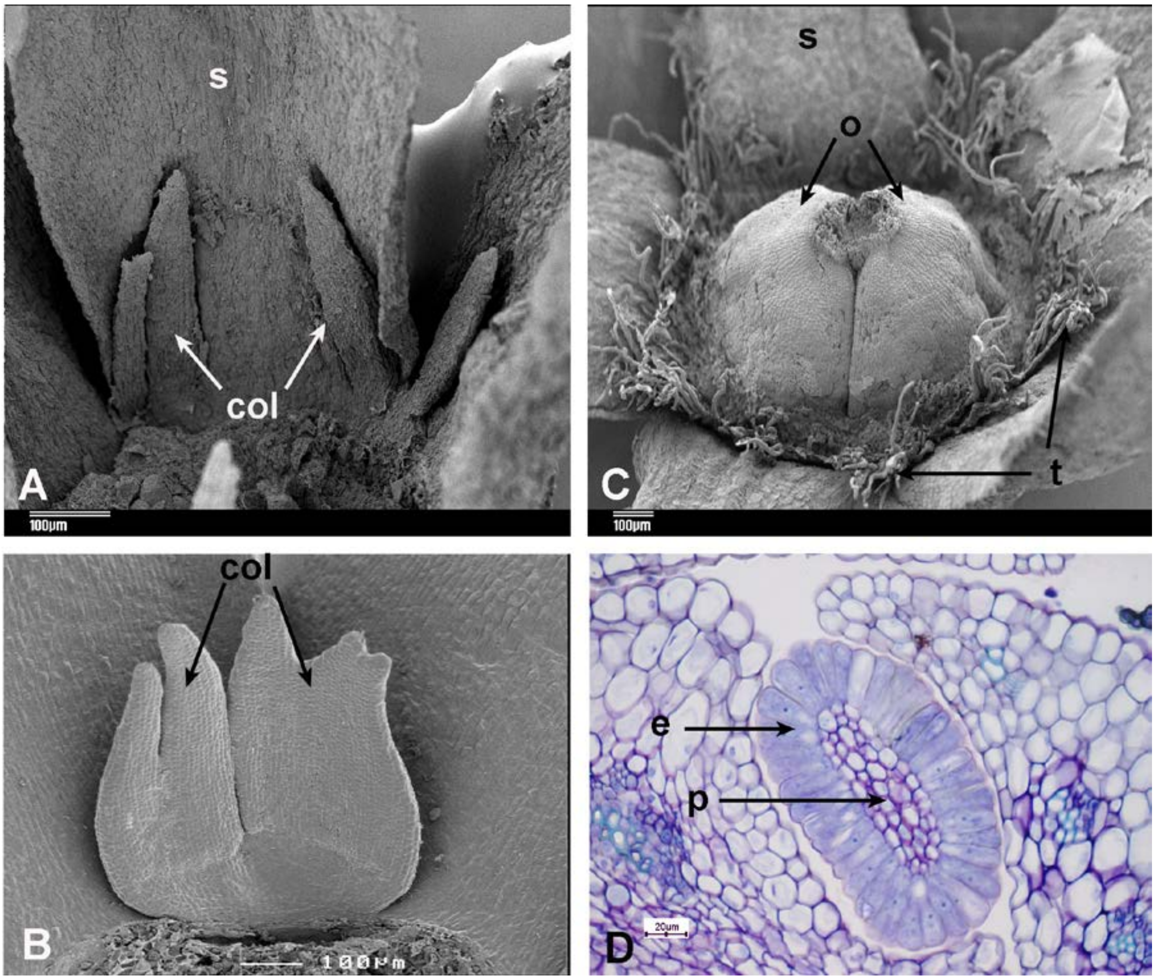


Fig. 3.6. Colleters in *Cryptolepis:* (A) *C. obtusa,* upper surface of sepals showing paired conical colleters at sepal margins, with SEM, (B) *C. capensis,* ovate colleter with dentate apex at sepal bases, with SEM, (C) *C. decidua,* upper surface of sepals showing clusters of trichomes at sepal bases and two apocarpous, semi-inferior ovaries, with SEM, (D) section of colleter in *C. obtusa*, showing central core of parenchyma cells, ensheathed by radially elongated epithelial cells, with light microscope. Legend: (col) = colleters, (e) = epithelial cells, (o) = ovaries, (p) = parenchyma cells, (s) = sepals, (t) = unicellular trichomes. Scale bars: (A–C) = 100 µm; (D) = 20 µm. Specimens: (A, D) *Venter 9299* (BLFU); (B) *Joubert 31* (BLFU); (C) *Verhoeven 165* (BLFU).

3.6 Terminology and structure of the flower

Flowers provide a large number of characters which are informative in the classification of the Apocynaceae at subfamilial, tribal and generic level. The flowers also provide many characters which are important in differentiating among the species. In the Apocynaceae, floral structures have become highly modified and diversified to attract and guide pollinators to the specialized reproductive structures (Fishbein, 2001). Consequently authors have suggested numerous specialized terms for describing the diversity of structures in the Apocynaceous flower. The large number and variety of terms and uncertainty about homology of floral structures (Fishbein, 2001; Liede and Kunze, 1993) have created much confusion in interpretation and description of the apocynoid flower and Endress and Bruyns (2000) stress the risk associated with using a single character for classification, in particular where strong selective pressure influences the structure or appearance of such a character. Meve and Liede (2004) and Venter (2009b) also show that floral morphology may not give an accurate indication of relationships within the Periplocoideae.

Recently, several authors have attempted to simplify the descriptive terminology and other authors have undertaken ontogenetic studies in order to determine the origin and homology of various floral structures in the family (Endress and Bruyns, 2000; Kunze, 1990; 2005; Liede and Kunze, 1993; Meve and Liede, 2004; Nilsson et al., 1993; Nishino, 1982; Venter and Verhoeven, 2001). In this section the development and structure of the Apocynaceous flower will be briefly discussed and the structure of the *Cryptolepis* flower will be placed in its context with the floral structures found in the rest of the Periplocoideae. The terminology used in the genus and species descriptions will also be elucidated.

Cryptolepis flowers exhibit the typical structure of Apocynaceae flowers in being pentamerous, actinomorphic and bisexual (Fig. 3.7). The corolla consists of a tube and lobes, which are dextrorsely contorted (Fig. 3.8. A) in the Apocynoideae and Periplocoideae, but sinistrorsely contorted in Rauvolfioideae (Endress and Bruyns, 2000). In *Cryptolepis* the corolla lobes are usually longer than the corolla tube, except in *C. eburnea,* where the tube is considerably longer than the lobes. In the Apocynaceae the corolla has developed a number of modifications which are diagnostic for the various subfamilies and genera (Endress and Bruyns, 2000).

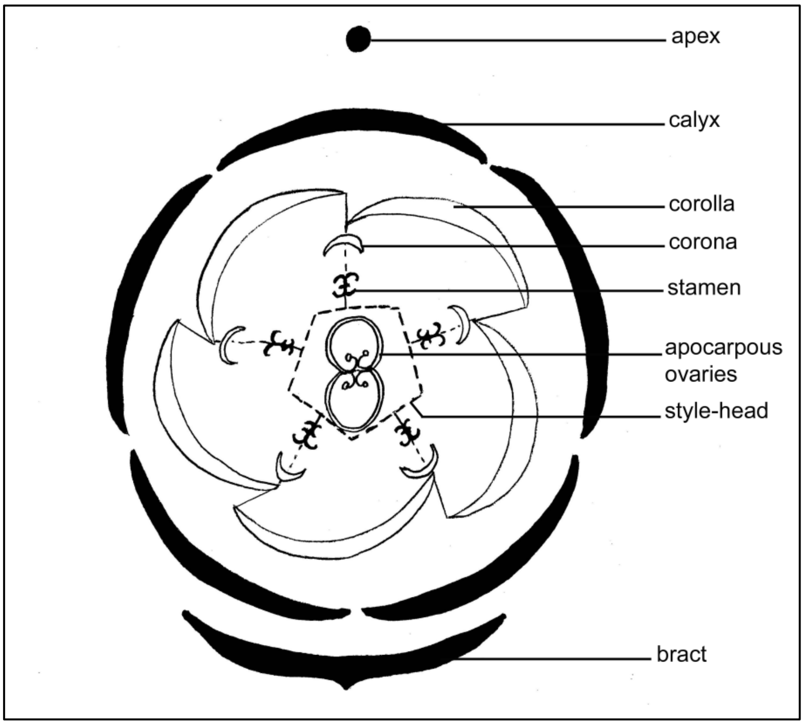


Fig. 3.7. Floral diagram of *Cryptolepis*. (Symbols following De Craene (2010)).

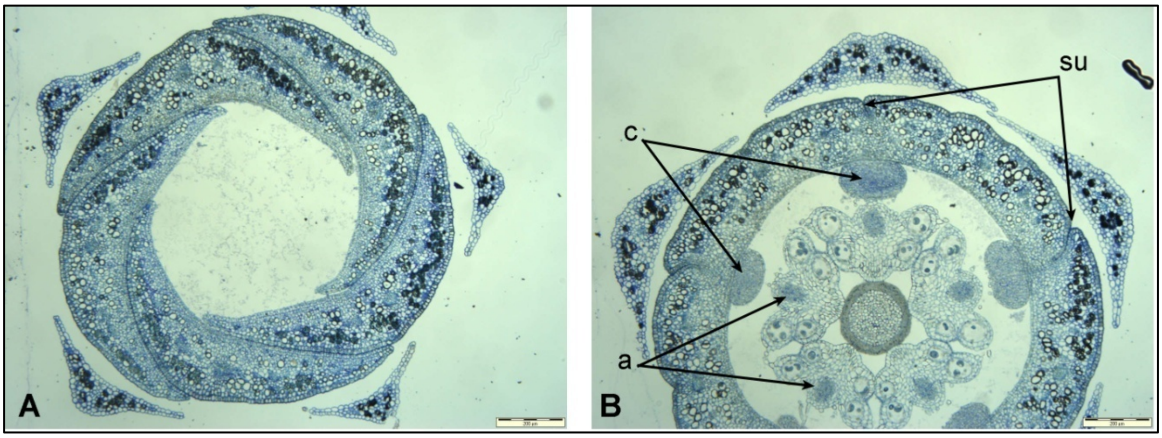


Fig. 3.8. Light micrographs of cross section of *Cryptolepis oblongifolia* bud: (A) dextrorsely contorted corolla lobes, (B) upper corolla tube, formed by postgenital fusion of corolla lobes, showing corona lobes and anthers around style-head. Legend: (a) = anthers; (c) = primary corona lobes; (su) = suture left in corolla tube where corolla lobes are postgenitally fused. Scale bars: (A–B) = 200 µm. Specimen: (A–B) *Joubert 26* (BLFU).

The corolla tube is divided into two sections: The first is referred to as the lower corolla tube (LCT) and is formed by a congenitally fused corolla tube carrying five antisepalous, epipetalous stamens and interstaminal corolline nectaries (Kunze, 1990, 2005; Venter and Verhoeven, 2001) (Fig. 3.9.). The point of insertion of the staminal filaments and nectaries marks the upper limit of the lower corolla tube (Venter and Verhoeven, 2001). In some *Cryptolepis* species the staminal filaments are fused further up the corolla tube, causing the nectaries to appear sunken. In such cases the insertion point of the nectaries should still be regarded as the upper limit of the LCT. The nectaries of *Cryptolepis* as well as *Cryptostegia* R.Br.*, Gymnanthera* R.Br.*, Pentopetia androsaemifolia* Decne.*, Pentopetia albicans* (Jum. & H.Perrier) Klack.*, Raphionacme* and *Telectadium* Baill. are shelf-like and situated inside shallow nectar pockets, as opposed to the lobular nectaries of other periplocoid genera (Venter and Verhoeven, 2001).

The second section of the corolla is known as the upper corolla tube (UCT) and is formed by corolline tissue only (Fig. 3.9.). In most members of the Rauvolfioideae, Apocynoideae, Periplocoideae and Secamonoideae the upper corolla tube arises through postgenital fusion of the corolla lobes, whereas in most genera of the Asclepiadoideae the upper corolla tube is formed through congenital fusion of the margins of petal initials to form an annular meristem which elongates to form the corolla tube. The two basal tribes of the Asclepiadoideae, namely Fockeeae and Marsdenieae, also have an UCT which arises through postgenital fusion (Kunze, 2005).

Postgenital fusion happens early in the development of the Apocynaceous flower. The petal primordia expand laterally and the petal margins fuse behind the insertion of the stamens. In many genera this fusion does not extend fully to the bases of the petal primordia, resulting in a small gap behind the insertion point of the staminal filament. The gap may disappear as the flower matures, but in some genera the gap remains as evidence of the postgenital fusion of the UCT (Endress and Bruyns, 2000; Kunze, 2005; Nishino, 1982). Fusion is often weak on the dorsal side of the petals and results in a suture running down the corolla tube of the adult flower (Nishino, 1982) (Fig 3.8. B).

The fused region may undergo elongation to form an extended corolla tube. The length of the UCT is therefore dependant on the amount of lengthening which takes place after postgenital fusion of the petal margins (Kunze, 2005). Venter and Verhoeven (2001) distinguished between periplocoid genera which have an indistinct UCT and rotate to sub-rotate flowers and genera which have a distinctly campanulate, cylindrical or urceolate UCT. *Cryptolepis* is characterised by a distinct UCT which may be short or long, usually campanulate, but rarely urceolate or salver-form. In *Baseonema* Schltr. & Rendle, *Batesanthus* and *Parquetina nigrescens* the UCT is reflexed, exposing the gynostegium (Venter, 2009b; Venter and Verhoeven, 2001).

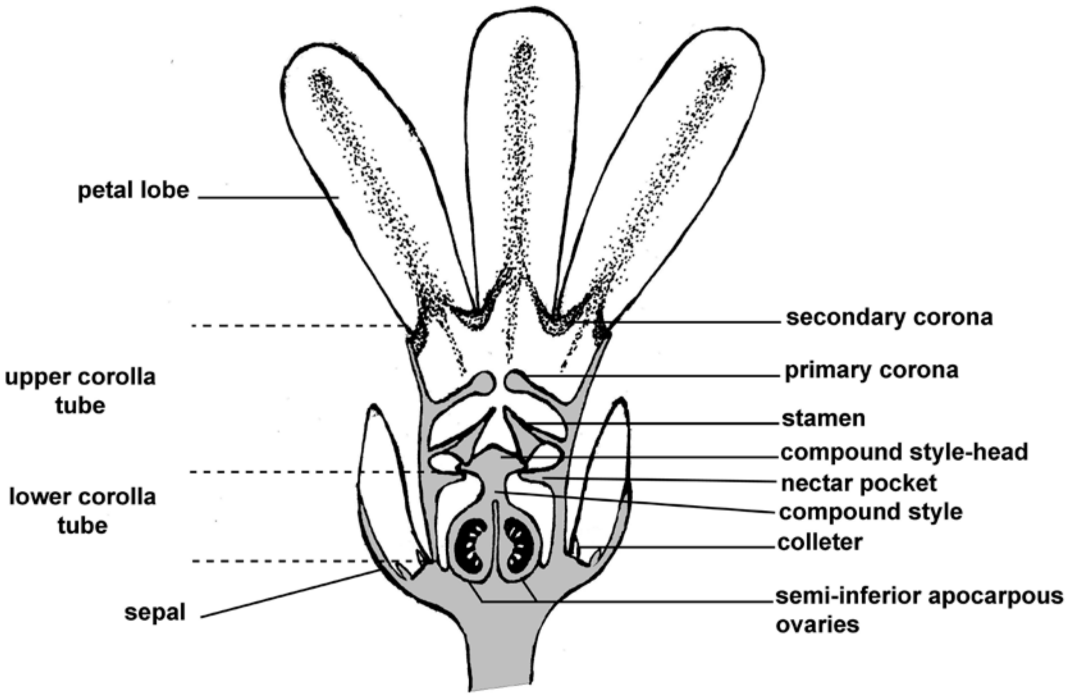


Fig. 3.9. Diagrammatic longitudinal section through a *Cryptolepis* flower.

A very important feature of the Apocynaceous flower is the development of a corona. The corona is regarded as systematically informative and has been studied extensively (Endress and Bruyns, 2000; Fallen, 1986; Fishbein, 2001; Kunze, 1990, 2005; Liede and Kunze, 1993; Schumann, 1895b).

In the Rauvolfioideae, Apocynoideae and Periplocoideae only corolline coronas occur. The Secamonoideae may have corolline and staminal coronas in the same flower and in the Asclepiadoideae only staminal coronas occur, except in the tribe Marsdenieae, where corolline coronas are found (Kunze, 2005). In the Periplocoideae a small number of genera, such as *Baroniella* Costantin & Gallaud, *Baseonema* and *Phyllanthera,* have no corona, but in most genera a simple or highly complex corolline corona is present (Venter and Verhoeven, 2001).

The corolline corona is always located in the UCT and develops from the meristematic zone along the postgenitally fused petal margins (Fig. 3.8. B). However, Kunze (2005) did not regard postgenital fusion of the petal margins as a prerequisite for corolline corona initiation since such coronas may also develop from free petal margins in several species of *Nerium.* The corolline corona may be positioned at various levels in the UCT, depending on the degree of basal lengthening the UCT undergoes after the corona lobes have been initiated (Kunze, 2005).

In some cases, where the UCT does not elongate much after corona initiation, the corona lobes are situated close to the base of the UCT, behind the insertion of the stamens. In such cases staminal filaments may become fused to the bases of the corona lobes (Kunze, 2005), this being termed staminal feet (Endress and Bruyns, 2000). The staminal feet may expand laterally to fuse into a staminal annulus or fuse laterally with the interstaminal nectaries. The staminal feet may expand to form a closed tube around the style as in *Hemidesmus* R.Br. (Endress and Bruyns, 2000).

Where the UCT undergoes elongation after initiation of the corona behind the stamens, the corona lobes are displaced higher up the corolla tube, thus separating them from the stamens (Kunze, 2005). In such cases a raised ridge extends from the point of corona initiation behind the stamen to the base of the corona and may be conspicuous or inconspicuous. Venter and Verhoeven (1999) referred to this conspicuous ridge in *Cryptolepis yemenensis* as a coronal pad, while Joubert (2007) referred to this ridge as the coronal foot.

The corona may also form a small pocket in the corolla lobe sinus. Outgrowths from the pocket rim in the form of lobules or filaments may add further complexity to the structure (Kunze, 2005). In some genera of Periplocoideae two corolline coronas are present (Fig. 3.5. F). The primary corona is expressed as lobes or filaments inserted inside the UCT, and the secondary corona occurs as pockets in the corolla lobe sinuses, these being simple (Figs. 3.5 F and 3.9.) or embellished by lobules or filaments arising from the pocket rim (Venter and Verhoeven, 2001). In some cases the meristem which gives rise to the corolline corona extends laterally onto the petals and produces corona lobes in the middle of the petals, as in *Apocynum*, or a continuous annulus as in *Prestonia* R.Br. (Kunze, 2005). All these variations of the corolline corona were regarded as homologous structures by Kunze (2005).

A lengthened UCT with prominent coronal pads extending from the insertion of the stamens to the corona lobes is found in the flowers of most *Cryptolepis* species. However, in *C. arbuscula* and *C. socotrana* the staminal filaments become fused to the coronal bases to form the staminal foot described by Venter and Verhoeven (2001). In all *Cryptolepis* species these primary corona lobes are positioned between the base and middle of the UCT. Fifteen of the 31 *Cryptolepis* species also have a double corona, with primary corona lobes and a secondary corona, in the form of pockets in the corolla lobe sinuses (Fig. 3.5. F). In two species, *C. ibayana* and *C. oblongifolia,* simple or bifid lobules or filaments may grow from the pocket rims of the secondary corona.

Venter and Verhoeven (2001) showed that coronal shape and size is not of use in generic classification of the Periplocoideae, but in *Cryptolepis* primary corona shape is useful in distinguishing several species. Coronal shape varies greatly, the majority of species exhibiting clavate (Fig. 3.5. B, F) or filiform primary corona lobes, but hastate, ovoid, bilobed, hooded and flap-like coronal lobes are diagnostic in a few species. Corona lobes are usually included in the UCT, but in species with filiform corona lobes the lobe apices may be slightly exserted from the corolla tube (Fig. 3.5. D). In all *Cryptolepis* species the coronal apices are connivent, concealing the gynostegium. This arrangement results in the LCT being accessible only through openings between the corona bases (Figs. 3.5. B, C, E, F). These openings are situated directly above the nectar pockets of the lower corolla tube. Therefore, in *Cryptolepis,* as in many other genera in the Apocynaceae, the corona functions in directing pollinators towards the specialized pollination mechanism of the gynostegium (Kunze, 2005).

In the Periplocoideae floral characters such as length of the UCT, relative positions of stamens, nectaries and primary corona lobes are of value in distinguishing genera, though these characters should be used in combination with various other vegetative and reproductive characters (Venter and Verhoeven, 2001; Venter, 2009b). Even though these characters are of diagnostic value, Ionta and Judd (2007) did not find any correlation of these characters with the molecular phylogeny of the subfamily. Consequently, relative position of stamens and corona lobes cannot be used to infer phylogenetic relationships among genera in the Periplocoideae. Table 3.1. shows the distribution of three characters, upper corolla tube length, position of stamens and position of corona lobes, in periplocoid genera.

Within the group with a distinct upper UCT, which includes *Cryptolepis,* the relative positions of the primary corona lobes and stamen insertion are of value in differentiating between the genera. Stamens inserted at the mouth of the corolla tube is characteristic of a number of genera, most of which were previously placed in the tribe *Gymnanthereae* (Venter and Verhoeven, 1997). In most of the genera, previously belonging to the tribe *Cryptolepideae* (Venter and Verhoeven, 1997), the stamens are inserted between the base and the middle of the corolla tube, but never near the mouth of the corolla tube. Within this latter group of genera the presence and position of the primary corona lobes are of value in differentiating genera.

In *Ectadium* E.Mey. and *Maclaudia* Venter & R.L.Verh. primary corona lobes are inserted at the mouth of the UCT, while primary corona lobes are inserted in the petal sinuses in *Pentopetia* Decne. and *Stomatostemma* N.E.Br*.* In *Cryptolepis, Cryptostegia, Parquetina* Baill. and *Telectadium* the primary corona lobes arise between the staminal insertion and the corolla mouth, but never at the corolla tube mouth (Fig. 3.10. A). *Cryptostegia* is distinguished from similar genera on the basis of flower size, the corolla length in *Cryptostegia* ranging from 40 to 60 mm, as opposed to corolla lengths below 25 mm in similar genera. The corollas of the two *Telectadium* species are conspicuously urceolate as opposed to campanulate corollas which are the norm in the other genera with similar staminal and corolline positions. In the flowers of *Parquetina* the corolla may be reflexed, and the gynostegium exserted, or the corolla may be campanulate. In both cases the corona lobes are inserted at the base of the UCT with staminal filaments fused to the corona lobe bases (Venter, 2009b; Venter and Verhoeven, 1996).

In the Apocynoideae, Periplocoideae, Secamonoideae and Asclepiadoideae the anthers are connivent over and fused to the style-head to form a gynostegium. The Rauvolfioideae have anthers connivent over the style-head, but not fused to it (Endress and Bruyns, 2000). The Apocynoideae, Secamonoideae, Asclepiadoideae and some genera in the Rauvolfioideae are also characterized by the presence of guide rails, consisting of lignified tissue in the anthers (Endress and Bruyns, 2000). Guide rails are absent from the anthers of all Periplocoideae genera (Venter and Verhoeven, 2001).

Table 3.1. Comparison of upper corolla tube (UCT) length and relative positions of primary corona lobes and stamens in Periplocoideae genera.

	Indistinct UCT		**Distinct UCT**			
	Primary corona absent/ reduced	**Primary corona inserted at base of UCT**	**Primary corona absent/reduced**	**Primary corona inserted in corolla tube mouth**	**Primary corona inserted in corolla lobe sinuses**	**Primary corona inserted between base of UCT and corolla tube mouth**
Stamens inserted at base of UCT	*Phyllanthera* Blume	*Atherandra* Decne. *Buckollia* Venter & R.L.Verh. *Decalepis* Wight & Arn. *Epistemma* D.V.Field & J.B.Hall *Finlaysonia* Wall. *Hemidesmus* R.Br. *Mondia* Skeels *Myriopteron* Griff. *Periploca* L. *Petopentia* Bullock *Sacleuxia* Baill. *Sarcorrhiza* Bullock *Streptocaulon* Wight & Arn. *Tacazzea* Decne. *Zygostelma* Benth.	*Baronniella* Costatin & Gallaud *Batesanthus* N.E.Br. (sometimes)	*Ectadium* E.Mey. *Maclaudia* Venter & R.L.Verh.	*Pentopetia* Decne. *Stomatostemma* N.E.Br.	*Cryptolepis* R.Br. *Cryptostegia* R.Br. *Parquetina* Baill. *Telectadium* Baill.
Stamens inserted at corolla tube mouth			*Baseonema* Schltr. & Rendle	*Camptocarpus* Decne. *Gymnanthera* R.Br. *Ischnolepis* Jum. & H.Perrier *Kappia* Venter *Raphionacme* Harv. *Schlechterella* K.Schum	*Pentopetia* Decne.	

Cryptolepis differs little from other periplocoid genera in the structure of the stamens. The stamens consist of a short filament and an anther, made up of two locules. Each locule is further subdivided into two thecae (Fig. 3.8. B). The anther connective extends beyond the locules to form an appendage which may expand into complex structures as in *Finlaysonia* Wall., *Atherandra* Decne. and *Phyllanthera.* However, in most genera, including *Cryptolepis,* the appendages are small, often deltoid structures (Venter and Verhoeven, 2001). The anthers are connivent over the style-head and their bases fused to the margin of the style-head, thus forming the gynostegium (Venter and Verhoeven, 2001). Venter and Verhoeven (2001) suggested that hairy anthers may be diagnostic for some periplocoid genera, but in *Cryptolepis* both glabrous and villous anthers are found. Though anther vestiture is of no diagnostic value for the genus, it is of value in distinguishing between different *Cryptolepis* species.

In the Apocynaceae the gynoecium usually consists of two apocarpous, semi-inferior ovaries, with the exception of a number of species in the Rauvolfioideae with congenitally syncarpous ovaries and few species in the Apocynoideae with postgenitally syncarpous ovaries (Endress and Bruyns, 2000). In the Periplocoideae only apocarpous ovaries are found (Fig. 3.10. A). The two short styles unite terminally to from a compound style, which gives rise to a pentagonal style-head (Fig. 3.10. A). The style-head is divided into three zones, namely the upper, marginal and lower zones (Venter and Verhoeven, 2001).

Within the Periplocoideae the gynoecium is informative in differentiating between different species, but gynoecial characters are too variable within genera to be used for classification above species level (Venter and Verhoeven, 2001). In *Cryptolepis* gynoecium characters are relatively uniform, with most species characterised by a broadly pyramidal style-head. The apex is usually acute to acutely bifid, but it may rarely be obtuse, attenuate or cuspidate. *Cryptolepis arbuscula* has a narrowly dome-shaped style-head while *C. socotrana* has a bell-shaped style-head with bifid-cuspidate apex, differentiating them from other *Cryptolepis* species.

In the Periplocoideae there are five grooves in the style-head, alternating with the anthers (Endress and Bruyns, 2000) (Fig. 3.10. B). The epithelial cells of each groove secrete a substance which hardens to form a spathulate translator onto which the pollen of two adjoining thecae of the two neighbouring anthers is shed.

The translator functions in transferring a single pollen load from two neighbouring anthers as a unit (Kunze, 1991).

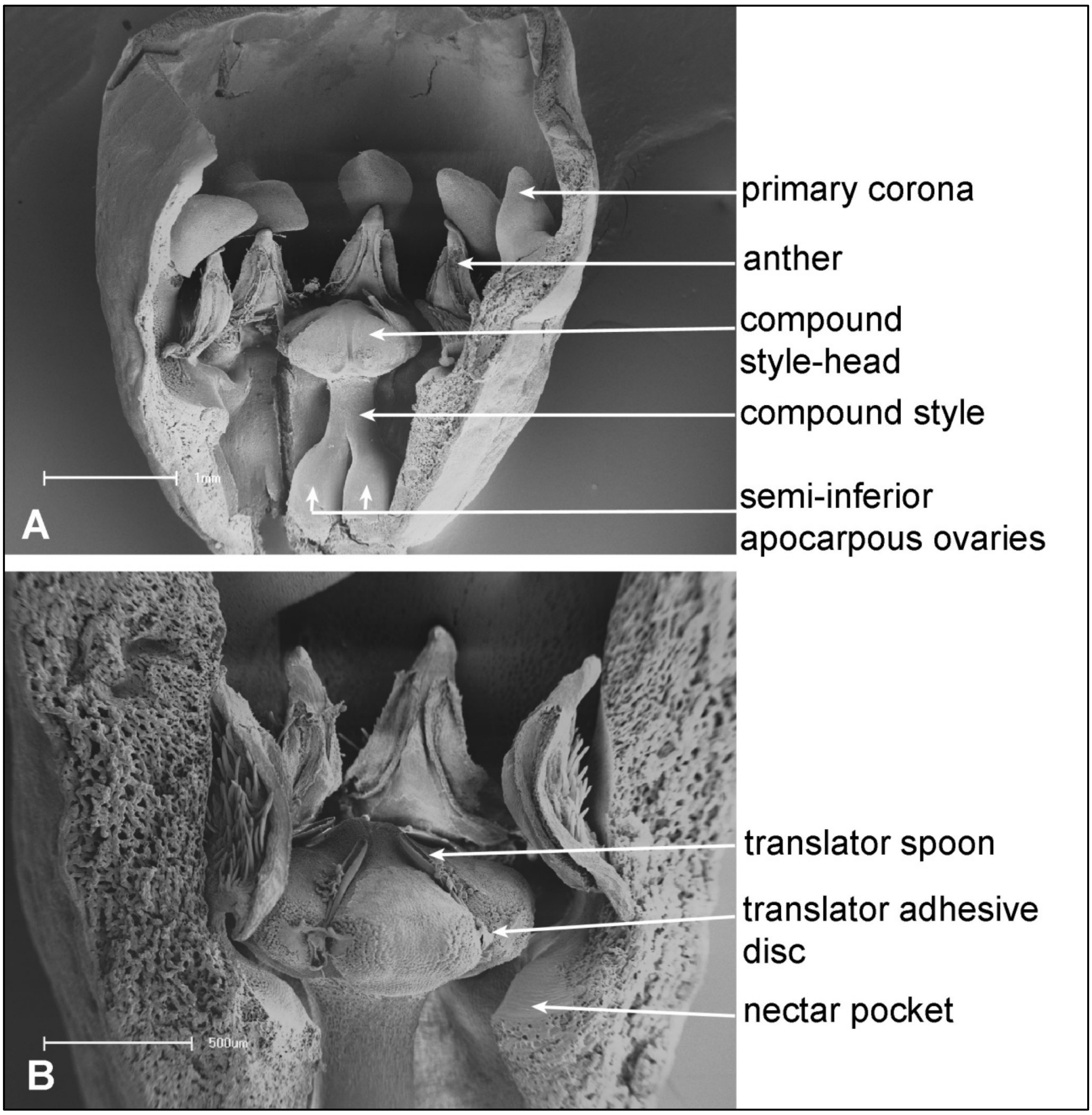


Fig. 3.10. Internal structure of *Cryptolepis obtusa* flower: (A) lower and upper corolla tubes with corona lobes in upper corolla tube, (B) compound style-head with translators in grooves and adhesive discs positioned directly above nectar pocket. Scale bars: (A) = 1 mm; (B) = 500 µm. Specimen: (A–B) *Venter 8783* (BLFU).

3.7 Pollen and translators

3.7.1 Introduction

Palynology has proved to be of great value in taxonomic and phylogenetic studies at higher taxonomic levels in all plant families (Walker and Doyle, 1975). In the Apocynaceae palynological data is of use in differentiating between subfamilies and gives some indication as to phylogenetic relationships between the subfamilies, as well as relationships of their genera and species. In their palynological survey of 408 species representing 114 genera of the Asclepiadaceae *sensu lato* (at present Asclepiadoideae) Schill and Jäkel (1978) found that palynology supported the familial and subfamilial classification of Schumann (1895b) for the most part and that pollen and translator characteristics were useful in differentiating higher taxa. Studies by Civeyrel (1994), Civeyrel et al. (1998), El-Gazzar and Hamza (1973), Endress et al. (1990), Galil and Zeroni (1969), Kunze (1993), Nilsson (1986, 1990), Nilsson et al. (1993), Verhoeven and Venter (2001) and Verhoeven et al. (2003) supported the use of pollen characters in the delimitation of subfamilies and tribes of the Apocynaceae *sensu lato*.

Studies by Arekal and Ramakrishna (1980), Kunze (1993), Nilsson et al. (1993), Schick (1982), Venter et al. (1990a), Verhoeven and Venter (1988, 1993, 1994a, 1994b, 1997, 1998) and Verhoeven et al. (1989, 2003) have added greatly to the current knowledge of Periplocoideae pollen. These studies indicated that, although some variation in taxonomic importance does occur regarding the pollen of the subfamily, palynological characteristics show a high level of homogeneity and are generally of little value in distinguishing genera and species (Verhoeven and Venter, 1993). Palynological characteristics listed by Walker and Doyle (1975), which have proved to be of value in the Apocynaceae, include the pollen-unit, pollen apertures and pollen wall architecture. To this must be added the taxonomic and systematic value of the pollen carrier (translator) structure.

3.7.2 Pollen unit and translator

In the Apocynaceae the pollen-unit (monads, tetrads or pollinia shed onto a translator or the pollinia attached to a corpuscule) forms one of the most important distinguishing characteristics of the subfamilies. The pollen-unit does, however, not only differentiate between the subfamilies of the Apocynaceae, but shows the close relationship between the subfamilies and supports their classification as a single family.

The Apocynoideae, with five exceptions, are characterized by single-grained pollen (Verhoeven and Venter, 1993, 1994a; Van der Ham et al., 2001). In contrast with other Apocynoideae genera, the genera *Apocynum* [=*Poacynum* Baill., =*Trachomitum* Woodson], *Callichilia* Stapf., *Condylocarpum* Desf. [=*Rhipidia* Markgr.], *Melodinus* J.R.Forst. & G.Forst. and *Tabernaemontana* L. [=*Pagiantha* Markgr.] have pollen arranged in tetrads, which suggests a close relationship with the Periplocoideae (Van der Ham et al*.,* 2001). However, Nilsson et al. (1993) pointed out that the pollen grains for *Apocynum* are only loosely attached to each other and that the grains are separated by a non-perforated double wall and that pores with different diameters are irregularly spaced. This differs from the tetrads of the Periplocoideae, where the pollen grains are firmly united to form tetrads with pores of equal size arranged in pairs on adjoining pollen grains. The walls separating individual pollen grains are perforated and thinner than the outer pollen walls. Consequently, Nilsson et al. (1993) concluded that pollen tetrads in *Apocynum* and the Periplocoideae are the result of parallel evolution. This hypothesis of Nilsson et al. (1993) was confirmed by the phylogenetic analysis of the Apocynaceae by Livshutz et al. (2007).

The Apocynoideae are also differentiated from the Periplocoideae, Secamonoideae and Asclepiadoideae by the absence of translators in the former, while the latter three subfamilies all have translators. The style-head of the Apocynoideae secretes an adhesive substance which causes pollen grains to stick to the pollinator’s proboscis (Nilsson et al*.,* 1993). Two genera in the Apocynoideae, namely *Apocynum* [=*Trachomitum*] and *Forsteronia* have simple, band-like translators that are homologous to those of the Periplocoideae and can be interpreted as a connection between the two subfamilies (Verhoeven and Venter, 1998). However, Livschultz (2010) pointed out that the description of these band-like translators are based on investigation of desiccated flowers in which the style-head adhesive, typical of Apocynoideae, may have become agglutinated into bands as an artefact of desiccation.

Pollen of the Periplocoideae occurs in free tetrads or with the pollen aggregated in pollinia. The pollinia in the Periplocoideae are composed of agglutinated pollen tetrads and not enclosed by a pollinium wall. Both free tetrads and pollinia are released onto spoon-like translators at anthesis (Verhoeven and Venter, 1998; 2001). The spoon-like translators of the Periplocoideae are formed by secretions which are moulded by grooves in the style-head, these alternating with the anthers (Fig. 3.10. B). A translator consists of three parts, namely the spoon, the stalk (stype) and the adhesive disc (viscidium) (following the terminology used by Verhoeven and Venter, 1997) (Fig. 3.11.). The spoon is orientated toward the apex of the style-head and receives the pollen tetrads or pollinia shed from two adjoining thecae of neighbouring anthers. The translator stalk is usually easily distinguished from the spoon, although the transition may be very gradual in some taxa, making the two parts indistinguishable (Verhoeven and Venter, 1997). The stalk connects the spoon to the adhesive disc which is located at the outer rim of the style-head. The adhesive disc is orientated over the entrance to the nectar pocket, directly below one of the openings between coronal bases, and attaches the translator to the proboscis of pollinators that attempt to feed on the nectar secreted in the nectar pocket (Kunze, 1991, 1993; Nilsson et al., 1993).

In Secamonoideae pollen tetrads are agglutinated to form four pollinia per anther, though a pollinium wall is absent, while in the Asclepiadoideae single pollen grains are agglutinated into two pollinia per anther, each pollinium also surrounded by a pollinium wall (Verhoeven and Venter, 2001). In both these subfamilies the pollinia are attached to translators and remain in the anther thecae until removed by the pollinator (Verhoeven and Venter, 1998, 2001). In these two subfamilies the translator consists of a clasping mechanism, the corpuscule (Civeyrel, 1994). In the Secamonoideae the pollinia are attached to the corpuscule via a dorsal process, while pollinia are attached to the corpuscule by two caudicles in the majority of the Asclepiadoideae (Wanntorp, 2007). *Fockea* differs from other Asclepiadoideae in that its four pollinia are directly attached to the corpuscule (Kunze, 1993), suggesting that this genus represents an intermediate form between the Secamonoideae and Asclepiadoideae. This hypothesis is supported by the cladistic analysis of Civeyrel (1998) in which *Fockea* occupies an intermediate position between the Secamonoideae and Asclepiadoideae. Endress and Bruyns (2000) suggested that, since caudicles may rarely be present in the Secamonoideae genera *Genianthus* Hook.f. and *Secamone* this character is not useful in distinguishing tribes in the Asclepiadoideae.

Though translator shape and size may vary considerably and may have taxonomic value in distinguishing genera and species in the Periplocoideae, the basic structure of all the translators of the subfamily is the same (Verhoeven and Venter, 1997). Schick (1982) analysed the chemical nature of the translator of *Periploca* and found that the spoon, stalk and adhesive disc all consisted of a solid part of cutin derivates, carbohydrates and terpenes. Safwat (1962) reported that the spoon was formed by epithelial cells of the style-head which first secreted a foamy substance that stained with fast green, followed by a solid substance that stained with safranin. In contrast, epithelial cells formed the adhesive disc by first secreting a solid substance, followed by a foamy substance (Safwat, 1962). The foamy substance corresponds to the adhesive material showing cell-like structures, and the solid substance corresponds to the solid layer without cell-like structures described in *Raphionacme* by Verhoeven and Venter (1997). The adhesive, foamy substance on the dorsal surface of the Periplocoideae translator is regarded as a more specialized form of the adhesive pollination mechanism of the Apocynoideae, further supporting the close relationship between the two subfamilies (Nilsson et al., 1993).

Ontogenetic studies on Periplocoid translators have shown that the scutellum, or solid part of the adhesive disc, developed first and that the stalk became attached to the disc before the adhesive substance was added to the lower side of the scutellum or the stalk elongated to connect the adhesive disc to the spoon (Kunze, 1993).

The upper part of the adhesive disc and the base of the stalk are regarded as the central element of the Periplocoid translator, possibly being homologous with the corpuscule of the Asclepiadoideae and Secamonoideae (Kunze, 1993). The homology of these two structures is supported by their secretion in the same region of the style-head and the cross-section of the inrolled stalk of the Periplocoid translator and cross-sections of the corpuscule of the Secamonoideae and Asclepiadoideae exhibiting the same shape (Endress, 2001). However, molecular phylogenetic analysis by Livshultz et al. (2007) and Livshultz (2010) reconstructed the Asclepiadaceae *sensu lato* as polyphyletic, suggesting that translators and pollinia in the Periplocoideae are not homologous to corpuscules and pollinia in the Secamonoideae and Asclepiadoideae.

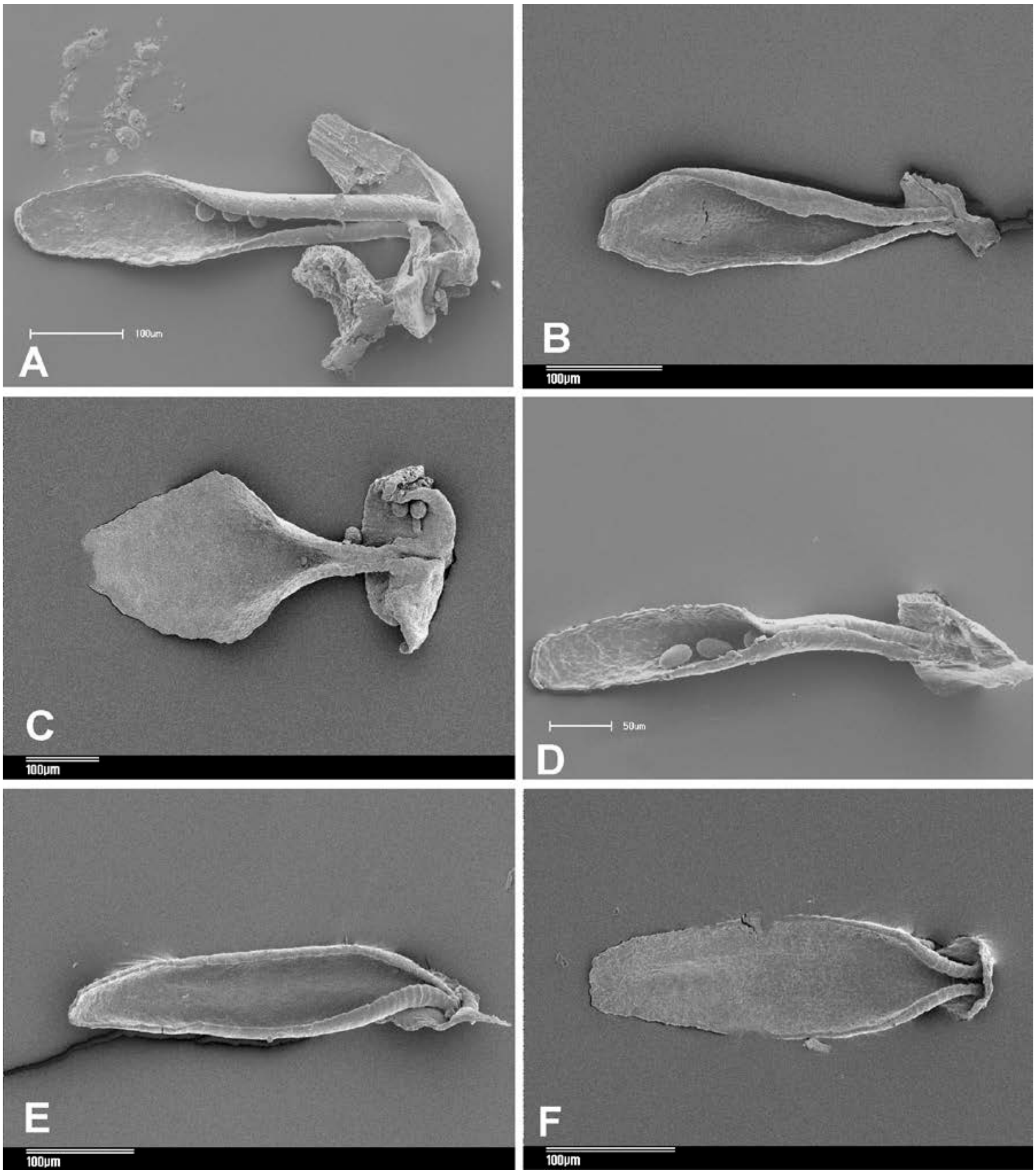


Fig. 3.11. SEM micrographs of *Cryptolepis* translators: (A) *C. capensis,* (B) *C. cryptolepioides*, (C) *C. decidua,* (D) *C. delagoensis,* (E) *C. oblongifolia,* (F) *C. obtusa.* Scale bars: (A–C, E–F) = 100 µm; (D) = 50 µm. Specimens: (A) *Joubert 31* (BLFU); (B) *Venter 9075* (BLFU); (C) *Verhoeven 165* (BLFU); (D) *Venter 9335* (BLFU); (E) *Van Wyk 113* (BLFU); (F) *Bingham 1442* (SRGH).

The translator shape of the different *Cryptolepis* species is virtually indistinguishable (Fig. 3.11. A–B, D–F). Most species have elongate-elliptic translators with obtuse apices, except *C. gossweileri* and *C. stefaninii,* which have retuse apices. In all species the translator spoon gradually narrows towards the base, where it is attached to the adhesive disc, making the spoon and short stalk nearly indistinguishable. The margins of the spoon are curled inward, becoming increasingly curled towards the base, giving the short stalk a U-shaped appearance. The stalk is attached at the upper third to quarter of the semi-elliptic adhesive disc.

The translators of *C. decidua* are distinct from those of the other species since the spoon is deltoid, not elongate-elliptic, with an obtuse apex (Fig. 3.11. C). The stalk is more defined than in the other *Cryptolepis* species. The margin of the lower half of the spoon is involute, the curl extending into the stalk, giving it an open u-shaped appearance. The stalk is attached at the upper third of the adhesive disc and a groove runs from the point of attachment to the upper edge of the disc. The upper edge of the adhesive disc is broad and linear. The adhesive disc is more than half the spoon size and may be as large as the spoon itself.

Translator sizes of the different species overlap to a great extent and are always proportional to the size of the style-head, which is mainly determined by flower size. In *Cryptolepis* translator size typically ranges from ± 0.3–0.6 mm in length. Translator sizes of selected representatives of African *Cryptolepis* species are given in Table 3.2.

Verhoeven and Venter (1997) found translator shape to be of taxonomic value in distinguishing species in *Raphionacme.* This does not seem to be the case in *Cryptolepis* where little distinction is discernable between the species and translator characters are, therefore, of limited value in classification at species level. However, translators are useful in distinguishing *Cryptolepis* from several other periplocoid genera which have a prominent adaxial ridge along the middle of the translator and the translator apex is often deeply bifid, such as the translators of *Raphionacme.*

Table 3.2. Translator size of representative African *Cryptolepis* species. *****Measurements from Venter and Verhoeven (2007); **measurements from Venter et al. (2006a); ***measurements from Venter and Verhoeven (1999).

Species	**Specimen**	**Translator size (µm)**
*C. africana**	Luke and Mbinda 5978	490–607
C. capensis	Joubert 31	506 ±3 (503–509) x 94 ±5 (89–99)
	Wood 11589	567.8 ±21.8 (546.7–594.2) x 91 ±15.6 (68.6–104.7)
C. cryptolepioides	Venter 9075	361 ±16.1 (334.9–377.7) x 72.9 ±10 (56.8–81.4)
	Burrows 1338	384 ±5.7 (380–388) x 77.5 ±3.5 (75–79.9)
C. decidua	Verhoeven 165	569.7 ±41.2 (530–649.3) x 179 ±23.1 (141.9–214.8)
	Van Vuuren 590	573.7 ±18.3 (550.5–602.4) x 172.3 ±19.3 (149.9–196.4)
C. delagoensis	Venter 9335	395.8 ±22.6 (361–436) x 63.7 ±5.1 (57.1–71.1)
	Bruyns 9365	350.8 ±13.7 (333–365.8) x 65 ±4.8 (58.4–69.6)
*C. nugaalensis***	Thulin et al. 10503	367–419
C. oblongifolia	Van Wyk 113	388.5 ±18.1 (368.7–411) x 81.4 ±7.8 (72.6–93.6)
	Joubert 26	446.2 ±19.7 (425–464) x 72.1 ±8.1 (63.8–80)
C. obtusa	Bingham 1442	311.9 ±22.9 (274.3–340.8) x 73.1 ±6.9 (66.3–86.3)
	Chase 8288	336 ±12 (328.7–353.7) x 73.9 ±5.9 (65.7–78.3)
*C. somaliensis***	Thulin et al. 10509	411–491
*C. yemenensis****	Boulos et al. 16899	338–396

3.7.3 Pollen structure

The pollen tetrads of the Periplocoideae are usually rhomboidal or decussate, but tetragonal, linear, T-shaped and tetrahedral arrangements have also been observed (Verhoeven and Venter, 2001). *Petopentia* Bullock is the only genus that can be identified accurately using tetrad arrangement since it uniquely has linear and T-shaped tetrads (Verhoeven et al*.,* 1989). Nearly all other Periplocoideae genera have decussate, rhomboidal and tetragonal tetrads and in most species all of these tetrad types are present, limiting the taxonomic value of this characteristic (Verhoeven and Venter, 1993, 1994a).

The tetrads of all *Cryptolepis* species previously belonging to *Curroria,* were described as rhomboidal, tetrahedral or decussate, the most common being decussate and tetrahedral, except in *C. volubilis* where rhomboidal tetrads were most common (Verhoeven and Venter, 1993). Nilsson et al. (1993) described the tetrads of *C. oblongifolia* and *C. dubia* [= *C. buchananii*] as being mostly rhomboidal, but Joubert (2007) reported mostly decussate tetrads from *C. oblongifolia*. In *C. somaliensis* and *C. nugaalensis* pollen tetrads were found to be decussate whereas in *C. yemenensis* and *C. africana* tetrads are usually decussate, with rhomboidal tetrads rarely occurring (Venter and Verhoeven, 1999, 2007; Venter et al., 2006a). In *Cryptolepis* tetrad structure is highly variable within species, and even within individual plants (Joubert, 2007), and is consequently of little value in distinguishing among *Cryptolepis* species or in differentiating *Cryptolepis* from other genera. Figures 3.12. and 3.13. show SEM micrographs and light micrographs respectively of pollen tetrads of representative *Cryptolepis* species.

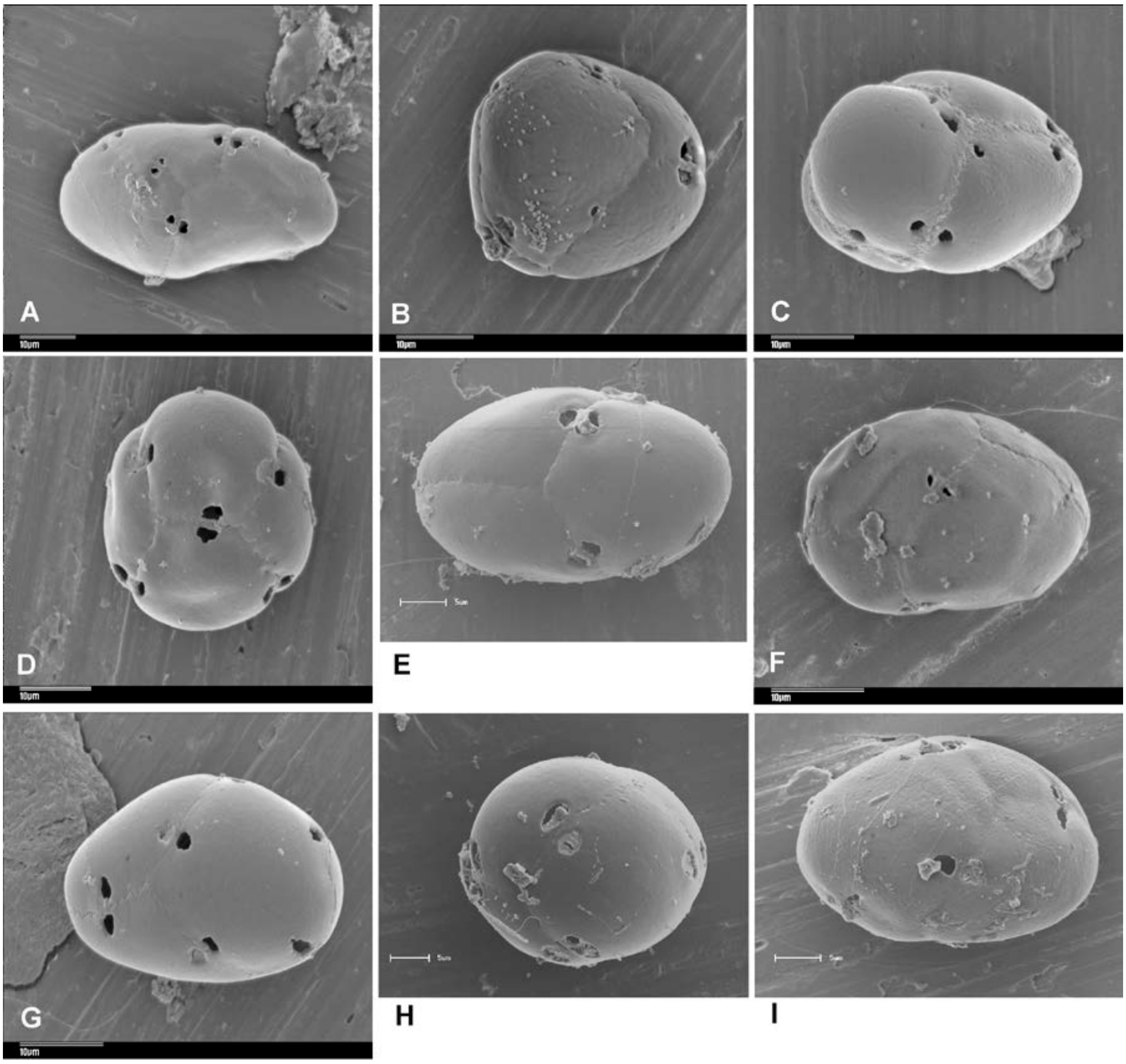


Fig. 3.12. SEM micrographs of *Cryptolepis* pollen tetrads: (A) *C. apiculata,* (B) *C. capensis,* (C) *C. cryptolepioides,* (D) *C. decidua,* (E) *C. delagoensis,* (F) *C. ibayana,* (G, H) *C. oblongifolia,* (I) *C. obtusa.* Scale bars: (A–D, F–G) = 10 µm; (E, H–I) = 5 µm. Specimens: (A) *Graham 1526* (MO); (B) *Strey 8352* (SRGH); (C) *Venter 9075* (BLFU); (D) *Beukes 22* (BLFU); (E) *Venter 9335* (BLFU); (F) *Bally 1749* (K); (G) *King 444* (SRGH); (H) *Joubert 26* (BLFU)*;* (I) *Phillips 2236* (SRGH).

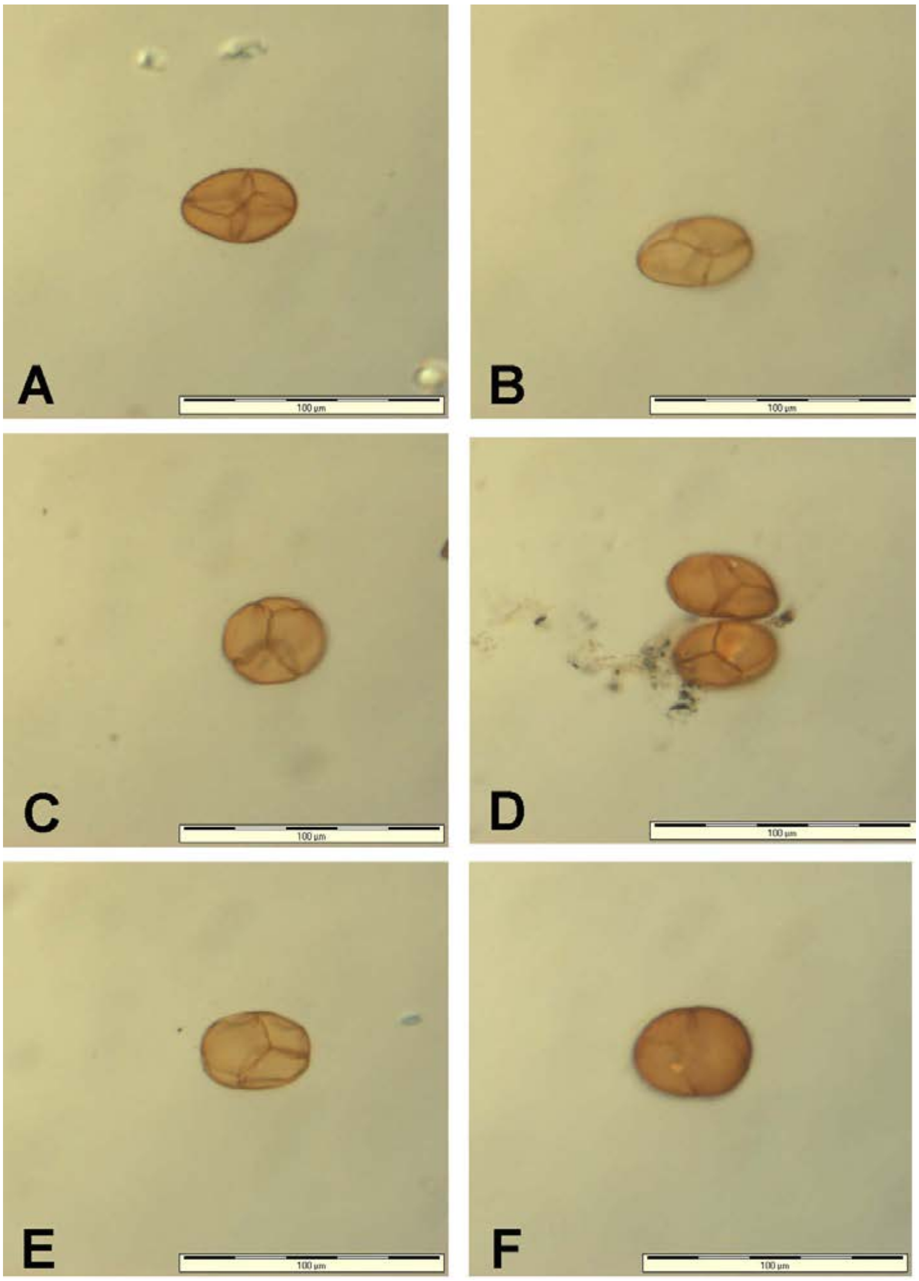


Fig. 3.13. Light micrographs of *Cryptolepis* pollen tetrads: (A) *C. capensis,* (B) *C. cryptolepioides,* (C) *C. decidua,* (D) *C. delagoensis*, (E) *C. oblongifolia*, (F) *C. obtusa.* Sale bars: (A–F) = 100 µm. Specimens: (A) *Strey 8352* (SRGH); (B) *Codd & Dyer 9139* (K); (C) *Beukes 22* (BLFU); (D) *Venter 9335* (BLFU); (E) *Smith 1293* (PRE); (F) *Phillips 2236* (SRGH).

Cohesion of tetrads may occur through connection of the tectum of adjoining grains (simple cohesion) or by connecting wall bridges (crosswall cohesion) (Knox and McConchie, 1986). Studies on the tetrads of *Petopentia*, *Tacazzea* Decne. and *Raphionacme* have shown the cohesion mechanism in Periplocoideae to consist of connecting wall bridges formed by the intine and granular layer (Verhoeven and Venter, 1993, 1998; Verhoeven et al., 1989).

Pollen wall architecture is very similar in all Periplocoideae genera that have been studied. The exine is typically smooth and may be divided into a tectum and an underlying granular layer. In *Camptocarpus* Decne. [=*Harpanema* Decne.] the exine of the outer pollen wall is differentiated into three strata. These are the tectum, underlain by a thin granular layer, which is subtended by a foot layer (Verhoeven and Venter, 1994a). In the Periplocoideae the walls separating the grains in a tetrad have the same structure as the outer wall, except in the genera *Camptocarpus* and *Finlaysonia* where the tectum is absent (Verhoeven and Venter, 1994a, 1998).

The pollen wall architecture of *Cryptolepis* is very similar to other investigated Periplocoideae genera. The exine is generally smooth, but slight perforations, not penetrating the exine, may be observed in some grains of all species (Fig. 3.12.). The exine consists of an outer distal stratum (tectum) subtended by a granular stratum consisting of granules of unequal size (Fig. 3.14. A). The intine is poorly differentiated and only clearly visible in the pore area (Fig. 3.14. C–D)). The inner walls separating the individual grains of the tetrad have the same structure as the external wall, consisting of tectum, granular stratum and intine. The walls are, however, not continuous, but interrupted by wall bridges consisting of intine and a granular stratum (Fig. 3.14. B).

Only *Raphionacme* (Verhoeven and Venter, 1994a, 1994b) and *Schlechterella* K.Schum. (Venter and Verhoeven, 1998) with 8–16 pores per grain, *Kappia* Venter, A.P.Dold & R.L.Verh. (Venter et al., 2006b) and *Baseonema* Schltr. & Rendle (Taoana, 2001) with 4–8 pores exceed the 4–6 pores per grain found in the rest of the Periplocoideae. The pores are opposite each other at the junction of adjacent pollen grains, and range from circular to semi-circular (Verhoeven and Venter, 1994a).

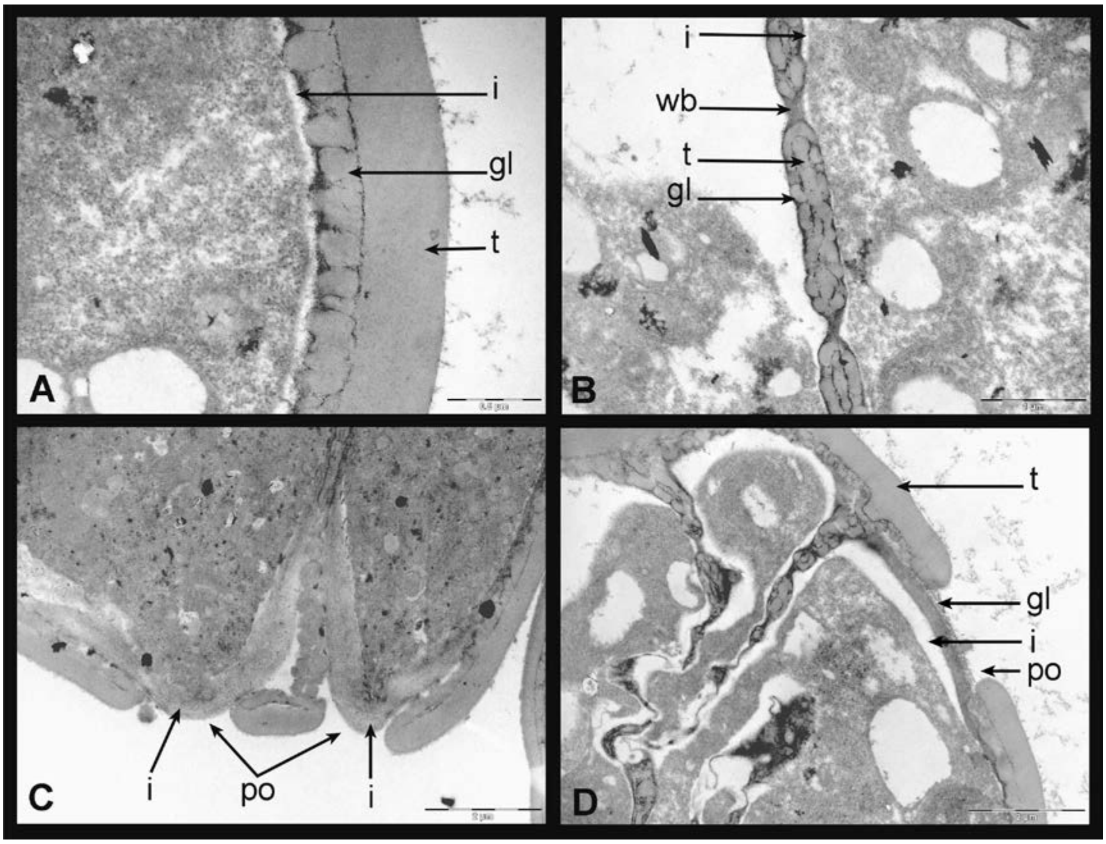


Fig. 3.14. Pollen wall architecture of *Cryptolepis:* (A) outer pollen wall of *C. oblongifolia* tetrad showing outer tectum, granular layer and intine, (B) inner pollen wall of *C. oblongifolia* tetrad showing tectum, granular layer, intine and wall bridges, (C) pores in the outer pollen wall of *C. decidua*, covered by intine, (D) pore in outer pollen wall of *C. oblongifolia*, covered by intine and granular layer. Legend: (gl) = granular layer; (i) = intine; (po) = pore; (t) = tectum; (wb) = wall bridge. Scale bars: (A) = 0.5 µm; (B) = 1 µm; (C–D) = 2 µm. Specimens: (A–B, D) *Joubert 26* (BLFU); (C) *Verhoeven 165* (BLFU).

In *Cryptolepis* individual pollen grains are tetraporate with pores arranged opposite each other at the junction of adjacent pollen grains (Fig. 3.12.). The pores are circular to semi-circular with irregular margins and are often covered by a thin layer of exine. Small particles may occasionally be observed clogging the pores of pollen grains (Fig. 3.12. H–I). This pore arrangement and number is very similar for all the *Cryptolepis* species investigated and does not differ significantly from most other genera in the Periplocoideae. Pollen pores are consequently of no taxonomic value in the *Cryptolepis* species examined.

Although tetrad size is very similar for many genera and overlaps to a great extent, it may be of taxonomic value in distinguishing certain genera and species in the Periplocoideae, as shown by measurements presented by Nilsson et al. (1993). Verhoeven and Venter (1994b) found the rhomboidal tetrad size of the monotypic *Ischnolepis* to be of taxonomic value in distinguishing this genus from other genera in the subfamily, while Verhoeven et al. (1989) found tetrad size of value in distinguishing *Tacazzea* from *Petopentia*, as well as differentiating between different *Tacazzea* species. Tetrad size was also of taxonomic value at species level in *Stomatostemma* (Verhoeven and Venter, 1993) and *Periploca* (Verhoeven and Venter, 1994b).

Tetrad sizes for the *Cryptolepis* species studied are given in Table 3.3. The size of individual tetrads varies considerably within each species. All species show considerable similarity in mean decussate tetrad sizes, ranging from 36 to 45.5 µm in length and 25.8 to 38.2 µm in width (Table 3.3.). On average the ratio of tetrad length to width is fairly constant for most species, ranging from 1.4 to 1.7, thus giving the tetrads an ellipsoid shape. Therefore, this feature has little value for distinguishing among species. The only exception is *C. decidua* which shows an average length to width ratio of 1.0 to 1.1, the tetrads being more globose than those of the other species and this exception corresponds to the unique translator shape in *C. decidua*.

Table 3.3. Pollen tetrad size of representative African *Cryptolepis* species. *****Measurements from Venter and Verhoeven (2007); **measurements from Venter et al. (2006a); ***measurements from Venter and Verhoeven (1999).

Species	**Specimen**	**Tetrad size (µm)**	**Mean ℓ:w**
*C. africana**	Luke and Mbinda 5978	46.5–57.6 x 29.7–35.3	
C. capensis	Strey 8352	41.6 ±3.2 (37.2–46.5) x 28.8 ±2.3 (24.2–31.6)	1.5
	Hilliard and Burtt 7575	45.5 ±0.7 (44.6–46.5) x 29.1 ±1.6 (26.9–31.6)	1.6
C. cryptolepioides	Venter 9182	37.8 ±6.1 (27.9–46.5) x 26.3 ±1.8 (24.2–29.8)	1.5
	Venter 9075	40.6 ±5.1 (33.5–49.3) x 26.7 ±3.4 (22.3–36.3)	1.5
	Codd and Dyer 9139	42.4 ±3.1 (38.1–47.4) x 25.8 ±1.6 (23.3–27.9)	1.7
C. decidua	Verhoeven 165	38.7 ±1.6 (37.2–41.9) x 34.3 ±1.9 (29.8–37.2)	1.1
	Beukes 22	36 ±0.9 (34.4–37.2) x 35.3 ±1.1 (33.5–37.2)	1.0
	Van Vuuren 590	38.7 ±1 (36.3–40) x 38.2 ±1 (36.3–39)	1.0
*C. nugaalensis***	Thulin et al. 10503	37.2–49.3 x 24.2–28.8	
C. delagoensis	Venter 9335	39.8 ±4.1 (31.6–47.4) x 26.3 ±2.2 (23.3–30.7)	1.5
C. oblongifolia	Joubert 26	41.2 ±2.4 (38.2–46.5) x 28.1 ±1.3 (26–31.6)	1.5
	Meeuse 9494	42.4 ±1.8 (40–45.6) x 27.4 ±2 (26–31.6)	1.6
	Compton 28476	42.8 ±2.6 (38.1–46.5) x 26 ±1.8 (22.3–27.9)	1.7
	Smith 1293	42.8 ±2.9 (39–48.4) x 27 ±2.4 (24.2–30.7)	1.6
C. obtusa	Bingham 1442	38.6 ±3.3 (32.6–44.6) x 28.3 ±2.3 (24.2–32.6)	1.4
*C. somaliensis***	Thulin et al. 10509	40.9–46.5 x 25.1–31.6	
*C. yemenensis****	Boulos et al. 16899	36.4–44.9 x 22.2–29.5	

3.8 Micromorphology of seed coat surfaces

Seeds are the reproductive units of flowering plants and function in the dispersal and survival of the species under varying environmental conditions. A great diversity of seed structures have evolved as a result of different environmental pressures to which seeds are exposed and this diversity often proves to be of taxonomic value (Boesewinkel and Bouman, 1984). Although seed surface characteristics may be a useful tool for resolving taxonomic questions, these characteristics alone have never proven to be sufficient taxonomic evidence and can only be used in combination with other characteristics (Brisson and Peterson, 1976).

Seed coat characteristics are stable during long periods of storage and, provided that seeds at the same developmental stage are used, the characteristics are very reliable in taxonomic studies (Brisson and Peterson, 1976). The taxonomic value of seed coat characteristics is further increased by the relative ease with which these characteristics can be studied. Seeds are easily studied using SEM procedures since the mature seeds are dry and no complicated preparation of the material is required. The SEM enables researchers to make detailed observations and study characteristics that would be impossible to observe using light microscopy (Boesewinkel and Bouman, 1984).

Seed coat descriptions in this study follow the terminology of Barthlott (1981) and Boesewinkel and Bouman (1984). Four main characteristics have been distinguished, namely cellular arrangement, shape of cells (primary sculpture), fine relief of the cell wall (secondary sculpture) and epicuticular secretions (tertiary sculpture) (Barthlott, 1981; Boesewinkel and Bouman, 1984). Cellular arrangement is rarely taxonomically useful, but may occasionally be of value at species or genus level. Cellular arrangement may be observed where different types of cells are interspersed to form a supercellular pattern (Barthlott, 1981).

Primary sculpture is one of the most important characteristics of the seed coat surface and includes characteristics such as outline of the cells, anticlinal wall shape, relief of the cell boundary and curvature of the periclinal wall (Barthlott, 1981; Boesewinkel and Bouman, 1984). Secondary sculpture includes striate, reticulate, smooth or micropapillate surfaces and may be caused by cuticular sculpture, secondary wall thickening or subcuticular or cuticular inclusions (Boesewinkel and Bouman, 1984). Striations may be described in terms of a variety of characteristics which include length, orientation, pattern and distribution (Wilkinson, 1979). Tertiary sculpture in the form of epicuticular secretion rarely occurs in seeds and is of little taxonomic importance (Boesewinkel and Bouman, 1984).

Very little research has been undertaken on the seed coat surface of the Periplocoideae and where research has been done the results remain unpublished as in the case of Claasen (1994), Joubert (2007) and Taoana (2001). Recent taxonomic publications containing data on seed characteristics include papers published by Venter and Verhoeven (1993, 1994, 1999) and Venter et al. (1990c). The seed morphology of the Periplocoideae has also been poorly studied. In most studies of periplocoid seeds the results have shown that the seeds are dorsiventrally flattened with a coma of hairs at the micropylar end (Venter and Verhoeven, 1993, 1999; Venter et al.,1990c). The hairs of *Stomatostemma* and *Petopentia* are hollow, with a smooth surface and show little variation (Venter et al., 1990c).

Seed characteristics are relatively homogenous in the Periplocoideae and seeds of all *Cryptolepis* species are flattened with a ridge running along the centre of the lower seed surface, from the micropylar to the chalazal end of the seed (Fig. 3.15. B, D). The seeds of all the species, except *Raphionacme namibiana* Venter & R.L.Verh. and *Finlaysonia obovata* Wall., have a characteristic coma of hair at the micropylar end (Fig. 3.15. C). The hairs are hollow, with a smooth outer surface.

The presence or absence of protuberances on seed coat surfaces has been used several times as a supporting characteristic for distinguishing Periplocoideae genera. According to Venter et al. (1990b; 1990c) the genera *Petopentia* and *Tacazzea* were characterized by smooth seed surfaces, whereas *Cryptolepis decidua* (then *Curroria decidua* subsp. *decidua* Bullock) and *Cryptolepis migiurtina* (then *Curroria migiurtina* (Chiov.) Bullock) were characterized by the presence of protuberances on their seed surfaces. The absence of protuberances on the seed surface of *Buckollia volubilis* (Schltr.) Venter & R.L.Verh. was also used as part of the motivation for its removal from the genus *Curroria,* in which all other species had seed surfaces covered by protuberances (Venter and Verhoeven, 1994). These studies suggested that seed coat surface characteristics may be taxonomically useful in distinguishing genera within the subfamily Periplocoideae. Published results of seed coat studies of *Cryptolepis* species suggested that this genus could be characterized by the presence of protuberances on the seed surfaces (Venter and Verhoeven, 1999; Venter et al., 1990c).

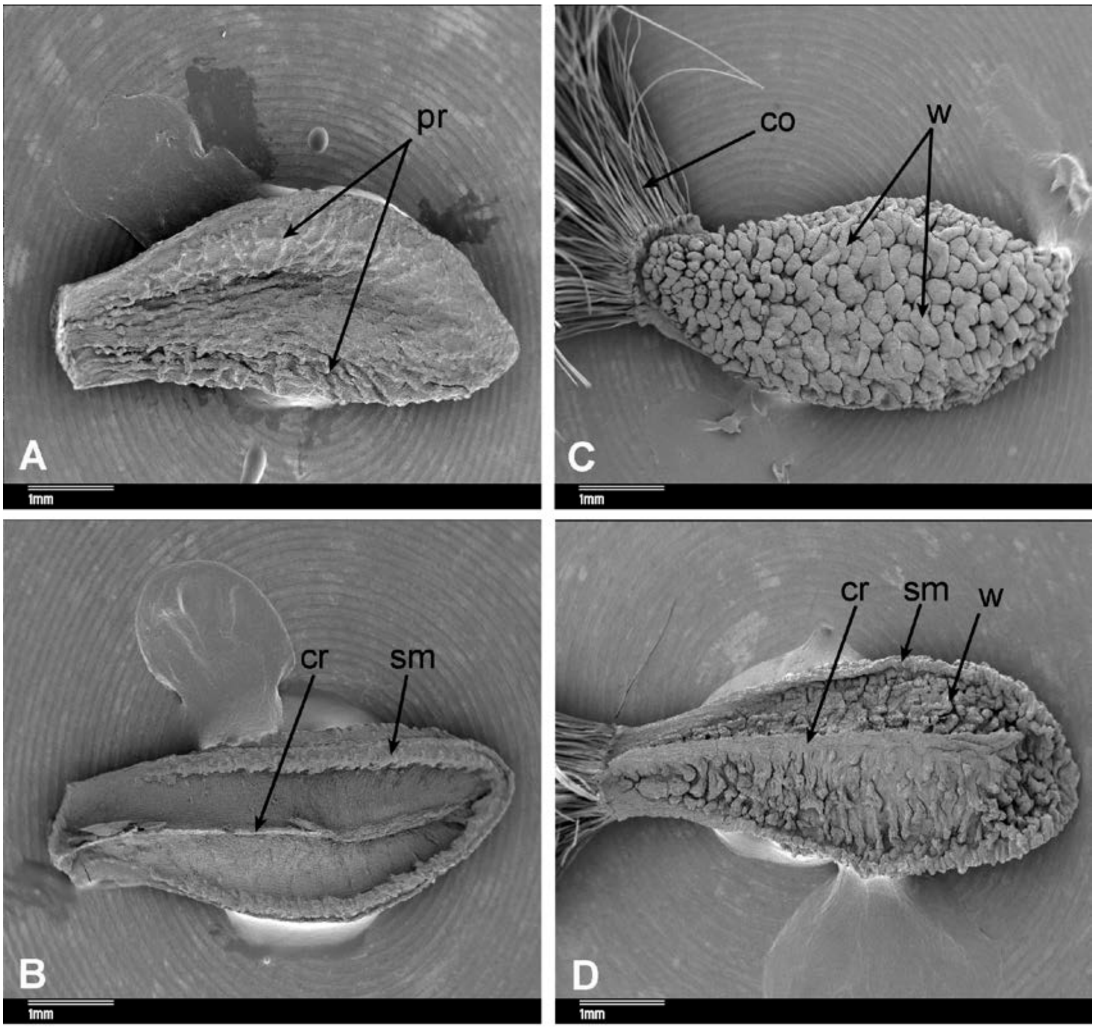


Fig. 3.15. *Cryptolepis* seeds: (A) adaxial view of *C. oblongifolia* seed showing protuberances consisting of deformed cells, (B) abaxial view of *C. oblongifolia* seed showing the central ridge, extending from mycropylar to chalazal end of seed, and thickened seed margin, (C) adaxial view of *C. cryptolepioides* seed showing wart-covered surface and coma of hairs at mycropylar end, (D) abaxial view of *C. cryptolepioides* seed showing central ridge, thin seed margin and small warts. Legend: (co) = coma of hair; (cr) = central ridge; (pr) = protruberances; (sm) = seed margin; (w) = warts. Scale bars: (A–D) = 1 mm. Specimens: (A–B) *Venter 8805* (BLFU); (C–D) *Venter 9197* (BLFU).

The results of the present study show that there is considerable variation in seed surface characteristics in *Cryptolepis.* Seed surfaces vary from smooth to smooth with inconspicuous protruberances of contorted cells, conspicuous protuberances (Fig. 3.15. A) or rough, wart-like surfaces (Fig. 3.15. C–D). Consequently the surface texture of the seeds cannot be used to distinguish *Cryptolepis* from other periplocoid genera as previously thought. Seed surface texture is, however, useful in distinguishing different species of *Cryptolepis.* Where species show similar cellular arrangement they may be differentiated by primary and secondary sculpture. The cells are usually tetra- to hexagonal and vary from isodiametric to elongate. The periclinal walls vary from concave to tabular or convex, while anticlinal walls are usually deeply sunken. The cuticle may be smooth or range from granular to striate. Seed characters are never sufficient to identify a *Cryptolepis* species, but these characters are useful in placing a specimen within a group of species with similar seed characteristics.

The seeds of the Periplocoideae are adapted to anemochoric dispersal. The primary adaptation to anemochoric dispersal is the coma of hairs that occur at the tip of the seed. As in other Apocynaceae genera the coma of hair in *Cryptolepis* is of micropylar origin (Boesewinkel and Bouman, 1984).

Sylla and Albers (1989) suggested that the raised seed margin in the Asclepiadoideae (then Asclepiadaceae) was an adaptation to aid anemochoric dispersal. In *Finlaysonia obovata* (Periplocoideae) the seed margin becomes broadened to from wings (Nwigwe, 2012) or a ring of hair may grow from the margin as in *Raphionacme namibiana* (Periplocoideae) (Venter and Verhoeven, 1986) replacing the coma as a distribution mechanism. The raised seed margins of the *Cryptolepis* species, though not as highly developed as in the case of the above mentioned taxa, could therefore be regarded as an aid to wind dispersal.

Surface roughness through heavy surface sculpturing would cause turbulence in laminar air flow and it has been suggested that this increases thermodynamic exchange and leads to cooling of sculptured structures such as seeds that do not have stomata for cooling gas exchange (Barthlott, 1981). Increased turbulence around a wind dispersed seed with a coma of hair could possibly increase uplift around the seed and in this way aid dispersal. Surface sculpturing, such as the protuberances in *C. decidua* and *C. obtusa*, ridges in *C. oblongifolia* and rough warts in *C. cryptolepioides,* possibly aid dispersal by increasing turbulence around the seeds.

Cryptolepis species show variety of seed coat sculpture and texture and these characteristics have significant taxonomic value at species level. The great variety of seed coat characteristics found in the genus, however, reduces the value of seed characteristics in distinguishing this genus from other genera in the subfamily.

CHAPTER 4

TAXONOMIC TREATMENT

4.1 Generic treatment of *Cryptolepis*

***Cryptolepis* R.Br.** Memoirs of the Wernerian Natural History Society: 1: 69 (1810b); Blume: 146 (1850); Baill.: 300 (1891), 802–803 (1889); K.Schum.: 320 (1895a), 219 (1895b); N.E.Br.: 242 (1902), 526–527 (1907); Schltr.: 300 (1895b), 314–315 (1986), 26 (1905b); H.Huber: 2 (1967), 28–29 (1973), 183 (1983); Bullock: 279 (1955); P.I.Forst.: 274 (1990), Venter & R.L.Verh.: 713 (1997); Venter: 136 (2006), 126 (2012).
Type species: *C. dubia* (Burm.f.) M.R.Almeida [=*C. buchananii* Roem. & Schult.] (*fide* Santapau & Irani (1960)).

= *Cochlanthus* Balf.f. in Proceedings of the Royal Society of Edinburgh 12: 78 (1884), 167 (1888) *nom. illegit.* [non *Cochlianthus* Benth.]
Type species: *Cochlanthus socotranus* Balf.f.

= *Curroria* Planch. in Hook.f. & Benth. in Hook., Niger Flora, 457–458 (1849); Benth. & Hook.f.: 741 (1876a); K.Schum.: 219 (1895b).
Type species: *C. decidua* Planch. in Hook.f. & Benth.

= *Ectadiopsis* Benth. in Benth. & Hook.f., Genera Plantarum 2(2): 741 (1876a). Balf.f.: 31: 162 (1888); Schltr.: 300 (1895b); K.Schum.: 320 (1895a), 219 (1895b); Bullock: 268 (1955).
Type species: *E. oblongifolia* (Meisn.) B.D.Jacks.

= *Lepistoma* Blume, Flora Javae: 7 (1828) *nom. illegit.*
Type species: *L. javanicum* (Blume) Steud.

= *Leposma* Blume, Bijdragen tot de Flora van Nederlandsch Indië 16: 1049 (Oct. 1826 – Nov. 1827).
Type species: *L. javanica* Blume (*Lepistoma javanicum* (Blume) Steud.).

= *Mangenotia* Pichon, Bulletin de la Société Botanique de France 101: 246 (1954).
Type species: *M. eburnea* Pichon.

= ***Mitolepis*** Balf.f. in Proceedings of the Royal Society of Edinburgh 12: 78 (1884), 165 (1888).
Type species: *M. intricata* Balf.f.

= ***Socotranthus*** Kuntze in T.Post & Kuntze, Lexicon Generum Phanerogamarum: 523 (1902).
Type species: *S. socotranus* (Balf.f.) Kuntze.

Description

Slender climbers, small suffrutices, shrubs or small trees. *Roots* non-tuberous, rarely a perennial rootstock. *Stems* woody, prostrate, erect, spreading or twining, with white, rarely orange to red latex, smooth to verrucose; young stems green, light- to dark-, purplish-, greyish- or bright reddish-brown to bright orange-red, glabrous, puberulent, puberulous, scabrous, tomentose or muricate; older stems pale to dark greyish-, purplish-, reddish-, or blackish-brown, glabrous or slightly muricate to puberulous; interpetiolar ridges with reddish to blackish conical colleters. *Leaves* opposite, decussately opposite or rarely fascicled, sessile, sub-sessile or petiolate; petiole slightly to deeply grooved; blade simple, broadly to narrowly elliptic, orbicular, ovate, obovate, oblong, oblong-elliptic, oblong-obovate, linear, lanceolate or oblanceolate, herbaceous, coriaceous or semi-succulent, mostly glabrous, occasionally slightly puberulous along main vein, rarely slightly puberulent, tomentose or villous on the adaxial surface and papillate, puberulous, tomentose or villous on abaxial surface, dark-, pale-, yellowish- or bright green, rarely glaucous, adaxially, pale green to pale grey or glaucous abaxially, purple spots occasionally present along main vein and margin; venation pinnate, consisting of primary midrib with secondary arching veins and tertiary reticulate veins; apex variously shaped, normal to recurved or incurved; base rounded, obtuse, cuneate, attenuate or truncate, rarely cordate; margin entire, plane, occasionally revolute or wavy. *Flowers* solitary or in cymose inflorescences. *Inflorescences* terminal, axillary or occasionally extra-axillary; cyme of 1–7 monochasia or 1–10 dichasia, each peduncle terminating in 1–3 monochasia, lax to compact, few- to many-flowered, glabrous to muricate, rarely puberulent, puberulous or tomentose. *Bracts* opposite, acicular, triangular, oblanceolate or spatulate, glabrous, puberulent, tomentose to fimbriate, rarely mucronate. *Flowers* bisexual, actinomorphic, pentamerous, semi-epigynous. *Buds* ovoid, broadly ovoid, oblong-ovoid, narrowly ellipsoid or oblong, rarely dumb-bell shaped, apices acute, apiculate, attenuate or obtuse, rarely conical, corolla lobes slightly turned or half-turn to full-turn helically twisted. *Sepals* free, narrowly to broadly ovate, elliptic, lanceolate to narrowly lanceolate, orbicular or triangular, apices obtuse, acute, attenuate or rounded, rarely mucronate, glabrous, puberulent, puberulous, hirsute or fimbriate, paired colleters at inner bases ovate, with dentate apices, to conical or rarely trichome-like. *Corolla* white, cream, yellow, greenish to greenish-yellow, rarely brownish, reddish-brown, pale pink, mauve, violet or violet-red; tube campanulate, narrowly campanulate, rarely elongate-urceolate or salver-shaped, outside glabrous, rarely puberulent, inside glabrous to villous; lobes ovate, linear-ovate, oblong-ovate, oblong, linear-oblong, narrowly triangular, narrowly elliptic, or lanceolate, apices acute, rotund or obtuse, reflexed or spreading, glabrous or rarely fimbriate. *Corona* single or double; primary corona of 5 lobes alternating with corolla lobes, inserted on corolla tube above stamens, with spongy coronal feet; lobes sub-clavate, clavate, deltoid, ovoid, broadly fusiform, trullinate, oblong, hastate or filiform, free, included in the corolla tube to slightly exserted, fleshy, connivent over style-head; secondary corona sometimes present, arising from corolla lobe sinuses, pocket-like, glabrous to puberulous, occasionally with filiform or bifid lobes arising from pocket rims. *Stamens* inserted at lower half, third, quarter or fifth of corolla tube; anthers sub-sessile to sessile, hastate to triangular, glabrous to villous on outer surface, free from each other, free or fused to primary corona lobe bases, inner bases fused to lower margin of style-head, connivent over apex of style-head. *Pollen* in rhomboidal or decussate tetrads, grains 3–4-porate, smooth. *Interstaminal nectaries* pocket-like at base of upper corolla tube. *Ovaries* two, semi-inferior, sub-globose, unilocular, many-ovuled, glabrous, compound style terete, glabrous, style-head pentangular, broadly pyramidal, narrowly dome-shaped or bell-shaped, glabrous, translators from upper surface; translators spatulate with receptacle narrowly elliptic or rarely ovate or deltoid, apices acute or obtuse, rarely retuse or emarginate, but not split, stipe absent, viscidium prominent. *Gynostegium* included in corolla tube. *Follicles* paired or seldom solitary, erect or pendulous, divaricate, horizontal or reflected, cylindrical, ovoid, cylindrically-ovoid to narrowly ovoid, rarely broadly ellipsoid and falcate, finely ribbed, apices blunt, acute, apiculate or attenuate, bases cuneate to obtuse. *Seeds* obovate, oblong, oblong-obovate, obliquely obovate, oblanceolate, rhombic, broadly or narrowly elliptic, brown to dark reddish-brown, smooth to warty, with dorsal rib; coma of hairs at micropylar end, white to yellowish-white.

Diagnostic characteristics

Corolla lobes dextrorsely contorted in bud, longer than the corolla tube, rarely slightly shorter. Corolla with a distinct upper corolla tube, usually campanulate, rarely urceolate, salver-form or reflexed, shorter than 25 mm. Corona single or double. Primary corona lobes inserted between the base and upper third of the upper corolla tube, but never at the corolla tube mouth. Secondary corona may be present as pockets in corolla lobe sinuses. Stamens inserted between the base and middle of the corolla tube and may be separated from the primary corona lobes by coronal pads or the staminal filaments may be fused to the bases of the primary corona lobes. Anthers glabrous or villous. Translators elliptic, broadly elliptic or deltoid with a smooth adaxial surface without a central groove.

Distribution and ecology

Cryptolepis is widely distributed throughout sub-Saharan Africa, from Somalia in the East to Guinea Bissau in the West, southward to the north-western and eastern parts of South Africa. The genus is also found in Yemen, including Socotra, and southern Asia, growing from India to Taiwan, the Philippines and the southern islands of Indonesia. Species of *Cryptolepis* grow in a variety of habitats. These range from desert and semi-desert to grassland, savannah, tropical and sub-tropical forest, in which plants are found along rivers and lakes, on plains, mountain slopes, or in crevices on the sides of ravines. They are found on soils derived from sandstone, granite, quartzite, dolerite, chert, basalt, dolomite and shale to limestone.

Flowering in *Cryptolepis* generally occurs from late spring to late autumn, with a peak in mid-summer, but some species may flower throughout the year, or rarely in winter and early spring.

4.2 Key to the species

1a. **Slender climbers or scramblers** growing in evergreen or deciduous forest, thicket, scrub or bushland of tropical and sub-tropical Africa and southern Asia, but absent from the arid Mandeb Circle (Somalia, Socotra and Yemen). **Leaves usually large to medium sized**, larger than 20 x 11 mm.

2a. Leaves elliptic, broadly elliptic or orbicular.

3a. Pedicels 5 mm or shorter. Corolla 10 mm or shorter. Leaves usually coriaceous with well developed areoles, rarely herbaceous with areole development lacking.

4a. Leaves sessile or petiole shorter than 4 mm. Intersecondary venation absent.

5a. Leaves larger than 70 x 28 mm. Buds broadly ovoid, apiculate, Corolla tube yellow-green and corolla lobes pink, mauve or reddish-brown. Found in Tropical Africa................***C. hypoglauca***

5b. Leaves smaller than 70 x 28 mm. Buds narrowly ovoid to oblong, acute to attenuate. Corolla tube and lobes white to yellow, often tinged red. Widesread over sub-Saharan Africa. ....***C. oblongifolia***

4b. Leaves petiolate, petioles 4 mm or longer. Intersecondary venation present.

6a. Leaves with 9–16 pairs of secondary veins on either side of the main vein. Inflorescences compact and many-flowered. Corolla tube glabrous inside. Growing in southern Asia or the eastern parts of Southern Africa.

7a. Leaves elliptic; bases cuneate. Corolla 8–10 mm long. Follicles ovoid, longer than 65 mm. Southern Asia. ....***C. dubia***

7b. Leaves orbicular, rarely broadly elliptic; bases rounded. Corolla 5 mm or shorter. Follicles narrowly ovoid, shorter than 60 mm. Southern Africa. ....***C. cryptolepioides***

6b. Leaves with 4–7 pairs of secondary veins on either side of the main vein. Inflorescences sub-compact to lax and few-flowered. Corolla tube villous below stamen insertion. Forests of East Africa.

8a. Leaves elliptic; apices acuminate to obtuse. Pedicels 3 mm or shorter. Corolla greenish-yellow, 8 mm or shorter. Corona double; primary corona lobes clavate; secondary corona pockets in corolla lobe sinuses prominent with deeply bifid lobes from pocket rims. Montane forest. ....***C. ibayana***

8b. Leaves broadly elliptic; apices rounded to emarginate. Pedicels 4 mm or longer. Corolla white to cream-coloured, 9 mm or longer. Corona single; primary corona lobes ovoid. Coastal and lowland forest................................***C. africana***

3b. Pedicels longer than 5 mm. Corolla longer than 10 mm. Leaves usually herbaceous, rarely coriaceous, but then with corolla longer than 15 mm.

9a. Latex red or orange. Inflorescences with bracts oblanceolate to spatulate, 3 mm long. Tropical Central to West Africa. ....***C. sanguinolenta***

9b. Latex white. Inflorescences with bracts acicular to triangular, 2 mm or shorter. Southern and East Africa, Mozambique, Zimbabwe or India.

10a. Inflorescences slender, bracts acicular. Corona single; primary corona lobes deltoid to trullate. Anthers villous. South Africa. ....***C. capensis***

10b. Inflorescences robust, bracts triangular. Corona double; primary corona lobes clavate; secondary corona pocket-like in corolla lobe sinuses. Anthers glabrous.

11a. Leaves coriaceous; venation brochidodromous. Pedicels 8 mm or longer. East Africa, Mozambique and Zimbabwe. ....***C. apiculata***

11b. Leaves herbaceous; venation eucamptodromous. Pedicels 7 mm or shorter. Endemic to India. ....***C. grandiflora***

2b. Leaves oblong, oblong-lanceolate or lanceolate, occasionally ovate, oblong-ovate or oblong-obovate.

12a. Leaves glabrous with no globular micromicropapillae on the abaxial leaf surface; apices rounded, obtuse or retuse, rarely acute. Inflorescences many-flowered. Corona double; primary corona lobes longer than 0.5 mm; secondary corona pocket-like.

13a. Primary peduncle 15 mm or shorter, secondary peduncles shorter than 10 mm and pedicels shorter than 4 mm. Buds less than 8 mm long. Corolla tube campanulate, 2 mm or shorter. Primary corona lobes clavate. East Africa to Southern Africa......***C. obtusa***

13b. Primary peduncle longer than 15 mm, secondary peduncles 10 mm or longer, pedicels 10 mm or longer. Buds 12 mm or longer. Corolla tube urceolate, longer than 4 mm. Primary corona lobes turbinate. Southern Asia. ....***C. sinensis***

12b. Leaves often slightly puberulent or densely villous, rarely glabrous adaxially, always with globular micromicropapillae abaxially. Apices attenuate to acuminate. Inflorescences few-flowered. Corona single, primary corona lobes shorter than 0.5 mm.

14a. Leaves glabrous or rarely sparsely puberulent adaxially. Buds dumb-bell shaped, apices conical. Corolla tube salver-shaped, puberulent outside, glabrous inside, tube longer than 7 mm. Tropical West Africa. ....***C. eburnea***

14b. Leaves sparsely puberulent or densely villous, rarely glabrous adaxially. Buds oblong, apices apiculate to attenuate. Corolla campanulate, glabrous outside and inside; tube shorter than 5 mm long. Central and East Africa.

15a. Leaves slightly puberulent to glabrous adaxially. Bracts triangular, 0.5–0.8 mm long. Sepals triangular to broadly ovate, acute, shorter than 1 mm. Anthers hastate, villous. Angola and the Democratic Republic of the Congo. ....***C. microphylla***

15b. Leaves densely villous on both surfaces. Bracts acicular, 2.5–3 mm long. Sepals narrowly lanceolate, attenuate, ± 4 mm long. Anthers triangular, glabrous. Tanzania. ....***C. villosa***

1b. **Dwarf-shrubs, shrubs or small trees**, occasionally with stems twining. Grow in desert, semi-desert, grassland and savannah of sub-Saharan Africa, Socotra and Yemen. Leaves usually smaller than 20 x 20 mm. Leaves occasionally longer than 20 mm, but then width 10 mm or less. **Leaves rarely larger than 20 x 10 mm**, but then shrubs or small trees, never with twining branches.

16a. Leaves elliptic, broadly elliptic, obovate or orbicular, with l:w < 3:1; coriaceous, plants occasionally with trailing or twining branches.

17a. Shrubs or dwarf-shrubs, often with twining branches, rarely small trees. Leaves smaller than 30 x 20 mm, occasionally longer than 30 mm, but then width less than 25 mm and absent from Socotra. Sub-Saharan Africa and Socotra.

18a. Corolla violet-red; tube narrowly urceolate. Endemic to Angola. ....***C. gossweileri***

18b. Corolla white, cream-coloured or yellow; tube campanulate. Found in sub-Saharan Africa and on Socotra.

19a. Large shrubs or small trees, branches erect, never twining, nodes tumid.

20a. Leaves dark green adaxially, pale green abaxially, slightly to densely puberulous. Flowers solitary; pedicels 2–3 mm long; bracts linear. Primary corona lobes filiform, 3–5 mm long. Endemic to Socotra. ....***C. arbuscula***

20b. Leaves pale green, glabrous. Inflorescences few-flowered; pedicels 6–7 mm long; bracts acicular. Primary corona lobes clavate, 0.5–1 mm long. Endemic to Somalia. ....***C. migiurtina***

19b. Shrubs or dwarf-shrubs, branches slender, often twining, nodes normal.

21a. Leaves orbicular to broadly elliptic, rarely elliptic, but then with flowers solitary. Corolla 6.5 mm or longer. Endemic to Somalia.

22a. Leaves petiolate; petiole 3–4 mm long. Stems and inflorescences densely tomentose with crispate trichomes, leaves sparsely to densely tomentose. Few-flowered inflorescences. Corolla shorter than 10 mm. Corona double. ....***C. thulinii***

22b. Leaves sessile. Stems and inflorescences glabrous to slightly puberulous with short, straight trichomes, leaves slightly scabrid. Flowers solitary. Corolla 13 mm or longer. Corona single. ....***C. orbicularis***

21b. Leaves elliptic to broadly elliptic, rarely obovate. Corolla shorter than 6 mm, if longer than 6 mm then with filiform lobes on secondary corona pocket rims. Sub-Saharan Africa, but absent from Somalia.

23a. Stems always twining. Leaf venation inconspicuous. Globular micromicropapillae present on abaxial leaf surface. Corona single. Anthers villous. Eastern Southern Africa. ....***C. delagoensis***

23b. Stems erect, rarely twining. Leaf venation conspicuous. Globular micromicropapillae absent. Corona double. Anthers glabrous. Widespread over tropical and sub-tropical Africa. ....***C. oblongifolia***

17b. Large shrubs or small trees, stems never twining. Leaves large, 35–70 x 21–55 mm. Endemic to Socotra.

24a. Shrub. Leaves glaucous to pale green, sessile to sub-sessile. Pedicels shorter than 4 mm. Corolla white to pale yellow, longer than 10 mm. Primary corona lobe apices bilobed and hooded. Fruit broadly keel-shaped, falcate. ....***C. socotrana***

24b. Tree. Leaves dark green adaxially, pale green abaxially, petioles 5–10 mm long. Pedicels longer than 4 mm. Corolla brownish, shorter than 10 mm. Primary corona lobe apices pyramidal. Fruit narrowly ovoid. ....***C. macrophylla***

16b. Leaves linear, oblong, oblong-obovate, lanceolate, rarely obovate, with l:w > 4:1. Leaves semi-succulent and branches erect, not twining, or leaves rarely coriaceous with branches often trailing or twining.

25a. Flowers solitary. Primary corona lobes filiform.

26a. Corolla violet to white. South Africa, Namibia and southern Angola. ....***C. decidua***

26b. Corolla greenish-yellow to cream-coloured. Endemic to Somalia and Socotra.

27a. Leaves glabrous adaxially, densely puberulous abaxially. Corolla pale yellow to cream-coloured. Corona double; primary corona lobes 2–3 mm long, slightly exserted from corolla tube. Endemic to Socotra. ....***C. intricata***

27b. Leaves slightly scabrid on both sides. Corolla greenish-yellow. Corona single; primary corona lobes 0.8 mm long, included in corolla tube. Endemic to Somalia. ...***C. gillettii***

25b. Flowers in few- to many-flowered inflorescences. Primary corona lobes clavate.

28a. Leaves coriacious. Found on Socotra and in sub-Saharan Africa, but absent from Somalia and Yemen.

29a. Shrub, always with trailing or twining branches. Inflorescences few-flowered. Corolla tube 1 mm long. Corona single. Endemic to Socotra. ....***C. volubilis***

29b. Shrub with branches erect, occasionally trailing or twining. Inflorescences many-flowered, rarely few-flowered. Corolla tube longer than 1.5 mm. Corona double; secondary corona pockets in corolla lobe sinuses often with filiform or short, bifid lobes from pocket rims. Widespread over sub-Saharan Africa. ....***C. oblongifolia***

28b. Leaves semi-succulent. Endemic to Somalia or Yemen.

30a. Leaves 25 mm or longer. Corolla often tinged red on outer surface. ....***C. stefaninii***

30b. Leaves 20 mm or shorter. Corolla never tinged red.

31a. Shrub, up to 1.5 m tall. Sepals ovate, about 1 x 0.5 mm. Corolla greenish-white. Primary corona lobes shorter than 0.5 mm. Endemic to Yemen. ....***C. yemenensis***

31b. Dwarf-shrubs, up to 0.5 m tall. Sepals triangular to narrowly triangular, 1–3 x 1 mm. Corolla yellow. Primary corona lobes 1 mm long. Endemic to Somalia.

32a. Leaves oblong-obovate. Bracts subulate. Corolla 9 mm or longer; tube glabrous; lobes linear, 7–9 x 1 mm. Anthers glabrous. ....***C. nugaalensis***

32b. Leaves oblong. Bracts triangular. Corolla shorter than 5 mm; tube papillose below corona lobes; lobes triangular to ovate, 2–3 x 1 mm. Anthers villous. ....***C. somaliensis***

4.3 Species nomenclature, description and distribution

4.3.1 *Cryptolepis africana* (Bullock) Venter & R.L.Verh., South African Journal of Botany, 73(1): 40 (2007); Venter: 128 (2012). Basionym: *Cryptolepis sinensis* subsp. *africana* Bullock in Kew Bulletin 10(2): 282 (1955).

Type: Kenya, Kwale District, Buda Mafisini Forest, 13 km WSW of Gazi, 16-08-1953, *Drummond, R.B. & Hemsley, J.H. 3836* (K!, holo.; BR!, EA, K!, iso.).

A climber, with white latex, 2–3 m high. *Stems* woody, slender, up to 1.5 mm diameter,; young stems dark brown, smooth, glabrous; older stems unknown; interpetiolar ridges glabrous to slightly villous, prominent on younger stems, colleters present. *Leaves* opposite, axils slightly villous, petiolate; petiole greenish-brown, glabrous, slightly grooved, 6–10 mm long; blade broadly elliptic, 50–82 x 26–50 mm, herbaceous, green adaxially, pale grey abaxially, glabrous; margin plane; apex rounded to emarginate, apiculate, glabrous, not recurved; base obtuse to cuneate; venation brochidodromous, conspicuous on abaxial surface, 5–7 secondary veins on either side of main vein, intersecondary venation present, tertiary veins random reticulate, highly inconspicuous, areole development lacking, veinlets absent. *Inflorescences* cymose, lax, few-flowered, slender, each cyme consists of 1 dichasium or 1–3 compound monochasia, each ending in 1–2 monochasia, primary peduncle 15–30 mm long, secondary peduncles 15–40 mm long, pedicels 4–5 mm long; bracts sparsely arranged, opposite, glabrous, acicular, 0.5–1 mm long, margins glabrous. *Buds* slender, 9–10 mm long, oblong, apices attenuate, full turn helically twisted. *Sepals* ovate, ± 2 x 0.8 mm, acute, glabrous, colleters conical. *Corolla* white to cream, 9–10 mm long; tube campanulate, 2–3.5 mm long, glabrous outside, villous inside below stamen insertion; lobes spreading, linear to linear-ovate, 7–8 x 1 mm, apices obtuse to acute. *Corona* single; primary corona inserted 1.2–2 mm from corolla tube base, included; lobes ovoid, fleshy, ± 0.5 mm long, glabrous, apices acute to apiculate. *Stamens* inserted ± 1 mm from corolla tube base; anthers hastate, attenuate, villous outside, ± 1 mm long, sessile. *Nectaries* ± 1 mm from corolla tube base, prominent. *Ovaries* ± 0.9 x 1 mm; style ± 0.2 mm long, style-head broadly pyramidal, truncate, ± 0.5 x 0.9 mm. *Translators* narrowly elliptic, ± 0.5 mm long, apices acute. *Follicles* unknown. *Seeds* unknown. (Fig. 4.3.1.1.)

Diagnostic characteristics

Cryptolepis africana is a slender climber from East Africa. It has broadly elliptic leaves with rounded to emarginate apices; large, 50–82 x 26–50 mm. This species is distinguished from similar species with coriaceous leaves, such as *C. apiculata, C. dubia, C. hypoglauca* and *C. ibayana,* by a combination of herbaceous leaves, with the corolla white to cream-coloured, corona single and primary corona lobes ovoid, 0.5 mm long. *Cryptolepis africana* is distinguished from similar species with herbaceous leaves, such as *C. capensis, C. grandiflora* and *C. sanguinolenta,* by a combination of intersecondary veins being present, areole development lacking, bracts acicular, less than 1.5 mm long and corolla 10 mm or shorter.

Distribution and habitat

Cryptolepis africana is found in Kenya, in the Kwale and Kilifi Districts (Fig. 4.3.1.2.). It forms part of coastal and lowland forest, at altitudes ranging from 60–80 m. Associated species are not known. Flowering occurs from August to September.

Representative specimens

— 3º54' S, 39º37' E: Kenya, Kilifi District, Kaya Ribe Forest, 02-09-1999, *Luke, W.R.Q. & Mbinda, J. 5978* (K).

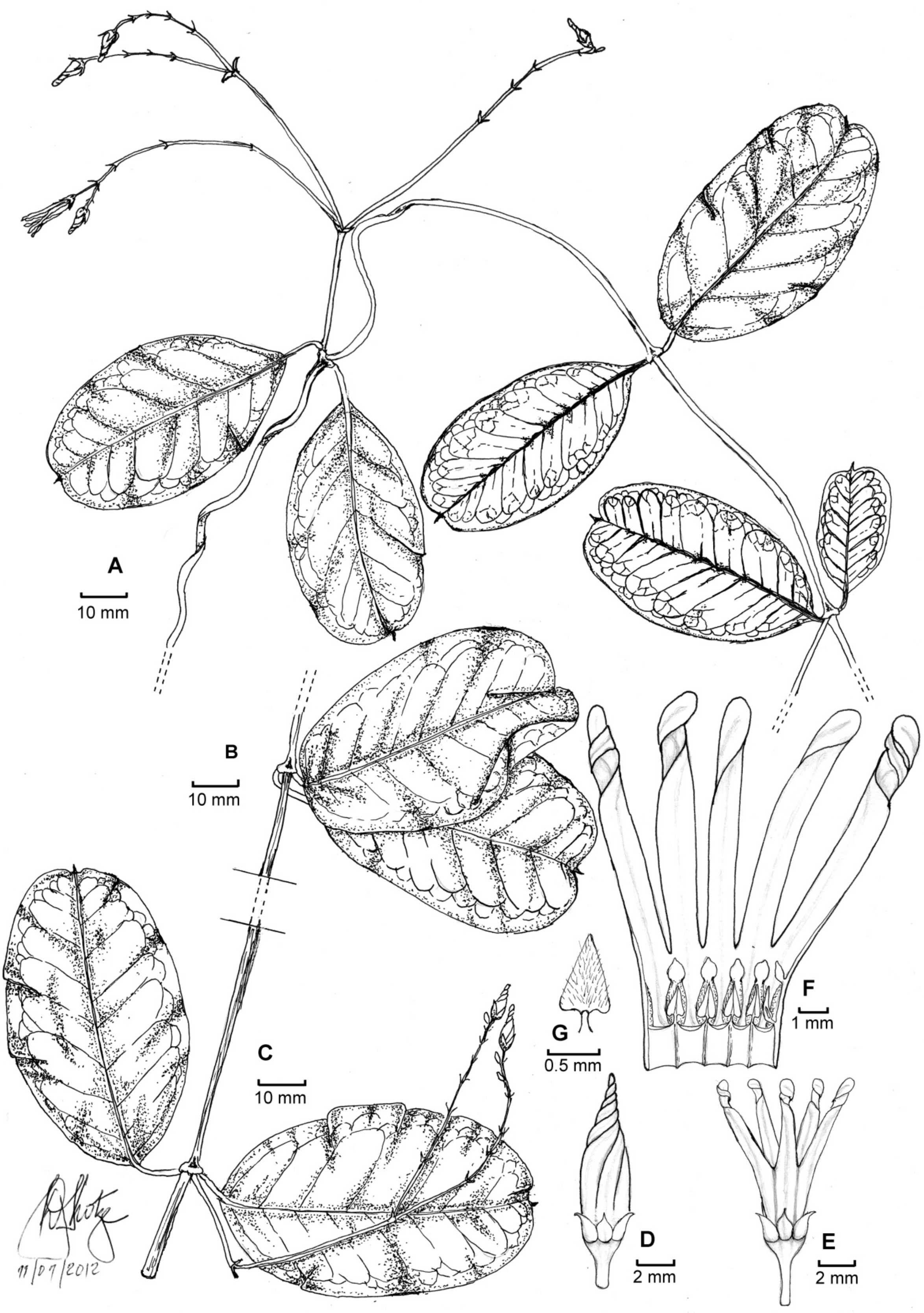


Fig. 4.3.1.1. Illustration of *Cryptolepis africana*: (A–C) stem with leaves and inflorescences, (D) external view of bud, (E) external view of mature flower, (F) corolla opened showing helically twisted corolla lobes, ovate, apiculate primary corona lobes, stamens with narrowly hastate anthers and prominent nectaries, (G) anther showing villous adaxial surface. Specimens: (A, C–G) *Drummond & Hemsley 3836* (K); (B) *Luke & Mbinda 5978* (K).

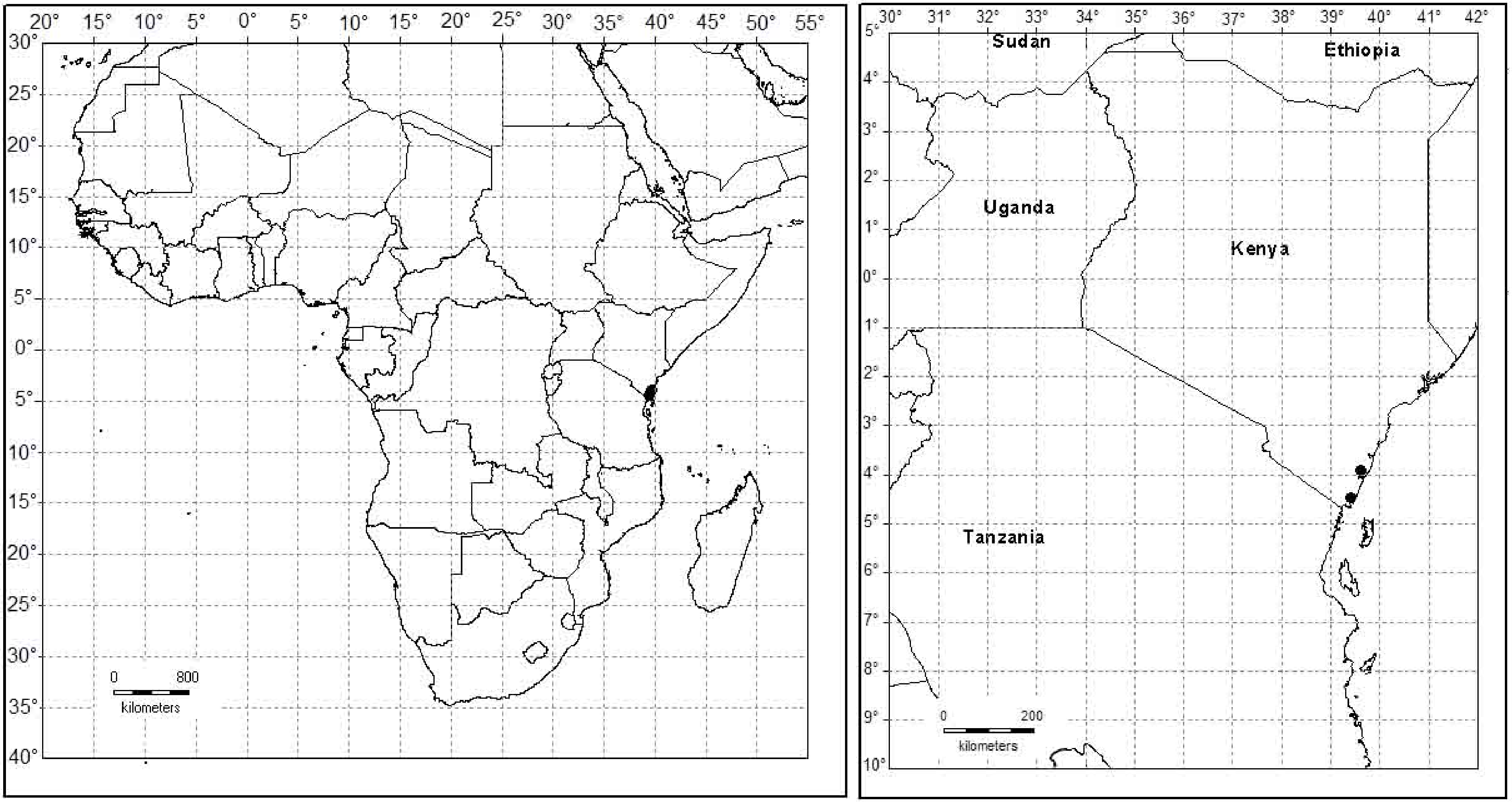


Fig. 4.3.1.2. Known distribution of *Cryptolepis africana*.

Leaf micromorphology

Cells on the adaxial surface are more or less isodiametric and tetra- to pentagonal. The periclinal walls are tabular while the anticlinal wall boundaries are straight. The cuticle is smooth to slightly striated with striations being straight, parallel and restricted to individual cells. (Fig. 4.3.1.3. A–C)

The abaxial epidermis consists of variously shaped cells with tabular to slightly convex periclinal walls and anticlinal walls which are curved to wavy and sunken. The cuticle has dense, wavy, randomly orientated striations which are continuous over intercellular boundaries. No wax is present. (Fig. 4.3.1.3. D–F)

The leaves are hypostomatic with stomata randomly orientated and slightly sunken or level with the surrounding epidermal cells. Stomata are paracytic with striations on subsidiary cells randomly orientated. The guard cells are elliptic and covered by a narrow stomatal ledge. (Fig. 4.3.1.3. D–F)

Seed micromorphology

Seed unknown.

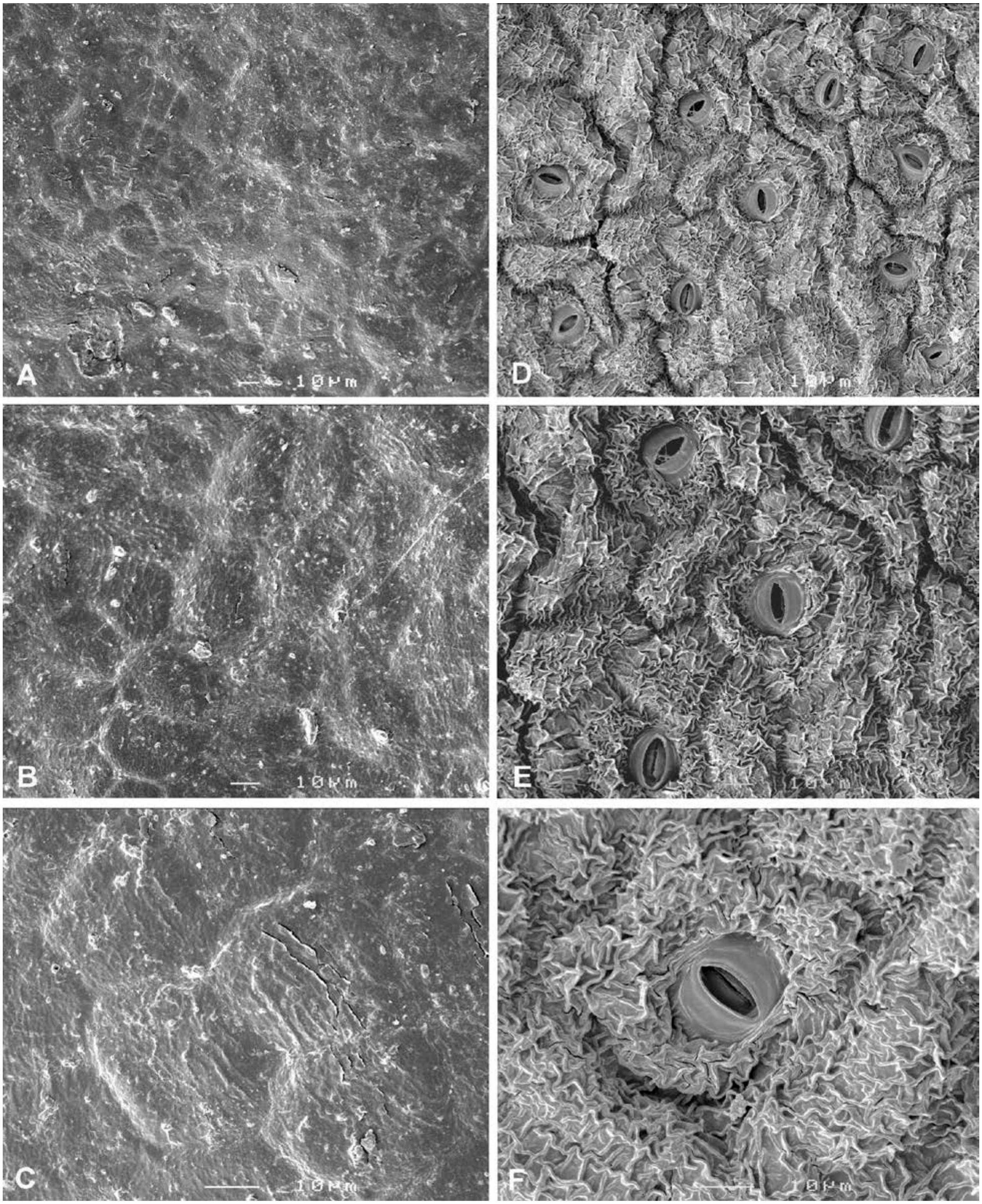


Fig. 4.3.1.3. *Cryptolepis africana* leaf epidermal surfaces: (A–C) adaxial epidermis showing isodiametric cells covered by a smooth to slightly striated cuticle, (D–F) abaxial epidermis showing variously shaped cells covered by a densely striated cuticle and stomata randomly orientated, with narrow stomatal ledges. Magnification: A, D = x400; B, E = x650; C, F = x1200. Specimen: (A–F) *Luke & Mbinda 5928* (K).

4.3.2 *Cryptolepis apiculata* K.Schum., Pflanzenwelt Ost-Afrikas C: 320 (1895a), 219 (1895b); N.E.Br.: 244 (1902); Brenan: 64 (1949); Bullock: 280 (1955); Venter: 128 (2012).[Note 1]

Type: Tanzania, Tanga District, Amboni-Hügel, *Holst 2564* (B†, holo.; M!, lecto. designated by Venter (2012), HBG-scan!, K!, COI, isolecto.).

A climber, with white latex, up to 3 m high. *Stems* woody, slender, 1.5–2.5 mm diameter; young stems light reddish-brown, smooth, glabrous; older stems grey-brown, verrucose, glabrous; interpetiolar ridges glabrous, colleters inconspicuous on younger stems, absent on older stems. *Leaves* opposite, axils glabrous, petiolate; petiole green, glabrous, slightly grooved, 4–14 mm long; blade elliptic to broadly elliptic, 75–145 x 30–60 mm, coriaceous, dark green adaxially, pale green abaxially, glabrous; margin plane to undulate; apex apiculate, glabrous, not recurved; base obtuse to cuneate; venation brochidodromous, conspicuous on lower leaf surface, 6–7 secondary veins on either side of main vein, intersecondary venation poorly developed, tertiary veins random reticulate, areoles imperfect, veinlets branched. *Inflorescences* cymose, lax, few-flowered, robust, each cyme consists of 1 dichasium ending in 1–3 monochasia, primary peduncle 35–85 mm long, secondary peduncles 15–35 mm long, pedicels 8–18 mm long; bracts opposite, sparsely to densely arranged, glabrous, triangular, 1–2 mm long, margins glabrous. *Buds* robust, 10–15 mm long, oblong, apices attenuate, full turn helically twisted. *Sepals* ovate to elliptic, 3 x 1.5 mm, obtuse, glabrous, colleters conical. *Corolla* white to cream or greenish, 17–20 mm long; tube campanulate, 4.5–5 mm long, glabrous; lobes reflexed, linear, 12–14.5 x 1.5–2 mm, apices obtuse. *Corona* double; primary corona inserted ± 3 mm from corolla tube base, included; lobes clavate, fleshy, apices acute to apiculate, 1–1.5 mm long, glabrous, connivent over gynostegium; secondary corona in corolla lobe sinuses, pocket-like, glabrous, inconspicuous. *Stamens* inserted ± 1 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 1 mm long, filaments ± 0.2 mm long. *Nectaries* conspicuous, inserted ± 0.2 mm from corolla tube base. *Ovaries* ± 1 x 0.9 mm; style ± 0.2 mm long, style-head broadly pyramidal, apiculate, ± 0.5 x 0.5 mm. *Translators* narrowly elliptic, ± 0.7 mm long, apices acute. *Follicles* pendulous, divaricate at 180°, cylindrical, 75–80 x 8–13 mm, brown, apices attenuate, bases cuneate. *Seeds* narrowly obovate, 7 x 1.5 mm, dark brown, smooth; coma white to yellowish-white, ± 27 mm long. (Fig. 4.3.2.1.)

Diagnostic characteristics

Cryptolepis apiculata is a slender climber from East and Southern Africa. It has large, 75–145 x 30–60 mm, elliptic to broadly elliptic leaves with apiculate apices. This species is distinguished from similar, coriaceous leaved species, such as *C. dubia, C. hypoglauca* and *C. ibayana,* by a combination of poorly developed intersecondary veins, imperfect areole development, lax, few-flowered inflorescences with primary peduncles longer than 30 mm, buds oblong and attenuate, and corolla longer than 15 mm. *Cryptolepis apiculata* is distinguished from herbaceous leaved species with similar corolla length, such as *C. africana, C. capensis*, *C. grandiflora* and *C. sinensis,* by a combination of intersecondary veins, inflorescences robust and corona double, with primary corona lobes clavate and longer than 1 mm.

Distribution and habitat

Cryptolepis apiculata is found in East and Southern Africa in Kenya, Tanzania, Mozambique and Zimbabwe (Fig. 4.3.2.2.). It grows in coastal and riverside forests in gullies, dry scrub and grassy eastern slopes at altitudes from 0–1100 m. *Cryptolepis apiculata* is often found in the forest margin or in disturbed sites where the vegetation has been cleared for roads. This species is associated with deep loamy soil on limestone outcrops. Associated species include *Brachystegia* spp. and *Julbernardia* spp. Flowering occurs during May in Kenya, from January to June in Tanzania, with a peak during April, during April in Mozambique and from November to February in Zimbabwe.

Notes

1. The name, *Cryptolepis apiculata* K.Schum., was published by Schumann (1894, 1895b) before the accepted earliest date of publication by Schumann (1895a). Since none of these publications contain a description, diagnosis or reference to a description or diagnosis of the species, none of these publications can be considered as valid publication of the new name.

Representative specimens

— **3º18' S, 39º44' E:** Kenya, Kilifi District, Mangea Hill (Sita), 24-03-1989, *Luke, W.R.Q. & Robertson 1784* (EA, K).

— **8º00' S, 36º44'03" E:** Tanzania, Ifakara District, Nyanganje [Nanganji] Forest Reserve, 04-1960, *Haerdi, F. 487/0* (K).

— **18º55' S, 34º26' E:** Mozambique, Sofala District, Gorongosa [National Park], 15-04-1966, *Macedo, A. 179* (WAG).

— **18º58'39" S, 32º41'50" E:** Zimbabwe, Mutare [Umtali] District, Commonage, 01-02-1957, *Chase, N.C. 6311* (COI, LISC, SRGH).

— **19º06'25" S, 32º49'51" E:** Zimbabwe, Mutare [Umtali] District, Burma Valley, Vumba [Botanical Reserve], on Steyns Farm, 04-12-1961, *Wild, H. & Chase, N.C. 5555* (K, MO, SRGH).

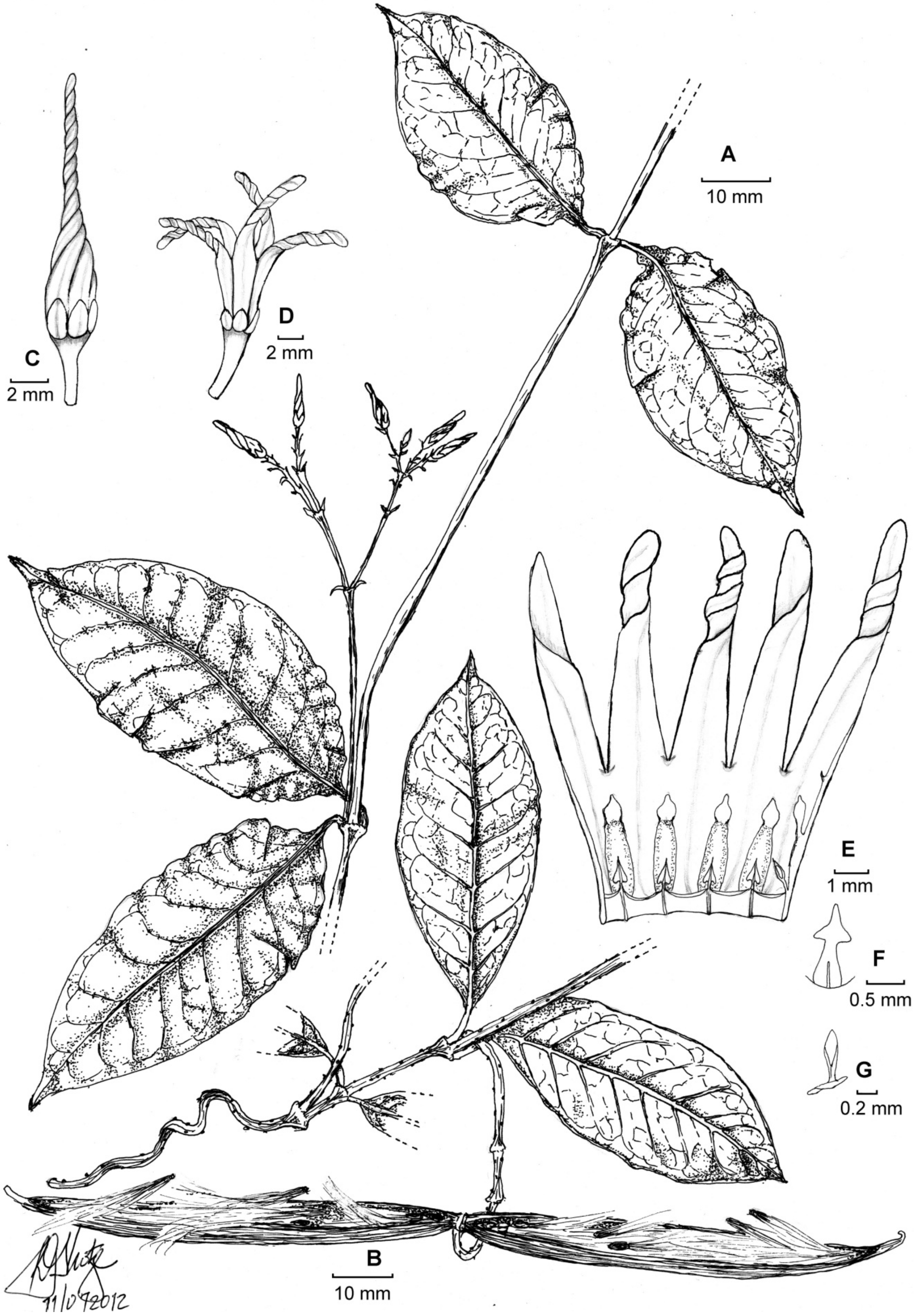


Fig. 4.3.2.1. Illustration of *Cryptolepis apiculata*: (A) stem with leaves and inflorescence, (B) stem with paired follicles, (C) external view of bud, (D) external view of mature flower, (E) corolla opened showing helically twisted corolla lobes, clavate, acute primary corona lobes, secondary corona pockets, stamens with narrowly hastate anthers and prominent nectaries, (F) pistil of semi-inferior apocarpous ovaries, style and broadly pyramidal style-head, (G) translator. Specimens: (A, C) *Wild & Chase 5555* (K); (B) *Chase 7730* (K); (D–G) *Chase 5185* (MO).

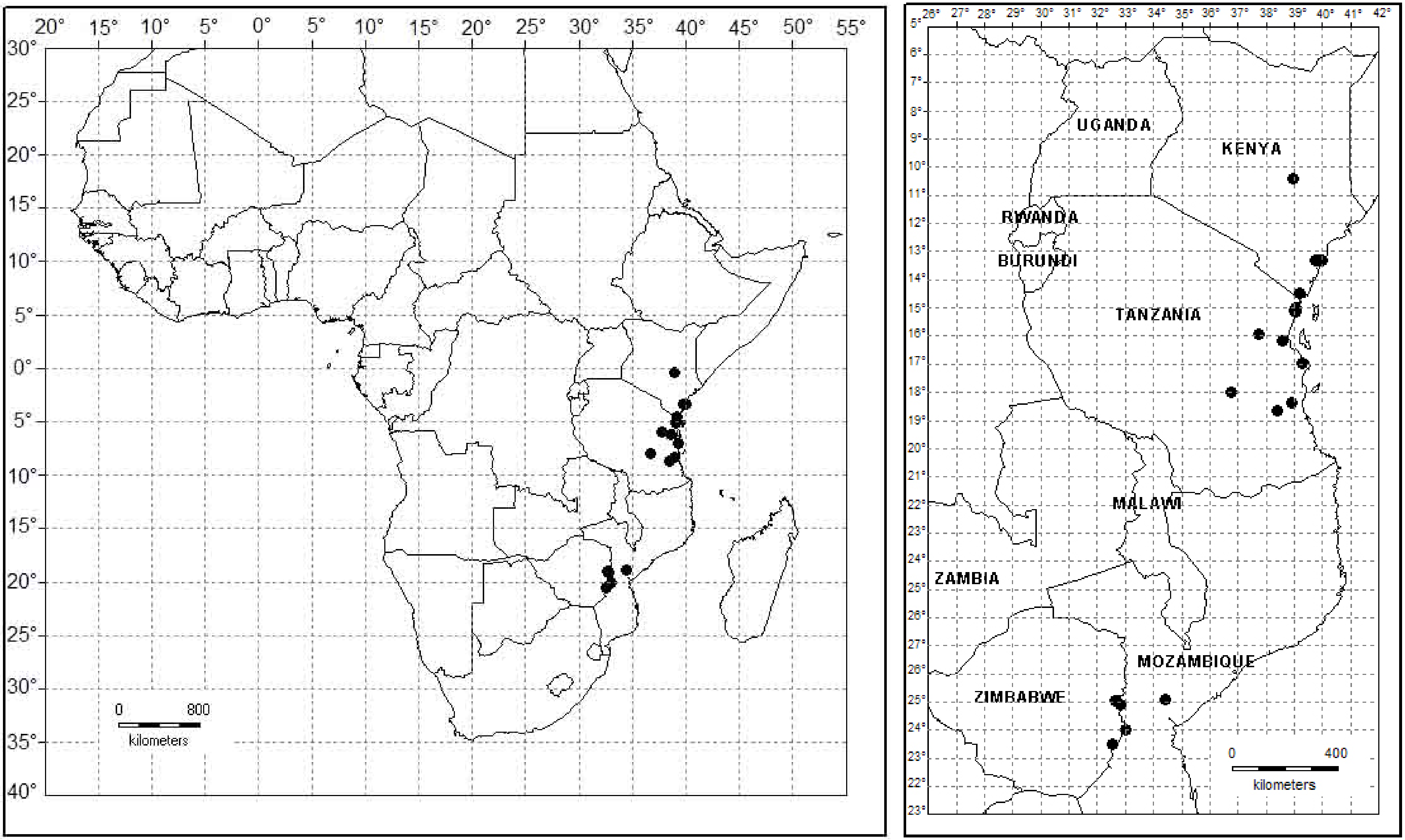


Fig. 4.3.2.2. Known distribution of *Cryptolepis apiculata*.

Leaf micromorphology

Cells on the adaxial epidermal surface are isodiametric, tetra- to hexagonal. Periclinal walls are tabular to concave. Anticlinal walls are straight and slightly sunken. The cuticle may be smooth or slightly to densely striated. Striations are straight or slightly wavy, randomly orientated and restricted to individual cells. (Fig. 4.3.2.3. A–C)

Cells on the abaxial epidermal surface are isodiametric, tetra- to hexagonal. Periclinal walls are tabular. Anticlinal walls are straight and slightly sunken. The cuticle is slightly to densely striated with striations wavy, randomly orientated and restricted to individual cells or continuous over intercellular boundaries. Wax platelets may be present. (Fig. 4.3.2.3. D–F)

The leaves are hypostomatic with numerous stomata randomly orientated and on the same level as the surrounding epidermal cells. Stomata are paracytic with striations on subsidiary cells randomly orientated. The guard cells are broadly elliptic and are covered by a narrow stomatal ledge. (Fig. 4.3.2.3. D–F)

Seed micromorphology

The adaxial seed surface is smooth with sparsely arranged, inconspicuous protuberances that are formed by raised epidermal cells (Fig. 4.3.2.4. A). Epidermal cells forming these protuberances show no clearly distinguishable shape (Fig. 4.3.2.4. B). Epidermal cells between the protuberances are more or less isodiametric and tetra- to hexagonal. Periclinal walls are convex while anticlinal walls are straight and deeply sunken (Fig. 4.3.2.4. C–D). The cells are covered by a coarse granular cuticle (Fig. 4.3.2.4. E).

Adaxially the seed has a narrow central ridge (Fig. 4.3.2.5. A). The surfaces between the ridge and the seed margins are smooth (Fig. 4.3.2.5. B) or dotted with inconspicuous protuberances formed by raised epidermal cells (Fig. 4.3.2.5. D). Cells are isodiametric to elongated and tetra- to hexagonal. Periclinal walls are convex or rarely concave while anticlinal walls are straight and deeply sunken (Fig. 4.3.2.5. C, E). The cells are covered by a coarse granular cuticle (Fig. 4.3.2.5. C)

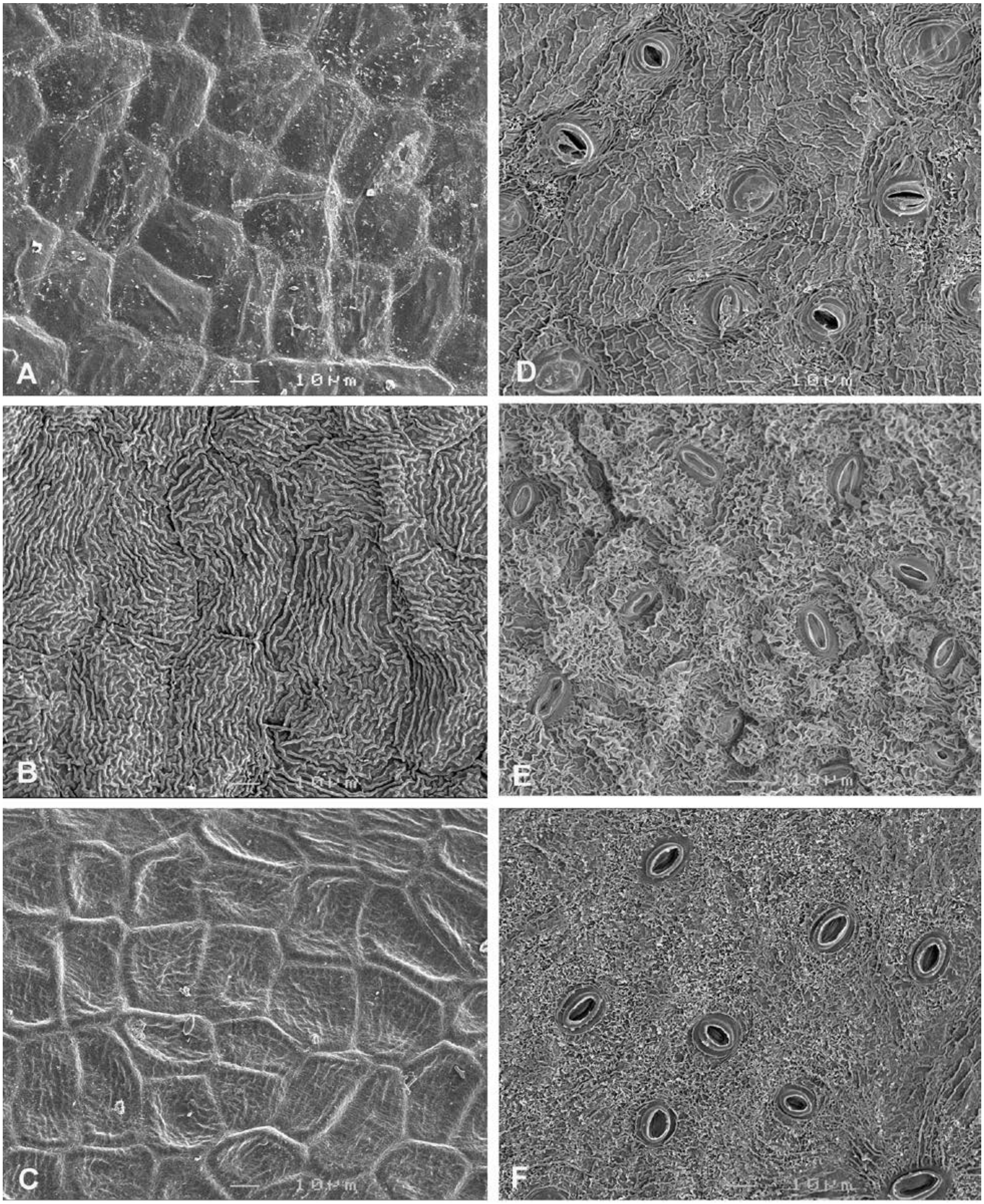


Fig. 4.3.2.3. *Cryptolepis apiculata* leaf epidermal surfaces: (A) adaxial epidermal cells with tabular periclinal walls and smooth cuticle, (B) adaxial epidermal cells with tabular periclinal walls and densely striated cuticle, (C) adaxial epidermal cells with concave periclinal walls and slightly striated cuticle, (D) abaxial epidermis with slightly striated cuticle, stomata and no wax platelets, (E) abaxial epidermis with densely striated cuticle, stomata and no wax platelets, (F) abaxial epidermis with slightly striated cuticle, stomata and dense covering of wax platelets. Magnification: A–F = x650. Specimens: (A, D) *Chase 6311* (SRGH); (B, E) *Haerdi* 487/0 (K); (C, F) *Wild & Chase 5555* (SRGH).

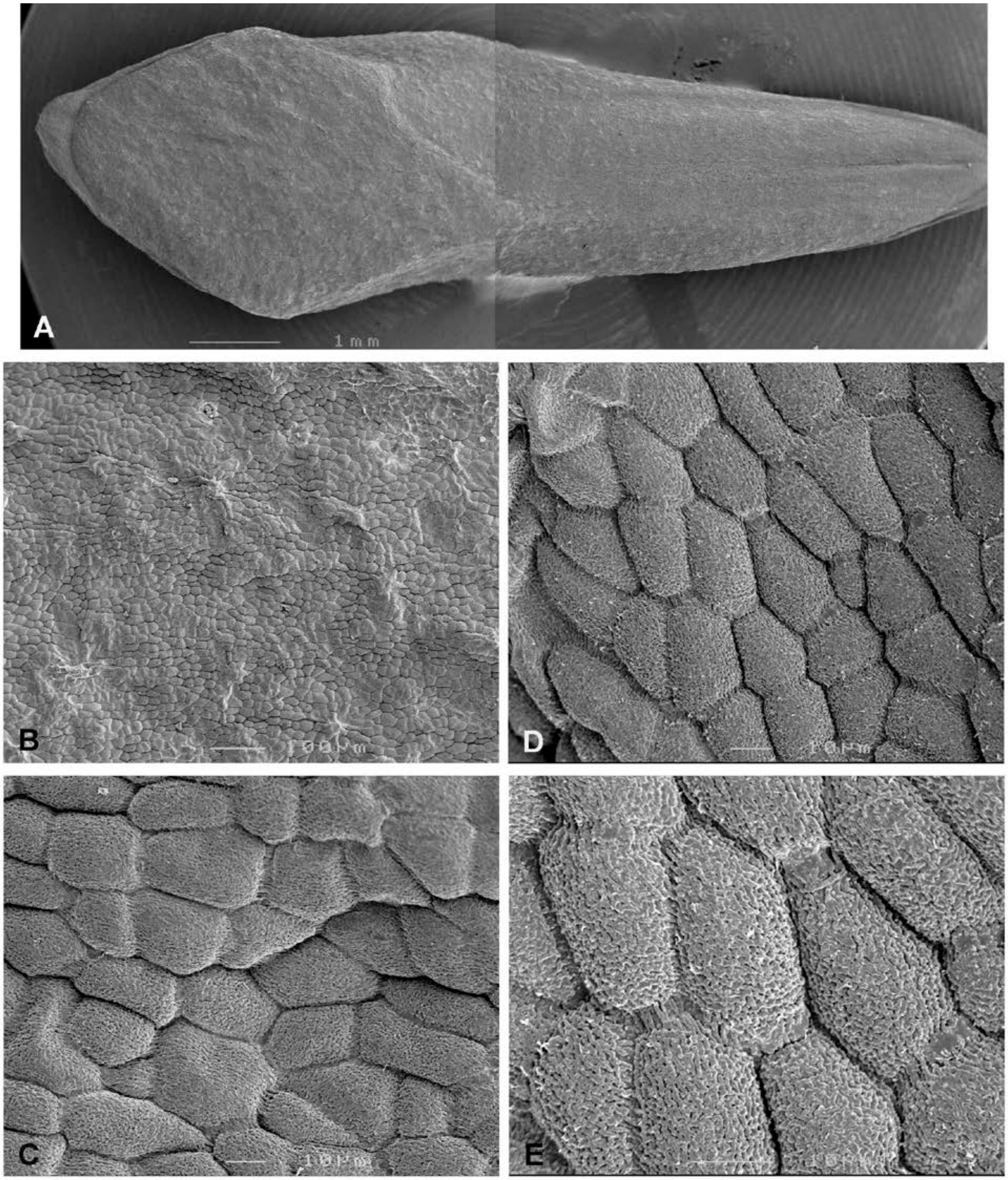


Fig. 4.3.2.4. *Cryptolepis apiculata* seed surface: (A) adaxial view of seed, (B) adaxial seed surface with inconspicuous, sparsely arranged protuberances, (C, D) cells tetra- to hexagonal with convex periclinal walls and deeply sunken anticlinal walls, (E) cells covered by a granular cuticle. Magnification: A = x20; B = x120; C–D = x900; E = x1800. Specimens: (A–C) *Chase 5056* (BM); (D–E) *Chase 7730* (SRGH).

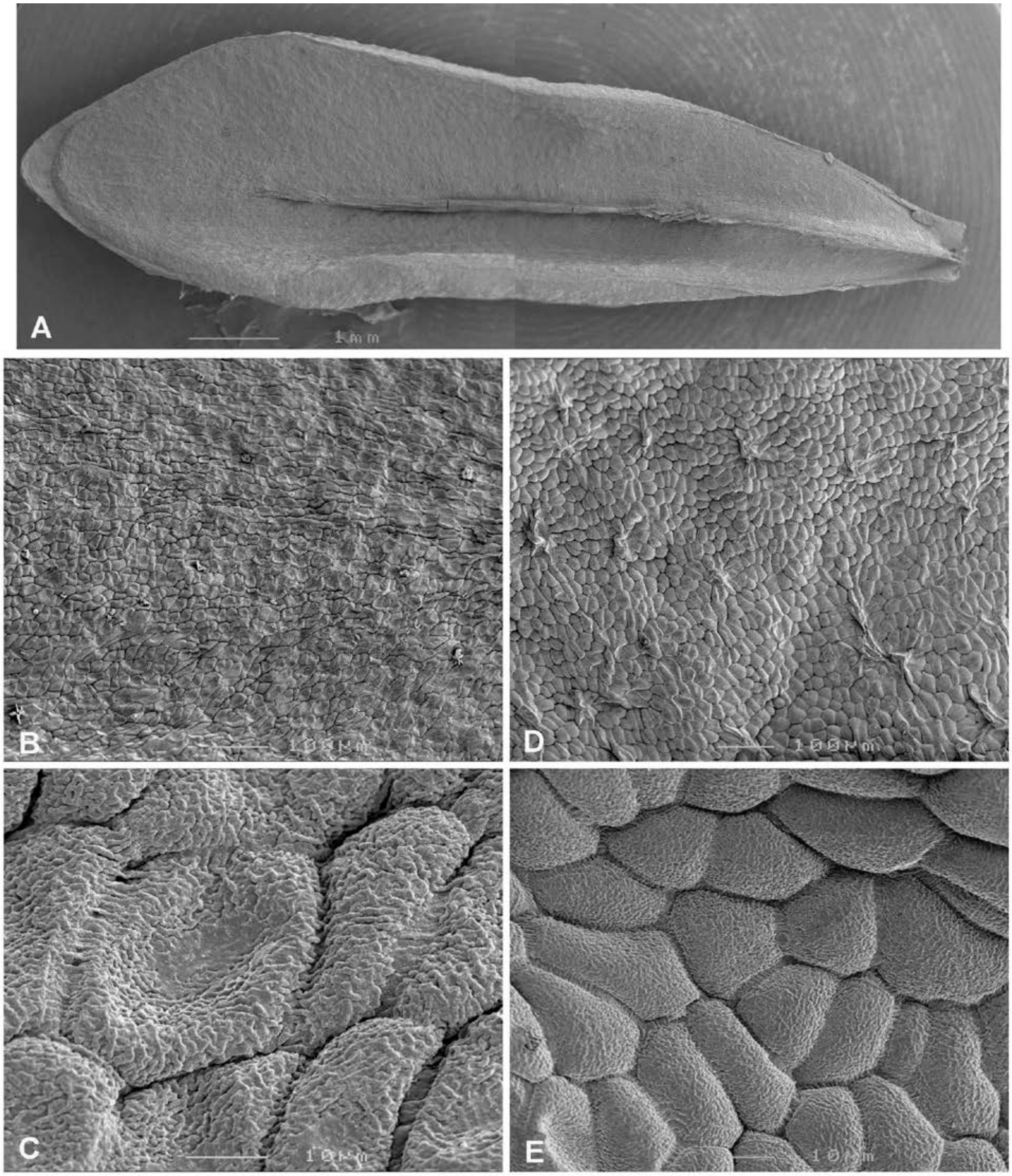


Fig. 4.3.2.5. *Cryptolepis apiculata* seed surface: (A) abaxial view of seed, (B) abaxial surface between central ridge and seed margin smooth, (C) cells with concave periclinal walls and granular cuticle, (D) abaxial surface between central ridge and seed margin with inconspicuous protuberances, (E) cells with convex periclinal walls and deeply sunken anticlinal walls. Magnification: A = x20; B, D = x120; C = x1800; E = x900. Specimens: (A–C) *Chase 5056* (BM); (D–E) *Chase 7730* (SRGH).

4.3.3 *Cryptolepis arbuscula* (Radcl.-Sm.) Venter in Venter & R.L.Verh., Taxon 46(4): 713 (1997). Basionym: *Mitolepis arbuscula* Radcl.-Sm., Hooker's Icones Plantarum 7(1): 3686 (1959).

Type: Socotra, Hamaderoh Mountain, *Smith & Lavranos 308* (K!, holo.; FT-scan!, iso.).

A shrub to small tree, with white latex, from 1.5–4 m high. *Stems* woody, erect, branching, stem diameter unknown; nodes tumid, creating a knobbly appearance; young stems light brown, verrucose, glabrous; older stems greyish brown, often rough and verrucose, glabrous; brachyblasts densely clustered enhancing knobbly appearance, surfaces tomentose; interpetiolar ridges inconspicuous on younger stems, absent on older stems, colleters present. *Leaves* opposite or fascicled, axils densely villous, sub-sessile to petiolate; petiole green, puberulous, slightly grooved, 1–3 mm long; blade obovate, rarely elliptic, 8–22 x 3–15 mm, coriaceous, puberulous, dark green adaxially, pale green abaxially; margin plane or occasionally undulate; apex obtuse to retuse, mucronate, tomentose, not recurved; base cuneate; venation brochidodromous, prominent abaxially, indistinct adaxially, 4–6 secondary veins on either side of main vein, intersecondary veins absent, tertiary veins weakly percurrent, areole development imperfect, veinlets absent. *Flowers* solitary on brachyblasts, pedicels 2–3 mm long, puberulous; bracts 1–2 per pedicel, opposite or spirally arranged, puberulent, linear, 1–2 mm long, margin fimbriate. *Buds* slender, ± 6 mm long, oblong-ovoid, apices acute, slightly turned. *Sepals* lanceolate, 3–5 x 0.6–0.8 mm, cuspidate, puberulous, colleters conical. *Corolla* yellow to cream with tinges of pale green, 10–14 mm long; tube campanulate, 2–3 mm long, glabrous; lobes spreading, linear to narrowly ovate, 7–12 x 2–3 mm, apices obtuse. *Corona* double; primary corona inserted 1–1.5 mm from corolla tube base, exserted; lobes filiform, concave near base, fleshy, 3–5 mm long, glabrous, apices connivent over gynostegium; secondary corona in corolla lobe sinuses, pocket-like, glabrous. *Stamens* inserted 1–1.5 mm from corolla tube base, fused to raised coronal foot; anthers hastate, attenuate, glabrous, ± 1.2 mm long, filaments ± 0.2 mm long. *Nectaries* prominent, inserted ± 0.2 mm from corolla tube base. *Ovaries* 0.5–0.7 x 0.8–0.9 mm; style ± 1 mm long, style-head narrowly dome-shaped, apex bifid, 0.5–1 x 0.6–0.8 mm. *Translators* narrowly elliptic, 0.8–1 mm long, apices acute. *Follicles* erect, widely divaricate at 110°–180°, narrowly ovoid, 31–38 x 4.5–7.5 mm, light brown, apices attenuate, bases cuneate. *Seeds* narrowly elliptic, ± 7 x 2 mm, dark brown, slightly warty; coma white to yellowish-white, ± 15 mm long. (Fig. 4.3.3.1.)

Diagnostic characteristics

Cryptolepis arbuscula is a shrub or small tree from Socotra. It has erect stems with tumid nodes and small, 8–22 x 3–15 mm, obovate to elliptic leaves, with obtuse to retuse apices, solitary flowers and filiform corona lobes. It is distinguished from the similar *C. migiurtina* from Somalia, which has light green glabrous leaves as opposed to leaves with dark green puberulent adaxial surfaces and pale green abaxial surfaces in *C. arbuscula. Cryptolepis migiurtina* is distinguished from *C. arbuscula*, by having flowers arranged in semi-compact, few-flowered inflorescences and clavate to subulate corona lobes. *Cryptolepis arbuscula* is distinguished from other species with similar growth form, such as *C. macrophylla* and *C. socotrana*, based on leaf shape and size, these species having broadly elliptic to orbicular leaves, larger than 35 x 21 mm, and flowers arranged in inflorescences and clavate corona lobes.

Distribution and habitat

Cryptolepis arbuscula is endemic to the island Socotra (Fig. 4.3.3.2.). It grows on mountain slopes, on cliffs and in ravines among large boulders and is associated with granite and limestone, at altitudes from 450–950 m. *Cryptolepis arbuscula* is a component of shrubland or deciduous woodland in association with *Boswellia* sp., *Buxus* sp., *Cephalocroton* sp., *Cocculus balfourii* Schweinf. ex Balf.f.*, Commiphora ornifolia* (Balf.f.) J.B.Gillett*, Commiphora planifrons* Engl.*, Croton elaeagnoides S.*Watson*, Dracaena* sp., *Euryops arabicus* Steud. ex Jaub. & Spach, *Ficus vasta* Forssk.*, Gnidia* sp., *Hypericum scopulorum* Balf.f.*, Cryptolepis intricata, Searsia thyrsiflora* (Balf.f.) Moffett and *Trichocalyx* sp. Flowering occurs from January to July.

Vernacular name

Gisso (Balfour, 1888).

Representative specimens

— **12º34' N, 54º07' E:** Socotra, eastern Hagghier Mountains, below Jebel Jaaf, 06-02-1992, *Miller, A.G. & Nyberg M. 11349* (E).

— **12º34'38'' N, 54º05'50'' E:** Socotra, Hagghier Mountains, S of Adho Dimello Pass (Adho-di-Melhoh Pass), 12-02-1990, *Miller, A.G., Bazara'a, M., Guarino, L. & Kassim, N. M.10463A* (E).

— **12º34'42'' N, 54º02'53'' E:** Socotra, Hagghier mountains, N of Adho Dimello Pass, *Damar, E. Soq., Alexander, D., Talib, N.M.A., Sulaiman, A.S., Affrar, A.I.A. & Boggs, R. M.18016* (E).

— **12º36' N, 53º57' E:** Socotra, Jebel Rughid Plateau, 30-01-1992, *Miller, A.G. & Nyberg M.11209* (E).

— **12º36'50'' N, 54º00'50'' E:** Socotra, Muqadrihon Pass, 10 km SW of Hadiboh, towards Reiged Plateau, 20-01-1990, *Miller, A.G., Bazara'a, M., Guarino, L. & Kassim, N. M.10101B* (E).

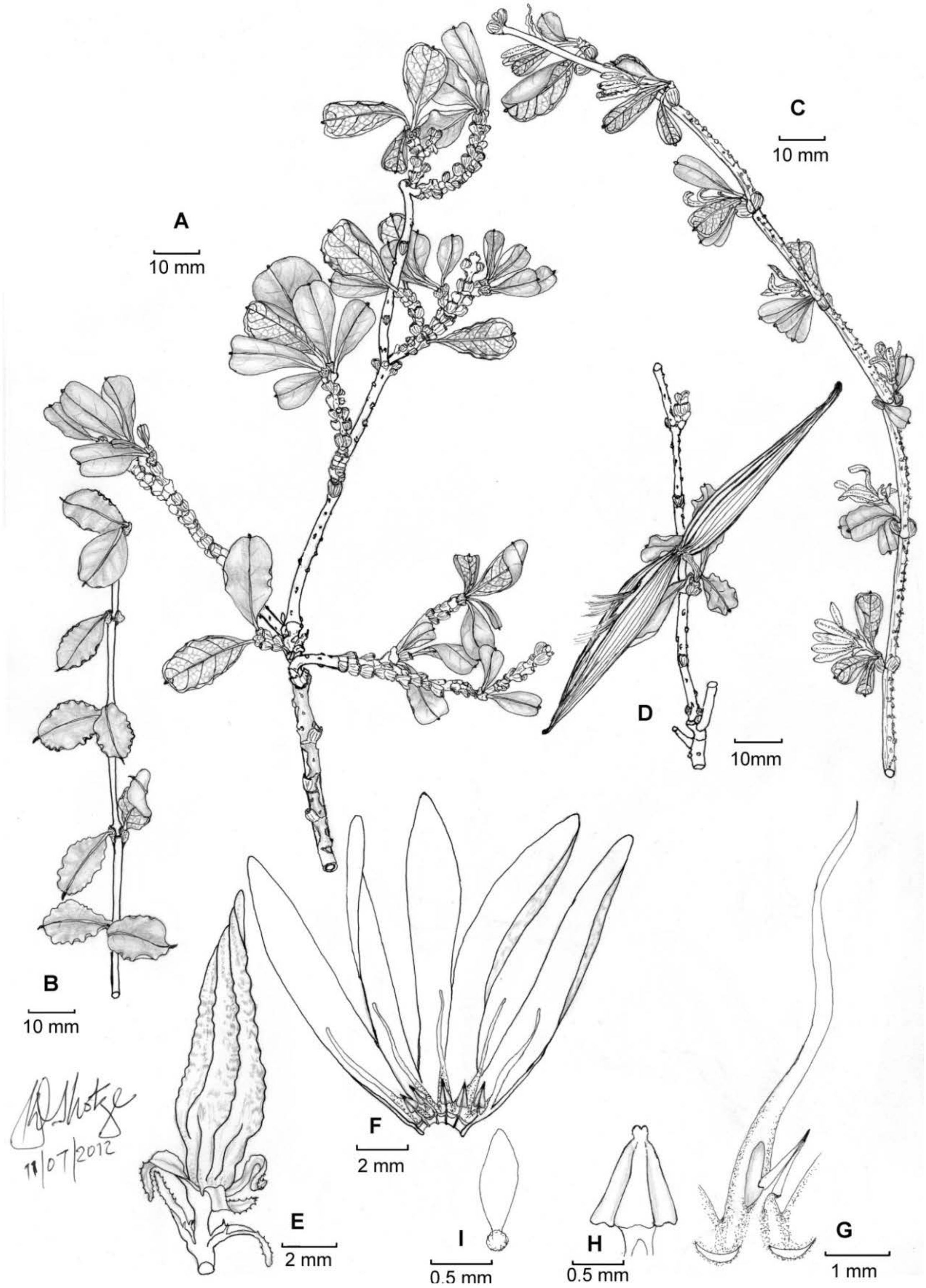


Fig. 4.3.3.1. Illustration of *Cryptolepis arbuscula*: (A–B) stem with leaves, (C) stem with solitary flowers, (D) stem with paired follicles, (E) external view of bud, (F) flower opened showing filiform corona lobes, stamens with narrowly hastate anthers, (G) filiform corona lobe with concave base, stamen fused to base of corona lobe and nectaries sunken below insertion point of stamen, (H) narrowly dome-shaped, bifid style-head, (I) translator narrowly elliptic with acute apex. Specimens: (A, G–I) *Miller et al. M.10101B* (E); (B, D) *Miller & Nyberg M.11209* (E); (C, F) *Alexander et al. M.18016* (E); (E) redrawn from Radcliffe-Smith (1971).

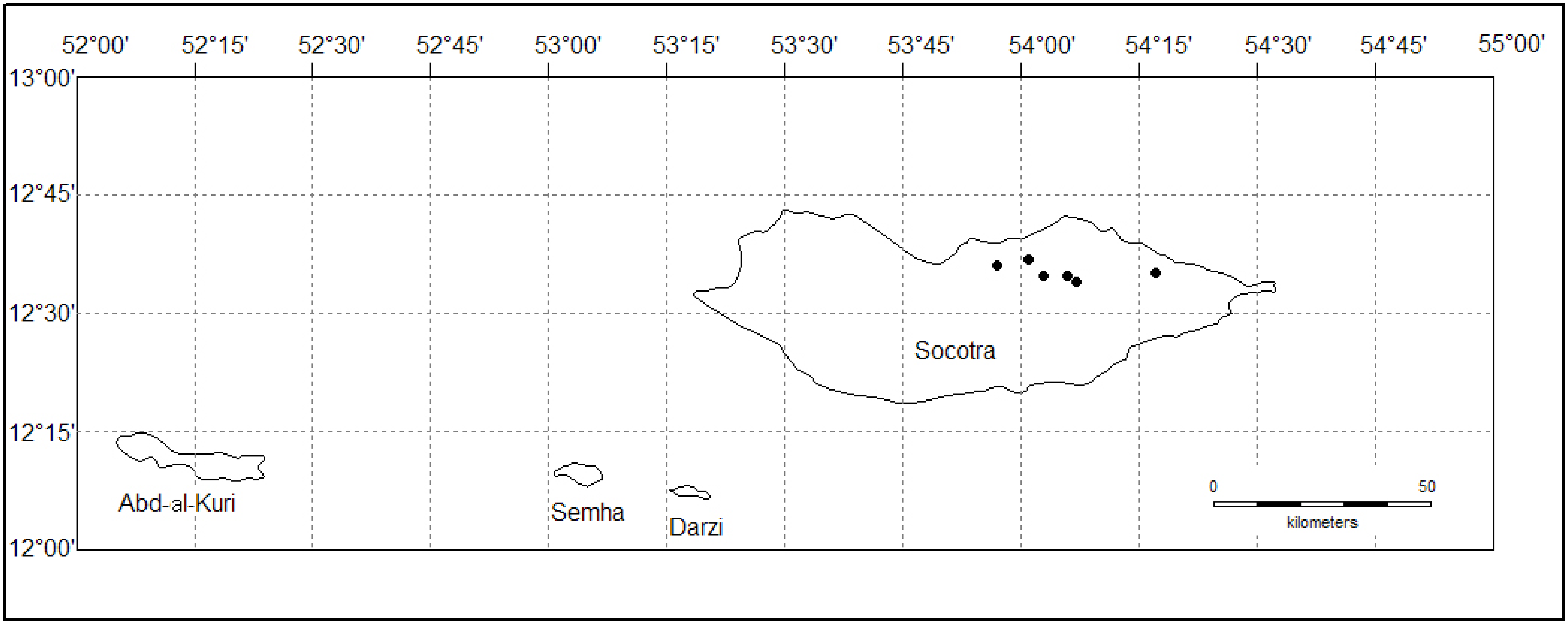


Fig. 4.3.3.2. Known distribution of *Cryptolepis arbuscula*.

Leaf micromorphology

Epidermal cell shape is not visible on either adaxial or abaxial leaf surfaces as both surfaces are densely covered by trichomes and cuticular striations obscuring cell boundaries (Fig. 4.3.3.3. A–B, D–E). Trichomes are unicellular, simple and broadly ovate with attenuate apices and nodular surfaces (Fig. 4.3.3.3. C).

On the adaxial surface the cuticle is densely striated with straight, parallel striations continuous over intercellular boundaries and radiating from trichome bases (Fig. 4.3.3.3. B–C). On the abaxial surface the cuticle is slightly striated and folded. Striations are parallel, slightly wavy and randomly orientated (Fig. 4.3.3.3. E–F).

The leaves are hypostomatic with few stomata randomly orientated between trichomes and level with surrounding epidermal cells (Fig. 4.3.3.3. E). Subsidiary cell arrangement is not visible and cuticular striations radiating from stomata are sparsely arranged. Guard cells are broadly elliptic and covered by a broad stomatal ledge (Fig. 4.3.3.3. F).

Seed micromorphology

The adaxial seed surface is smooth to uneven with sparsely arranged, inconspicuous, longitudinal ridges that are formed by raised epidermal cells (Fig. 4.3.3.4. A). Epidermal cells forming these ridges show no clearly distinguishable shape (Fig. 4.3.3.4. B–C). Epidermal cells between the ridges also have no clearly distinguishable shape, with periclinal walls convex to occasionally concave and anticlinal walls curved and deeply sunken (Fig. 4.3.3.4. D–E). The cells are covered by a granular to slightly striated cuticle. Striations are parallel and restricted to individual cells (Fig. 4.3.3.4. D–E).

Abaxially the seed has a relatively broad central ridge and thickened margins (Fig. 4.3.3.5. A). Narrow, inconspicuous ridges radiate from the central ridge to the seed margins (Fig. 4.3.3.5. A–B). These radiating ridges are formed by raised, contorted epidermal cells (Fig. 4.3.3.5. C). Cells between the ridges are isodiametric and tetra- to hexagonal, with periclinal walls convex and anticlinal walls curved and deeply sunken (Fig. 4.3.3.5. D–E). The cuticle is slightly granular to striated, with striations parallel and restricted to individual cells (Fig. 4.3.3.5. E).

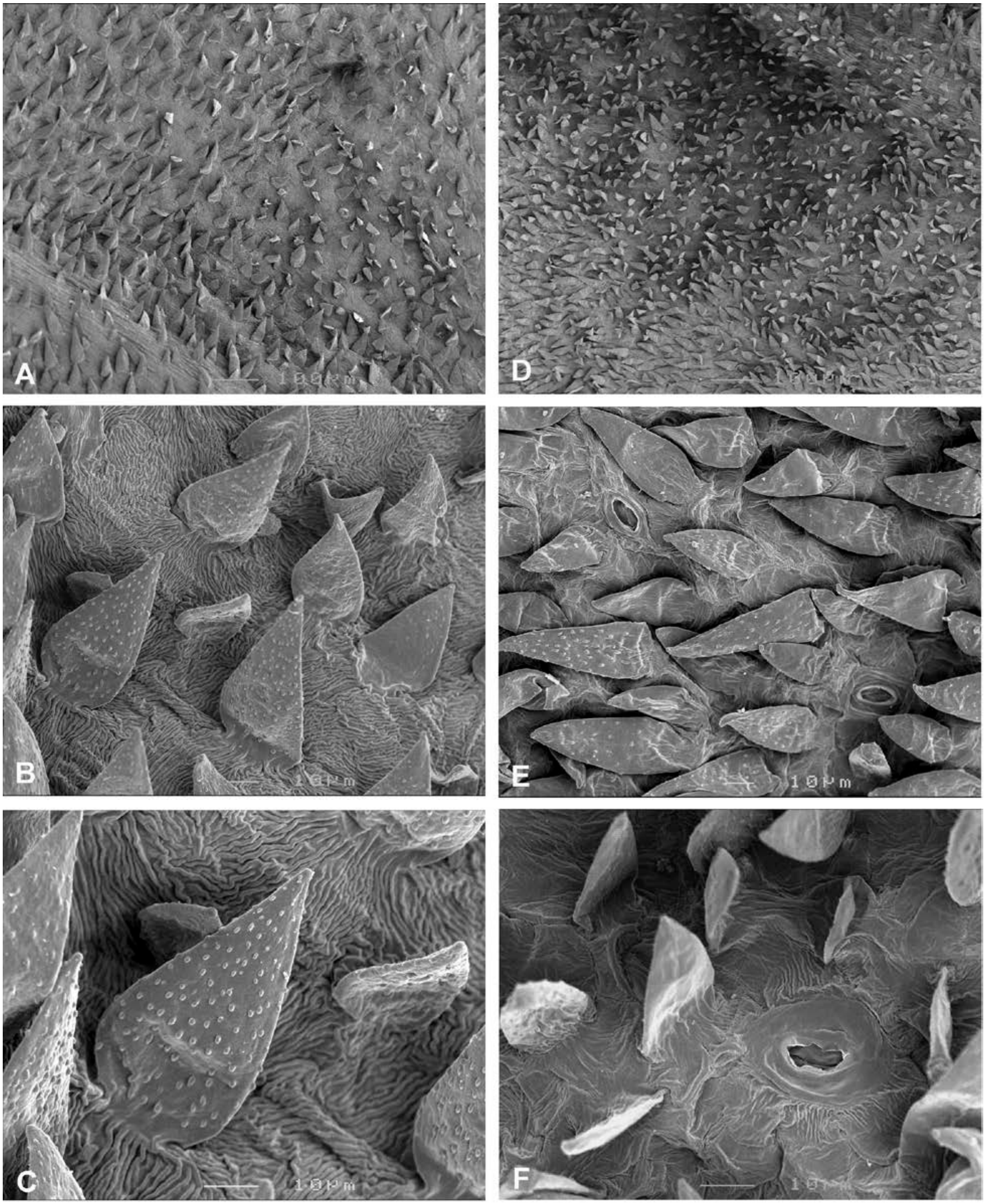


Fig. 4.3.3.3. *Cryptolepis arbuscula* leaf epidermal surfaces: (A) adaxial epidermis with densely arranged trichomes, (B) adaxial epidermis with trichomes and densely striated cuticle, (C) adaxial epidermal surface showing nodular trichome surfaces and densely striated cuticle, (D) abaxial epidermis with densely arranged trichomes, (E) abaxial epidermis with nodular trichome surfaces and stomata between trichomes, (F) abaxial epidermis with slightly striated, folded cuticle, stomata and trichomes. Magnification: A, D = x100; B, E = x650; C, F = x1200. Specimen: (A–F) *Miller, Bazara'a, Guarino & Kassim M.10463A* (E).

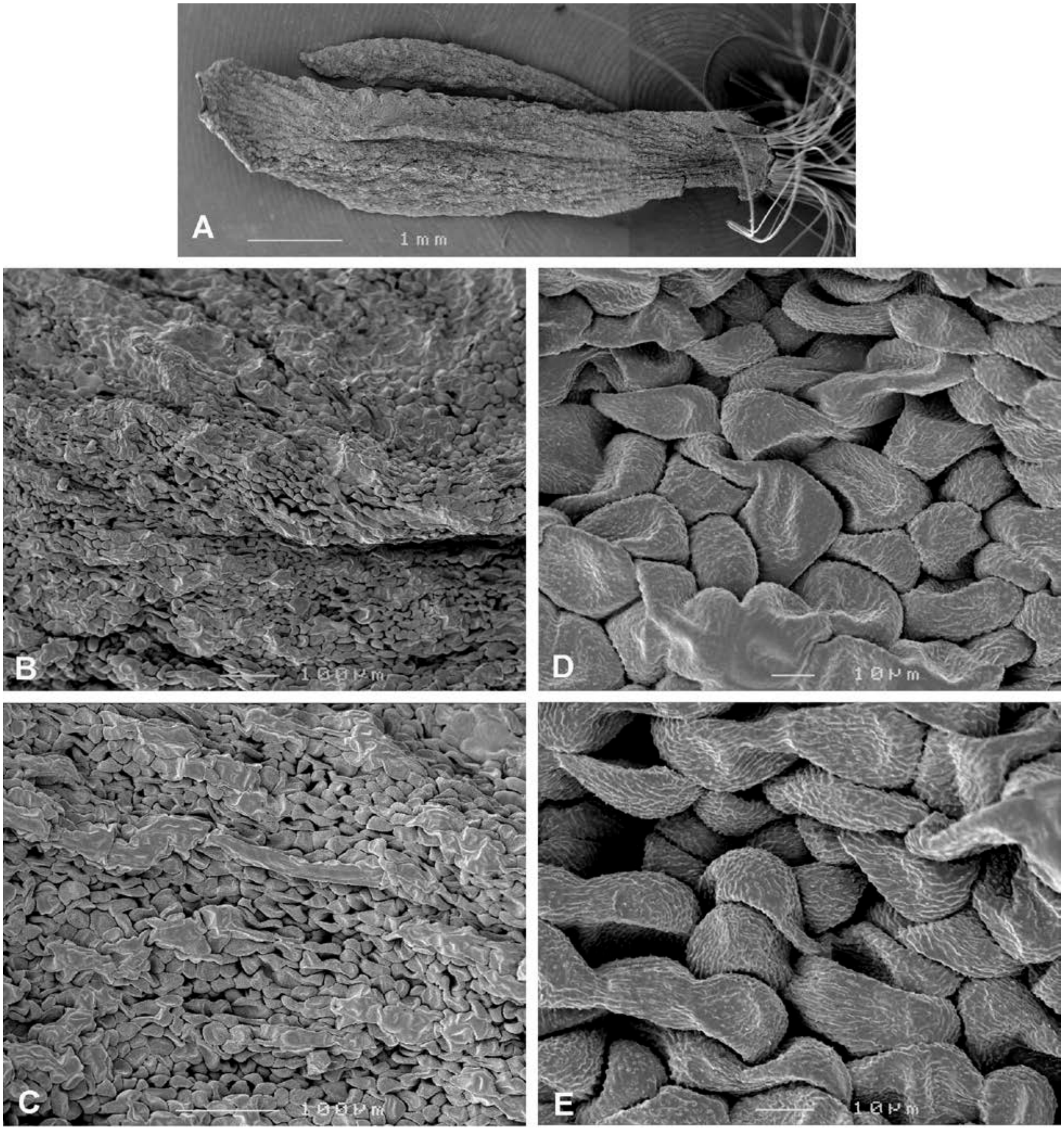


Fig. 4.3.3.4. *Cryptolepis arbuscula* seed surface: (A) adaxial view of seed with coma, (B, C) adaxial seed surface with inconspicuous ridges, (D, E) cells between ridges showing no clearly distinguishable shape with convex to concave periclinal walls, deeply sunken anticlinal walls and cells covered by a granular to slightly striated cuticle. Magnification: A = x20; B = x120; C = x220; D = x900; E = x1200. Specimen: (A–E) *Popov GP/So/270* (BM).

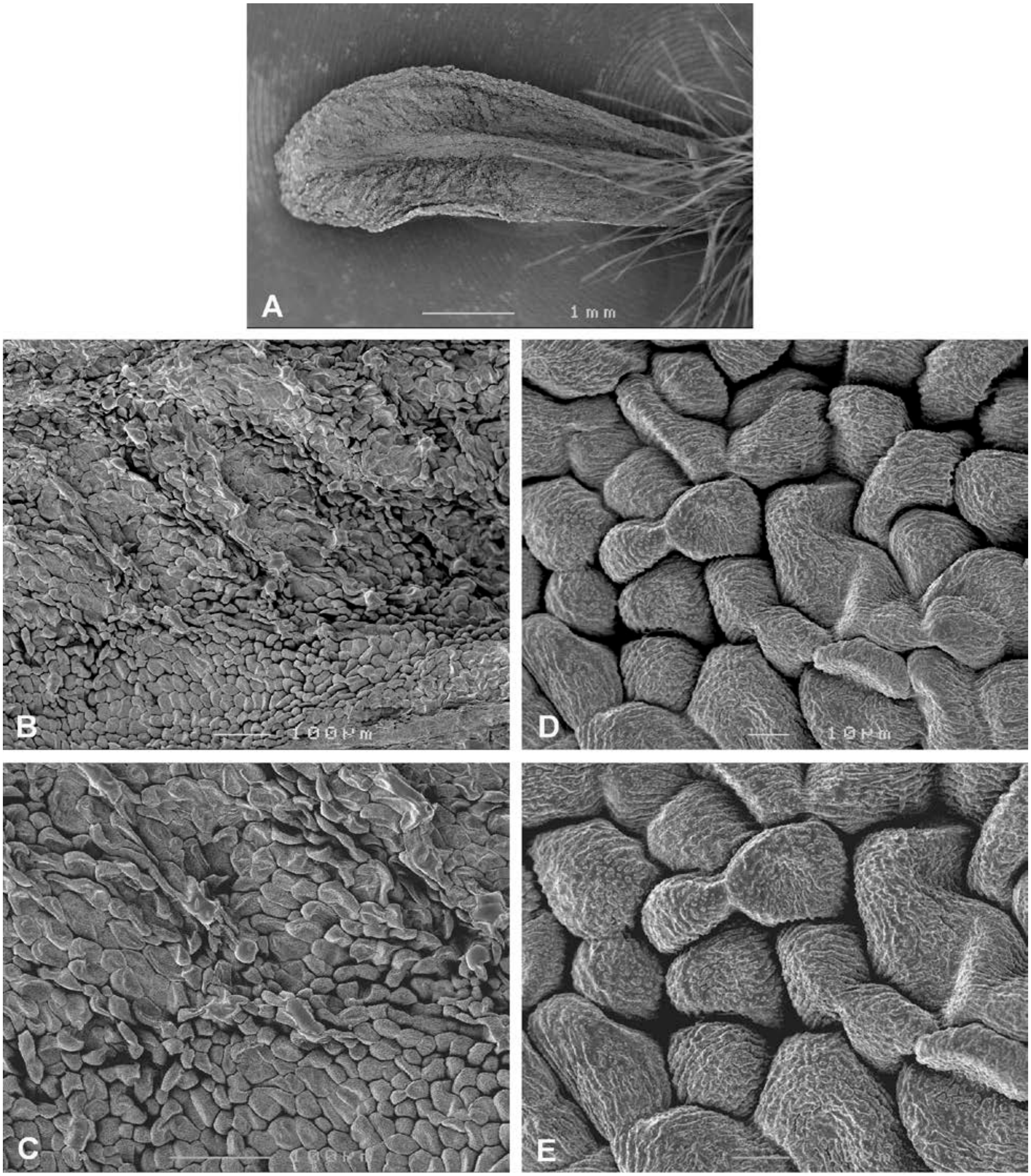


Fig. 4.3.3.5. *Cryptolepis arbuscula* seed surface: (A) abaxial view of seed, (B, C) abaxial surface with ridges between central ridge and seed margin, (D, E) cells between ridges tetra- to hexagonal with convex periclinal walls, deeply sunken anticlinal walls and cells covered by a granular to slightly striated cuticle. Magnification: A = x20; B = x120; C = x220; D = x900; E = x1200. Specimen: (A–E) *Popov GP/So/270* (BM).

4.3.4 *Cryptolepis capensis* Schltr., Verhandlungen Botanischer Verein der Provinz Brandenburg, 35: 47 (1893), 315 (1896); N.E.Br.: 527–528 (1907); J.M.Wood: 84 (1907).

Type: South Africa, Natal [KwaZulu-Natal Province], Inanda, *Wood, J. M. 1583* (B†, holo.; BOL!, lecto. here designated; BM!, K!, MO, NH [2 sheets]!, isolecto.).

A deciduous climber, with white latex, up to 7 m high. *Stems* woody, slender, twining, up to 3.5 mm diameter; young stems light brown, verrucose, glabrous; older stems brown, slightly verrucose, glabrous; interpetiolar ridges villous, colleters present. *Leaves* opposite, axils villous, petiolate; petiole green, glabrous, grooved, with bright purple spots occasionally present along groove edge, 8–13(–20) mm long; blade narrowly elliptic to elliptic, rarely obovate, 50–60(–113) x 20–30(–50) mm, herbaceous, smooth, glabrous, dark green adaxially, pale green abaxially, bright purple spots occasionally present along main vein; margin plane; apex attenuate to acuminate, not recurved, glabrous; base obtuse to cuneate; venation eucamptodromous to brochidodromous, 4–7 secondary veins on either side of main vein, intersecondary veins absent, tertiary veins weakly percurrent, areole development incomplete, veinlets absent. *Inflorescences* cymose, lax, few flowered, slender, each cyme consists of 2–5 monochasia, rarely 1–2 dichasia, each dichasium terminating in 1–3 monochasia, glabrous, primary peduncle (22–)30–50(–85) mm long, secondary peduncles (15–)20–35(–90) mm long, pedicels (5–)10–20(–25) mm long; bracts opposite, sparsely arranged, glabrous, acicular, ± 1.5 mm long, margins glabrous. *Buds* oblong, slender, 12–16 mm long, apices attenuate, full-turn helically twisted. *Sepals* narrowly ovate, 3 x 1 mm, acute, glabrous, colleters conical to ovate with dentate apices. *Corolla* white to greenish-white or pale yellow, rarely pale purple or mauve, (10–)10.5–16(–20) mm long; tube campanulate, (2–)4–5 mm long, glabrous; lobes reflexed, linear-ovate, 5–11 x 3 mm, apices acute. *Corona* single; inserted 2–3 mm from corolla tube base, included; lobes deltoid to trullate, fleshy, 0.8–1.0 mm long, glabrous; apices connivent over gynostegium. *Stamens* inserted ± 1.5 mm from corolla tube base; anthers hastate, attenuate, villous outside, ± 1 mm long, filaments 0.2 mm long. *Nectaries* inconspicuous, inserted ± 1.5 mm from corolla tube base. *Ovaries* 0.5–1.0 x 1.0 mm; style ± 1 mm long, style-head broadly pyramidal, acutely bifid, ± 0.5 x 0.5 mm. *Translators* narrowly elliptic, ± 0.5 mm long, apices acute. *Follicles* pendulous, narrowly divaricate at 20–50°, cylindrically ovoid to falcate, 121–204 x 3–4 mm, light brown, slightly nodose, apices attenuate, bases cuneate. *Seeds* oblong-obovate, 4–9 x 1.5–2.0 mm, dark brown, finely ribbed to slightly warty; coma white, ± 20 mm long. (Fig. 4.3.4.1.)

Diagnostic characters

Cryptolepis capensis is an endemic climber from South Africa. It has large, 50–60 x 20–30 mm, elliptic or rarely obovate, herbaceous leaves with attenuate to acuminate apices. This species is distinguished from similar species by a combination of slender inflorescences with acicular bracts, which are longer than 1 mm, villous anthers and cylindrically ovoid follicles, longer than 121 mm. *Cryptolepis capensis* is further distinguished from similar, herbaceous leaved species, such as *C. africana, C. grandiflora* and *C. sanguinolenta,* by a combination of incomplete areole development and primary corona lobes which are deltoid to trullinate and 0.8 mm or longer. *Cryptolepis capensis* is distinguished from similar, coriaceous leaved species, such as *C. apiculata, C. dubia, C. hypoglauca* and *C. ibayana*, by the absence of intersecondary venation, a corolla longer than 10 mm and having a single corona.

Distribution and habitat

Cryptolepis capensis has the most southerly range of all *Cryptolepis* species. It is distributed along the eastern side of South Africa, occurring mainly in the KwaZulu-Natal Province, with isolated populations in the provinces of Limpopo, Mpumalanga and the Eastern Cape, at altitudes from 50–1000 m (Fig. 4.3.4.2.). This species is found in afromontane and coastal forest where it is most common along the forest margin and in clearings. Associated species include *Cola natalensis* Oliv.*, Drypetes arguta* (Müll.Arg.) Hutch.*, Protorhus longifolia* (Bernh.) Engl.*, Rinorea angustifolia* (Thouars) Baill.*, Searsia acocksii* (Moffett) Moffett, *Rothmannia capensis* Thunb.*, Syzygium gerrardii* (Harv. ex Hook.f.) Burtt Davy and *Xymalos monospora* (Harv.) Baill. Flowering occurs from October to April, with a peak from November to February.

Notes

Leaves, stems and roots are used to prepare an antihelminthic remedy.

Vernacular name

Tsonga: nyokane.

Representative specimens

— **24º34'16" S, 30º47'12" E:** South Africa, Mpumalanga, Blyde River Canyon, at Forever Resort, along Lourie Trail, by large waterfall, 28-11-2008, *Joubert, L. 43* (BLFU).

— **27º52' S, 31º24' E:** South Africa, KwaZulu-Natal, Ngomi Forest, 50 m E of stream crossing below waterfall, 07-01-1983, *Venter, H.J.T. 8783* (BLFU).

— **29º42'20" S, 31º02'20" E:** South Africa, KwaZulu-Natal, Mount Edgecombe, 12-1909, *Wood, J.M. 11589* (GRA, J, NH, NU, PRE, Z).

— **29º46'30" S, 30º55'30" E:** South Africa, KwaZulu-Natal, Pinetown District, Everton, Molwani Kloof in Kranzkloof Nature Reserve, 02-01-1975, *Hilliard* & *Burtt 7575* (K, NU).

— **31º02'50" S, 30º10'15" E:** South Africa, KwaZulu-Natal, Port Edward, along Izingolweni road, at Clearwater Trails, Fish Eagle trail, about 200 m down the ravine, 22-11-2006, *Joubert, L. 31* (BLFU).

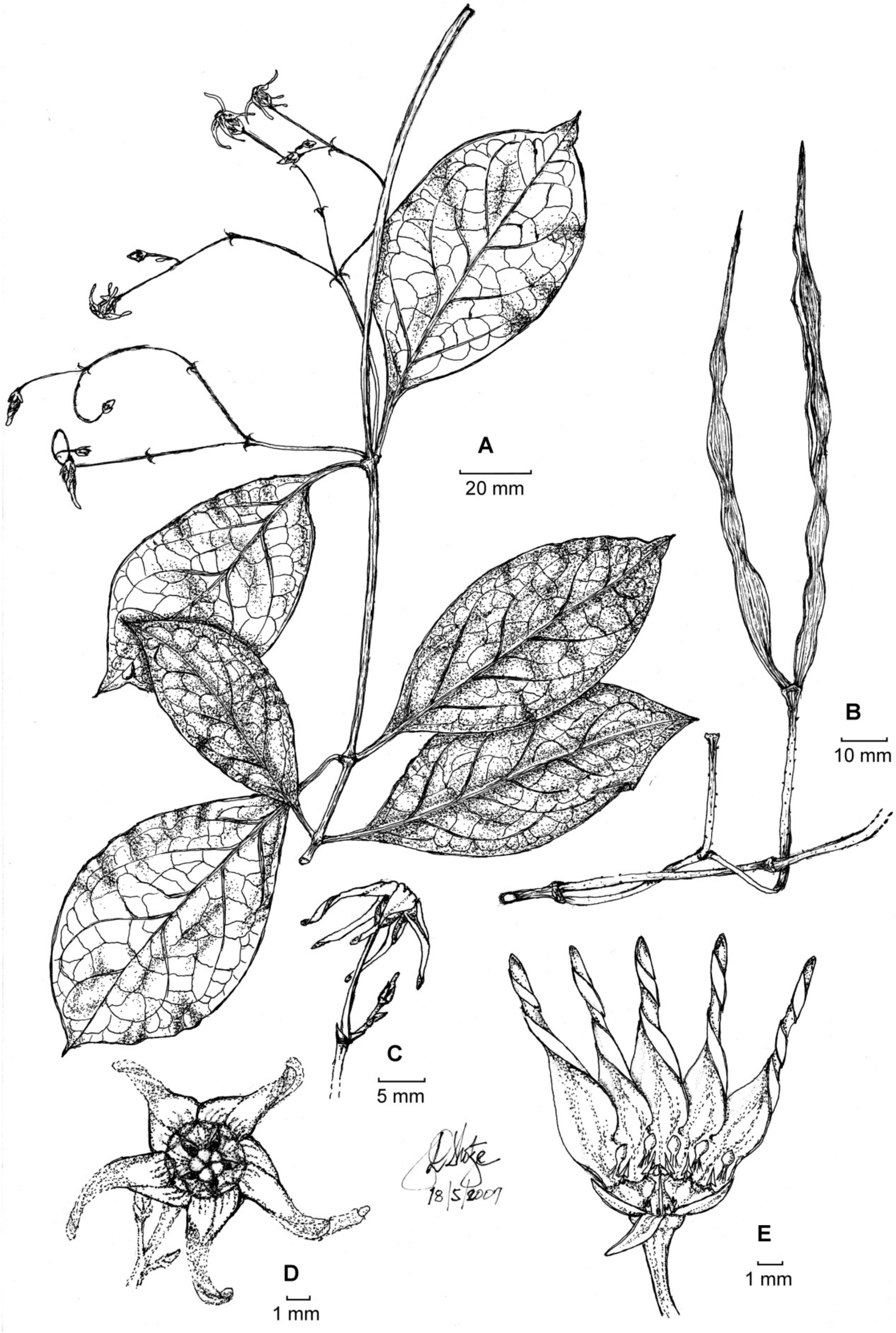


Fig. 4.3.4.1. Illustration of *Cryptolepis capensis*: (A) stem with leaves and inflorescence, (B) stem with paired follicles, (C) part of inflorescence, (D) external view of mature flower, (E) bud opened showing sepals, helically twisted corolla lobes, clavate corona lobes, stamens with narrowly hastate anthers and pistil of semi-inferior apocarpous ovaries, style and style-head. Specimens: (A) *Venter 8783* (BLFU); (B) *Wood 11589* (NU); (C–E) *Joubert 31* (BLFU).

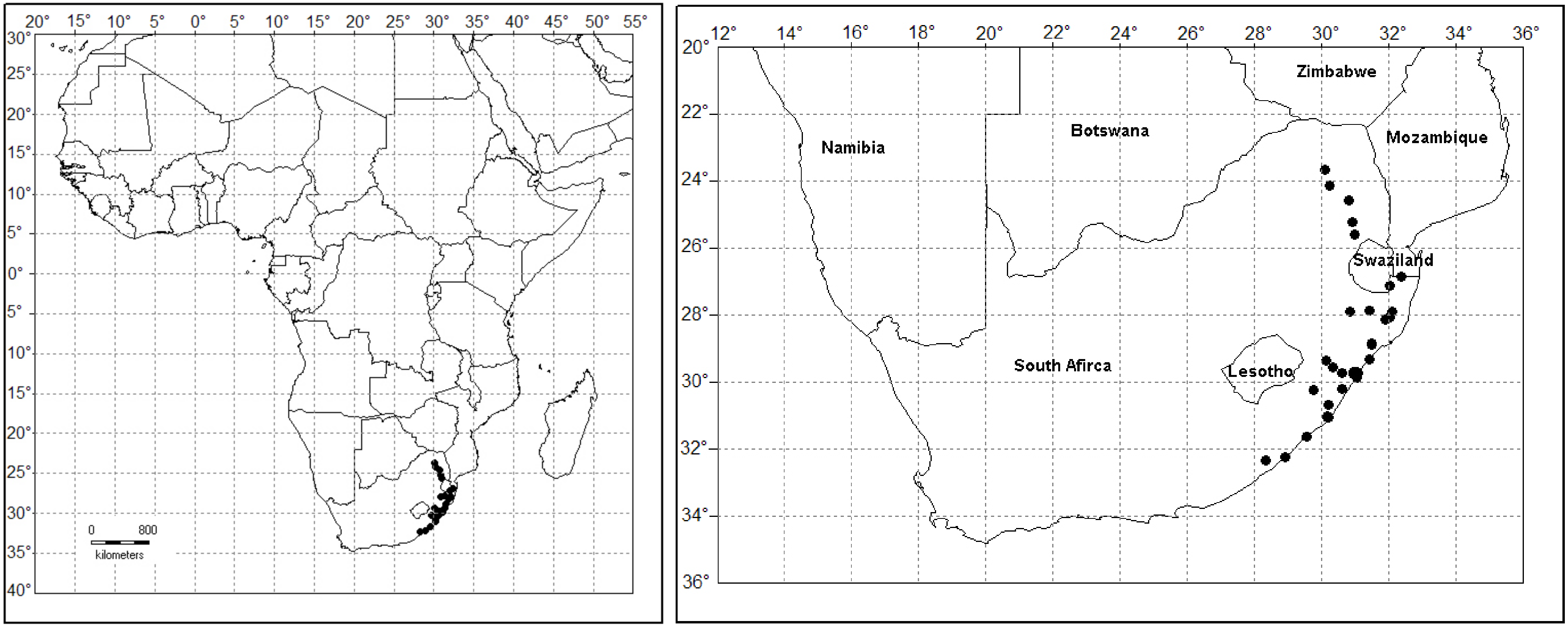


Fig. 4.3.4.2. Known distribution of *Cryptolepis capensis*.

Leaf micromorphology

Cells on the adaxial surface are more or less isodiametric and tetra- to hexagonal. Periclinal walls are convex (Fig. 4.3.4.3. A) to tabular (Fig. 4.3.4.3. B–C) while the anticlinal wall boundaries are straight to slightly curved and slightly sunken. The cuticle may be slightly or heavily striated with straight, parallel striations. Striations are usually restricted to individual cells (Fig. 4.3.4.3. B–C), but occasionally cross intercellular boundaries (Fig. 4.3.4.3. A).

The abaxial epidermis consists of more or less isodiametric cells characterized by convex periclinal walls. Anticlinal walls have loose to tight u-shaped curves with shallow amplitude and are slightly sunken. The cuticle has sparsely arranged straight to slightly wavy, parallel striations (Fig. 4.3.4.3. D–F). Wax platelets may be sparsely (Fig. 4.3.4.3. E) to densely packed, usually orientated perpendicular to the epidermal surface (Fig. 4.3.4.3. D, F).

Leaves are hypostomatic, although a small number of stomata may rarely occur next to the main vein on the adaxial surface (Fig. 4.3.4.3. A). On the abaxial surface numerous stomata are randomly orientated and level with the surrounding epidermal cells. Stomata are paracytic with striations on subsidiary cells either parallel to or sometimes radiating from the stomatal pore. Guard cells are broadly elliptic and covered by a broad stomatal ledge (Fig. 4.3.4.3. D–F).

Seed micromorphology

The adaxial seed coat surface shows undulating, longitudinal ridges (Fig. 4.3.4.4. A). Cells of the upper epidermis are isodiametric and tetra- to hexagonal. Periclinal walls are concave while anticlinal walls are straight to slightly curved and deeply sunken (Fig. 4.3.4.4. B–C). Cuticle is smooth to slightly granular (Fig. 4.3.4.4. D–E).

Adaxially the seed margins are involute resulting in seeds being U-shaped in cross section (Fig. 4.3.4.5. A). The abaxial epidermal surface is smooth, without warts or ridges (Fig. 4.3.4.5. B). Epidermal cells are isodiametric and tetra- to hexagonal. Periclinal walls are concave or rarely convex while anticlinal walls are straight to slightly curved and slightly to deeply sunken (Fig 4.3.4.5. C–E). The cuticle is smooth to finely granular (Fig. 4.3.4.5. C–E).

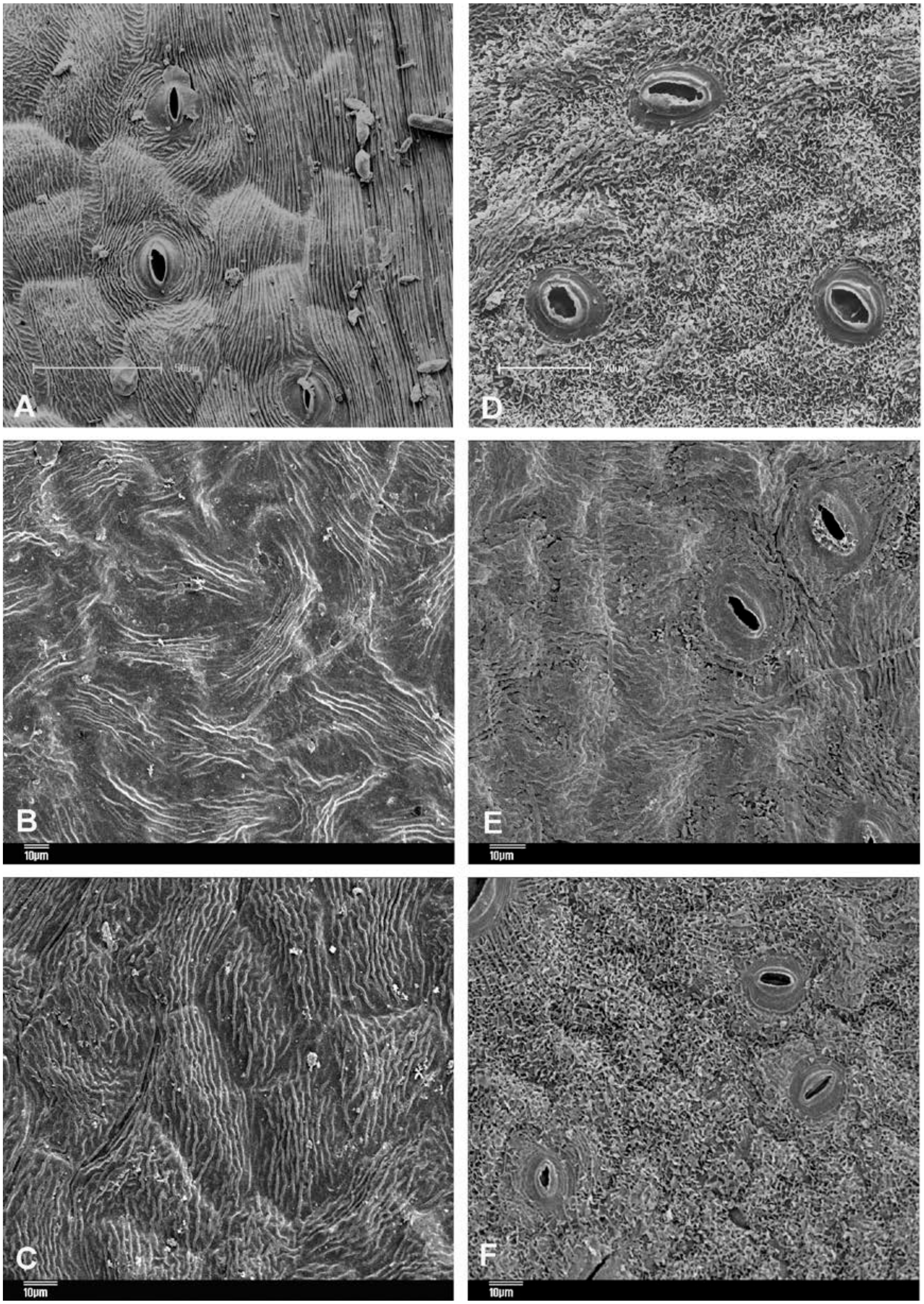


Fig. 4.3.4.3. *Cryptolepis capensis* leaf epidermal surfaces: (A) adaxial epidermal cells with convex periclinal walls, densely striated cuticle and stomata next to main vein, (B, C) adaxial epidermal cells with tabular periclinal walls and striated cuticle, (D) abaxial epidermal cells with slightly striated cuticle, densely packed wax platelets and stomata, (E) abaxial epidermis with slightly striated cuticle, sparsely packed wax platelets and stomata, (F) abaxial epidermis with slightly striated cuticle, densely packed wax platelets and stomata. Magnification: A–B = x650; C, F = x900; D = x1000; E = x950. Specimens: (A, D) *Wood 11589* (NU); (B, E) *Hilliard & Burtt 7575* (NU); (C, F) *Wood 11590* (NU).

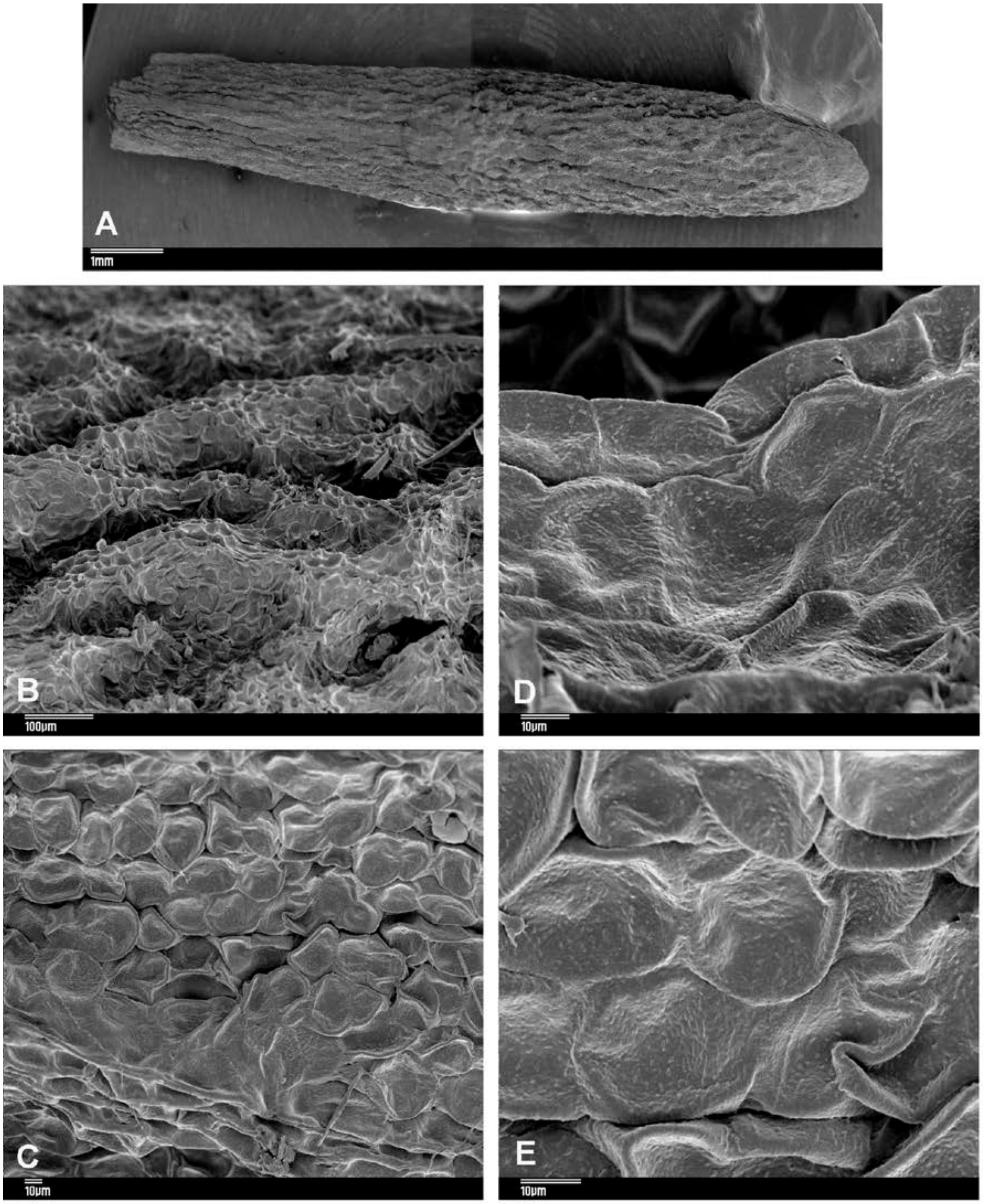


Fig. 4.3.4.4. *Cryptolepis capensis* seed surface: (A) adaxial view of seed with longitudinal ridges, (B, C) adaxial seed surface with anticlinal walls straight to slightly wavy and deeply sunken, (D, E) cells tetra- to hexagonal with convex periclinal walls, deeply sunken anticlinal walls and granular cuticle. Magnification: A = x18; B = x170; C = x430; D = x1200; E = x1500. Specimen: (A–E) *Wood 11589* (NU).

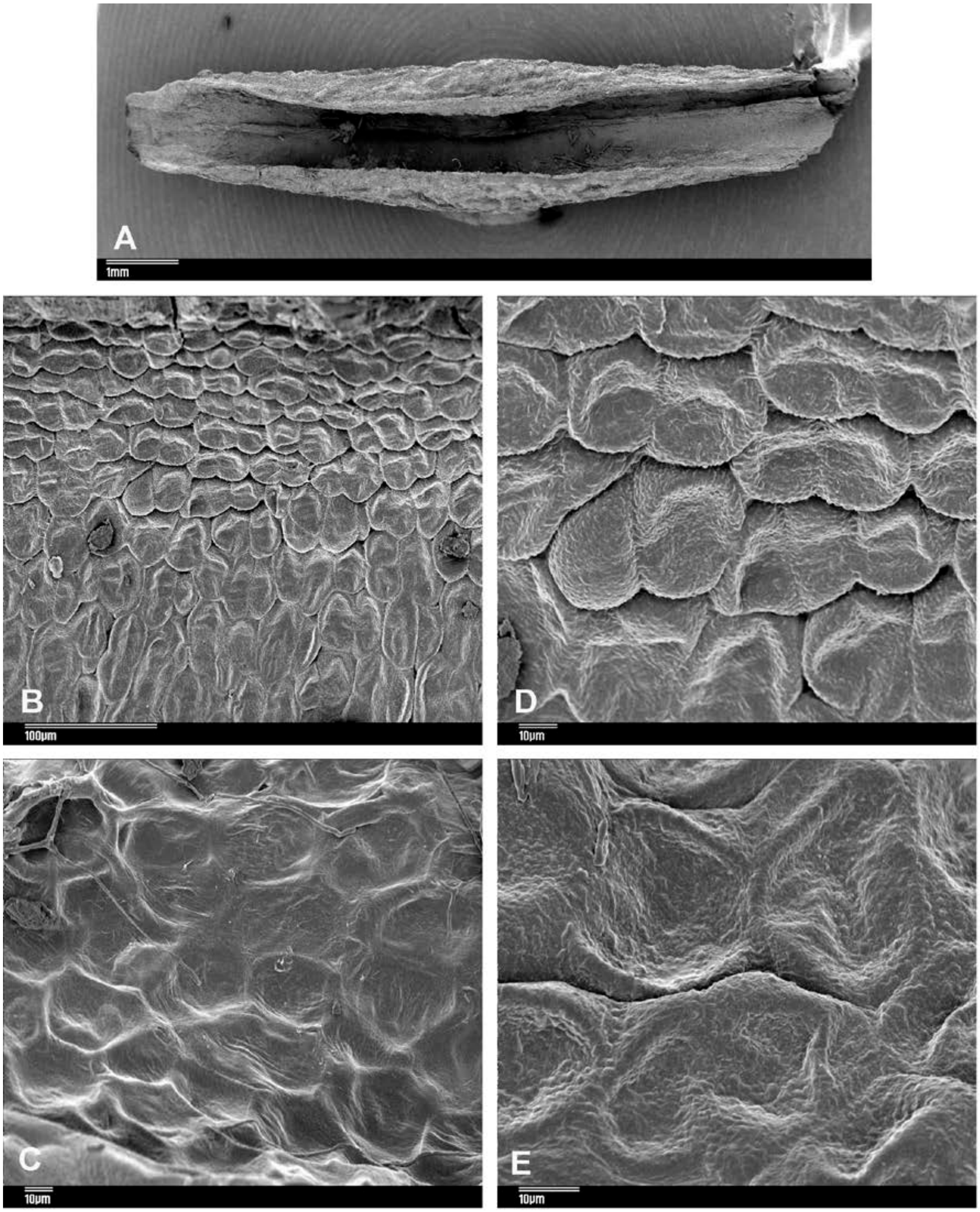


Fig. 4.3.4.5. *Cryptolepis capensis* seed surface: (A) abaxial view of seed showing involute margins and narrow central ridge, (B) abaxial surface between central ridge and seed margin smooth, (C) cells with concave periclinal walls and smooth cuticle, (D, E) cells with convex periclinal walls, deeply sunken anticlinal walls and finely granular cuticle. Magnification: A = x18; B = x33; C = x700; D = x950; E = x1500. Specimen: (A–E) *Wood 11589* (NU).

4.3.5 ***Cryptolepis cryptolepioides*** (Schltr.) Bullock, Kew Bulletin 10: 281 (1955); J.M.Wood: 84 (1907). Basionym: *Ectadiopsis cryptolepioides* Schltr. in Engl., Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 20(51): 10 (1895a)[Note 1]; K.Schum.: 219 (1895b).
Type: South Africa, Botsabelo, *Schlechter 4082* (B†, holo.; K!, lecto., here designated; BOL!, BM [2 sheets]!, BR!, G [2 sheets]!, GRA, K [2 sheets]!, NBG-SAM, NH!, PRE!, Z, isolecto.).

= ***C. transvaalensis*** Schltr., Journal of Botany 34: 315 (1896), *nomen superfluum* [Note 2]; N.E.Br.: 528 (1907); Eyles: 446 (1916).
Type: Homotypic synonym*.*

A climber or scrambler, with white latex, up to 2 m high. *Stems* woody, slender, densely branched, twining, up to 5 mm in diameter; young stems dark reddish-brown, smooth or slightly verrucose, glabrous; older stems dark greyish-brown, slightly verrucose, glabrous; interpetiolar ridges villous, colleters present. *Leaves* decussate, axils villous, petiolate; petiole bright purplish-red, glabrous, grooved, 4–9(–20) mm long; blade orbicular to broadly elliptic, (20–)29–41(–110) x (14–)19–29(–59) mm, coriaceous, rugose, glabrous, dark green adaxially, pale green abaxially, bright purple spots occasionally present along abaxial side of main vein; margin plane; apex rotund, rarely obtuse, acuminate, recurved; base rounded; venation brochidodromous, 9–10 secondary veins on either side of main vein prominent, composite intersecondary veins prominent, tertiary veins random reticulate, dense, prominent, areoles well developed, veinlets branching. *Inflorescences* cymose, compact, many flowered, each cyme consists of 5–10 dichasia, terminating in monochasia, glabrous, primary peduncle 4–10(–25) mm long, secondary peduncles 2–6(–11) mm long, pedicels 2–3(–12) mm long; bracts opposite, densely arranged, glabrous, acicular, 1.5 mm long, margins fimbriate. *Buds* slender, 3–4 mm long, ovoid, apices acute, half-turn helically twisted. *Sepals* broadly ovate, ± 1.5 x 1 mm, rotund, margins fimbriate, colleters conical. *Corolla* greenish, deep cream or pale yellow, 4–5 mm long; tube campanulate, 1.5–2 mm long, glabrous; lobes spreading, oblong, 2–3 x 1 mm, apices rotund to obtuse. *Corona* double; primary corona inserted 0.5–0.8 mm from corolla tube base, included, lobes clavate, apices conical, fleshy, 0.8–1 mm long, glabrous, apices connivent over gynostegium; secondary corona in corolla lobe sinuses, pocket-like, glabrous. *Stamens* inserted ± 0.3 mm from corolla tube base; anthers hastate, attenuate, villous outside, ±

0.5 mm long. *Nectaries* prominent, inserted ± 0.3 mm from corolla tube base. Ovaries ± 0.5 x 0.3–0.6 mm; style ± 0.3 mm long, style-head broadly pyramidal, acutely bifid, ± 0.5 x 0.5 mm. *Translators* narrowly elliptic, ± 0.4 mm long, apices acute. *Follicles* erect, widely divaricate at 110–135°, narrowly ovoid, (32–)41–57 x 6–15 mm, brown, apices apiculate, bases obtuse. *Seeds* obovate to obliquely obovate, 4–9 x 2–4 mm, brown, warty; coma white to yellowish-white, 19–27 mm long. (Fig. 4.3.5.1.)

Diagnostic characteristics

Cryptolepis cryptolepioides is a climber or scrambler. The combination of leaf shape and venation pattern distinguishes it from other species in the region. *Cryptolepis cryptolepioides* has orbicular or, rarely, broadly elliptic leaves with rotund and acuminate apices. Leaves are medium sized, rarely small or large, (20–)29–41(–110) x (14–)19–29(–59) mm and coriaceous. Venation is distinctive, with intersecondary veins prominent and tertiary venation well developed. Flowers are grouped into compact, many-flowered cymes and carried on short pedicels, 2–3 mm long. The corolla is 4–5 mm long. Follicles are erect, widely divaricate at 110–135°, narrowly ovoid to ovoid, 41–57 x 6–15 mm, apices apiculate to attenuate.

Distribution and habitat

In South Africa this species is distributed throughout the Limpopo Province, the eastern parts of North West Province, Gauteng Province, and the northern parts of Mpumalanga Province, at altitudes from 750 to 1500 m (Fig. 4.3.5.2.). The distribution range of this species also extends into Zimbabwe and Mozambique. *Cryptolepis cryptolepioides* occurs in bushveld, scrub and ravine forest, on mountain slopes, cliffs and plateaus. This species is associated with sandy soil on granite or sandstone outcrops, often in moist areas such as ravines, along riverbeds and around dams. Associated species include *Celtis africana* Burm.f., *Cryptolepis oblongifolia, Cussonia spicata* Thunb., *Diospyros lycioides* Desf., *Ekebergia capensis* Sparrm., *Englerophytum magalismontanum* (Sond.) T.D.Penn., *Faurea saligna* Harv., *Ficus ingens* (Miq.) Miq., *Melinis repens* (Willd.) Zizka, *Nuxia floribunda* Benth., *Protea caffra* Meisn., *Searsia dentata* (Thunb.) Moffett and *Searsia leptodictya* (Diels.) Moffett. Flowering occurs in summer and early autumn, from November to April, with a peak from December to February.

Notes

1. Even though Schumann (1891, 1895b) refers to *Ectadiopsis cryptolepioides* Schltr., the name was only validly published by Schlechter in 1895a. The name published by Schumann (1891, 1895b) is consequently considered to be a *nom. nud.*

2. Schlechter (1895a) originally placed this species under *Ectadiopsis* as *Ectadiopsis cryptolepioides,* but later transferred it to *Cryptolepis* and named it *Cryptolepis transvaalensis* (Schlechter, 1896). The name *Cryptolepis transvaalensis* is consequently a superfluous name which was used by Brown (1907). Bullock (1955) corrected the name to *Cryptolepis cryptolepioides* (Schltr.) Bullock.

Representative specimens

— **14º57' S, 38º19' E:** Mozambique, Niassa District, Ribaue, Mepalué, 25-01-1964, *Torre, A.R. & Paiva, J. 10.248* (BR).

— **18º25' S, 32º10' E:** Zimbabwe, Makoni Distric, 14-02-1960, *Chase, N.C. 7261* (SRGH).

— **24º34'18" S, 30º47'57" E:** South Africa, Mpumalanga, Blyde River Canyon, Three Rondawels viewpoint, 29-11-2008, *Joubert, L. 47* (BLFU).

— **25º44'12" S, 28º16'29" E:** South Africa, Gauteng, Pretoria, near Herbarium in Pretoria National Botanical Garden, 01-2007, *Joubert, L. 33* (BLFU).

— **26º26' S, 32º16' E:** South Africa, KwaZulu-Natal, Ndumo Game Reserve, 14-11-1983, *Venter, H.J.T. 8983* (BLFU).

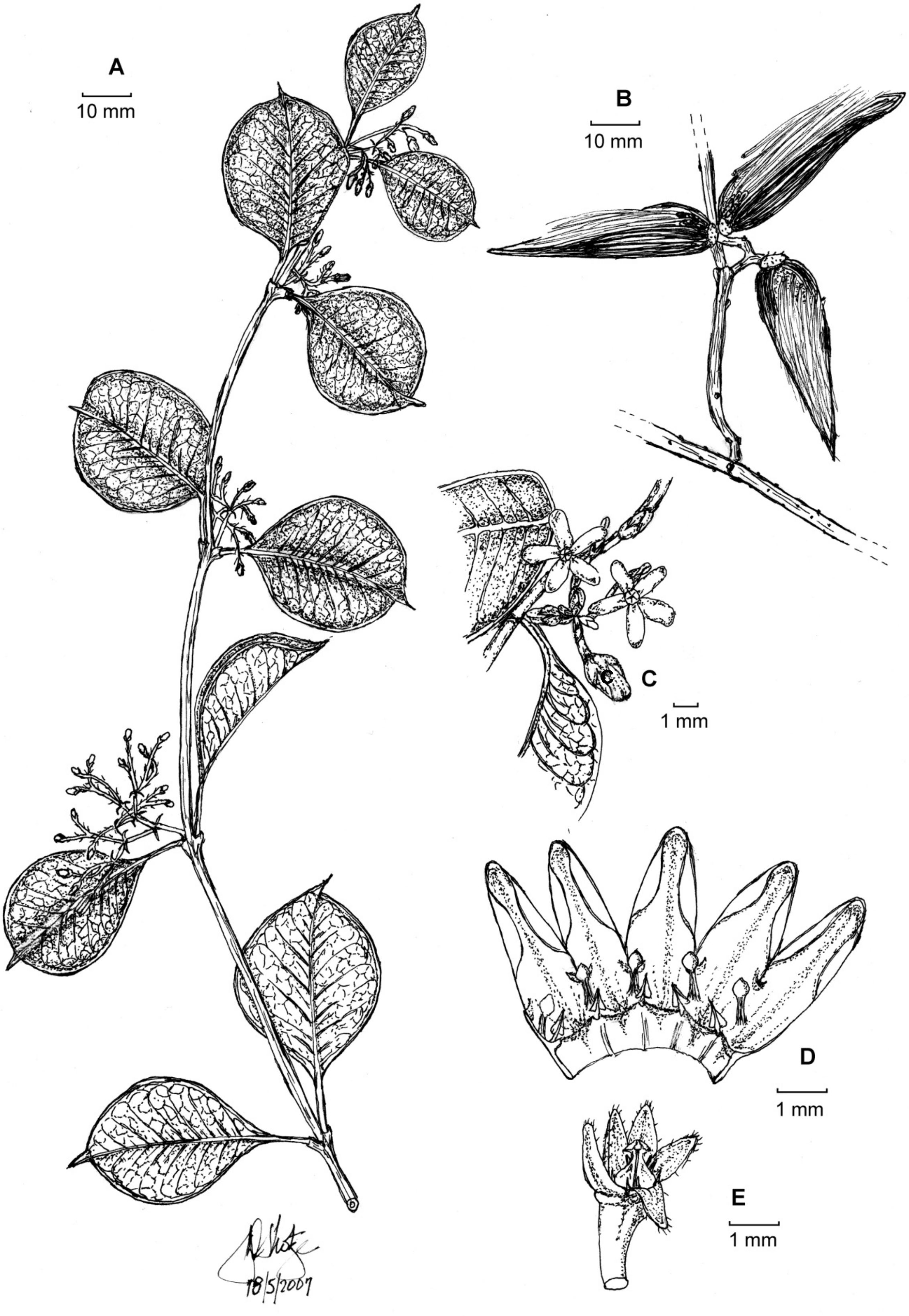


Fig. 4.3.5.1. Illustration of *Cryptolepis cryptolepioides*: (A) stem with leaves and inflorescences, (B) stem with paired and single follicles, (C) stem with inflorescence, (D) corolla opened showing clavate primary corona lobes, secondary corona pockets and stamens with hastate anthers, (E) calyx of hairy sepals, pistil of semi-inferior apocarpous ovaries, style and style-head. Specimens: (A) *Chase 7261* (SRGH); (B) *West 2162* (SRGH); (C) from photograph by *Hyde, M.*; (D–E) *Joubert 33* (BLFU).

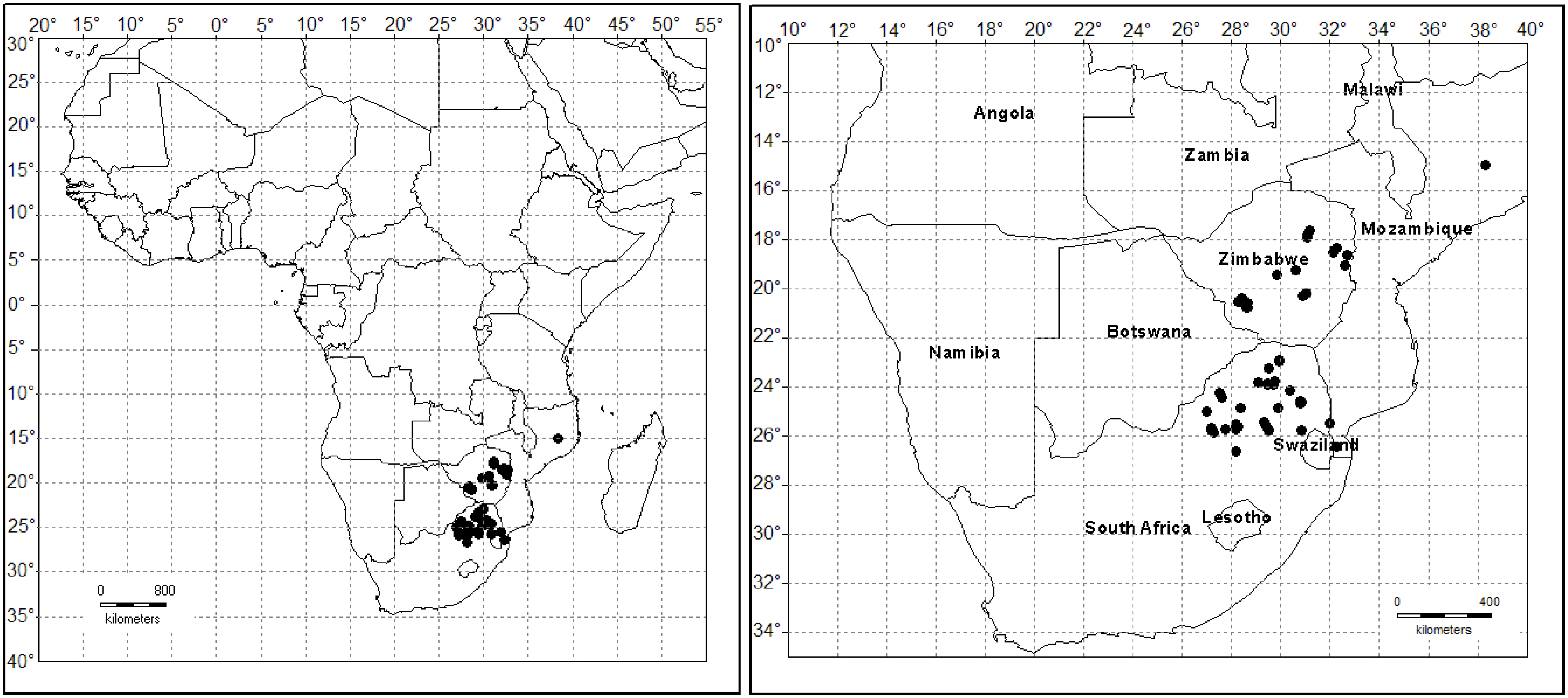


Fig. 4.3.5.2. Known distribution of *Cryptolepis cryptolepioides*.

Leaf micromorphology

Cells on the adaxial surface are more or less isodiametric and tetra- to hexagonal. Periclinal walls are convex, while anticlinal walls are straight (Fig. 4.3.5.3. C) to slightly wavy or curved and sunken (Fig. 4.3.5.3. A–B). The cuticle is slightly striate with straight, parallel striations crossing intercellular boundaries (Fig. 4.3.5.3. A–C).

The abaxial epidermis consists of isodiametric, tetra- to hexagonal cells. Periclinal walls are convex and anticlinal walls show tight, frequent, U-shaped curves of shallow amplitude and are deeply sunken. The cuticle forms a dense network of undulate, randomly orientated striations continuous over several cells. (Fig. 4.3.5.3. D–F)

The leaves are hypostomatic, though stomata rarely occur on the adaxial leaf surface along the main vein. Stomata are randomly orientated and slightly sunken (Fig. 4.3.5.3. D, F) or level with the surrounding epidermal cells (Fig. 4.3.5.3. E), paracytic with striations on subsidiary cells running parallel or perpendicular to the stomatal opening. The guard cells are elongate-elliptic and covered by a narrow stomatal ledge (Fig. 4.3.5.3. D–E).

Seed micromorphology

The upper seed coat surface is rough, with cells clustered into tightly packed warts covering the entire surface (Fig. 4.3.5.4. A). Warts vary in shape and size and show no clear pattern of organization (Fig. 4.3.5.4. B). Cells forming the warts are isodiametric and tetra- to hexagonal. Periclinal walls are tabular to slightly convex while anticlinal walls are straight. The cuticle is sparsely striated with broad striae along the anticlinal wall boundaries, rarely crossing periclinal wall surfaces. Fine, parallel striations may cross intercellular boundaries (Fig. 4.3.5.4. C).

Abaxially the seed margins are slightly thickened. The surfaces between margins and broad central ridge are warty. Warts are not as tightly packed as on the upper surface and are often grouped in rows. Rows of warts are arranged irregularly or perpendicular to the seed margin (Fig. 4.3.5.4. D). Cells of the warts are contorted and cell shape is not distinguishable (Fig. 4.3.5.4. E). The cells between warts are isodiametric and tetra- to hexagonal. Periclinal walls are slightly convex to concave while anticlinal walls are straight and slightly sunken. The cuticle is finely striated with striations densely arranged, parallel and continuous over intercellular boundaries (Fig. 4.3.5.4. F).

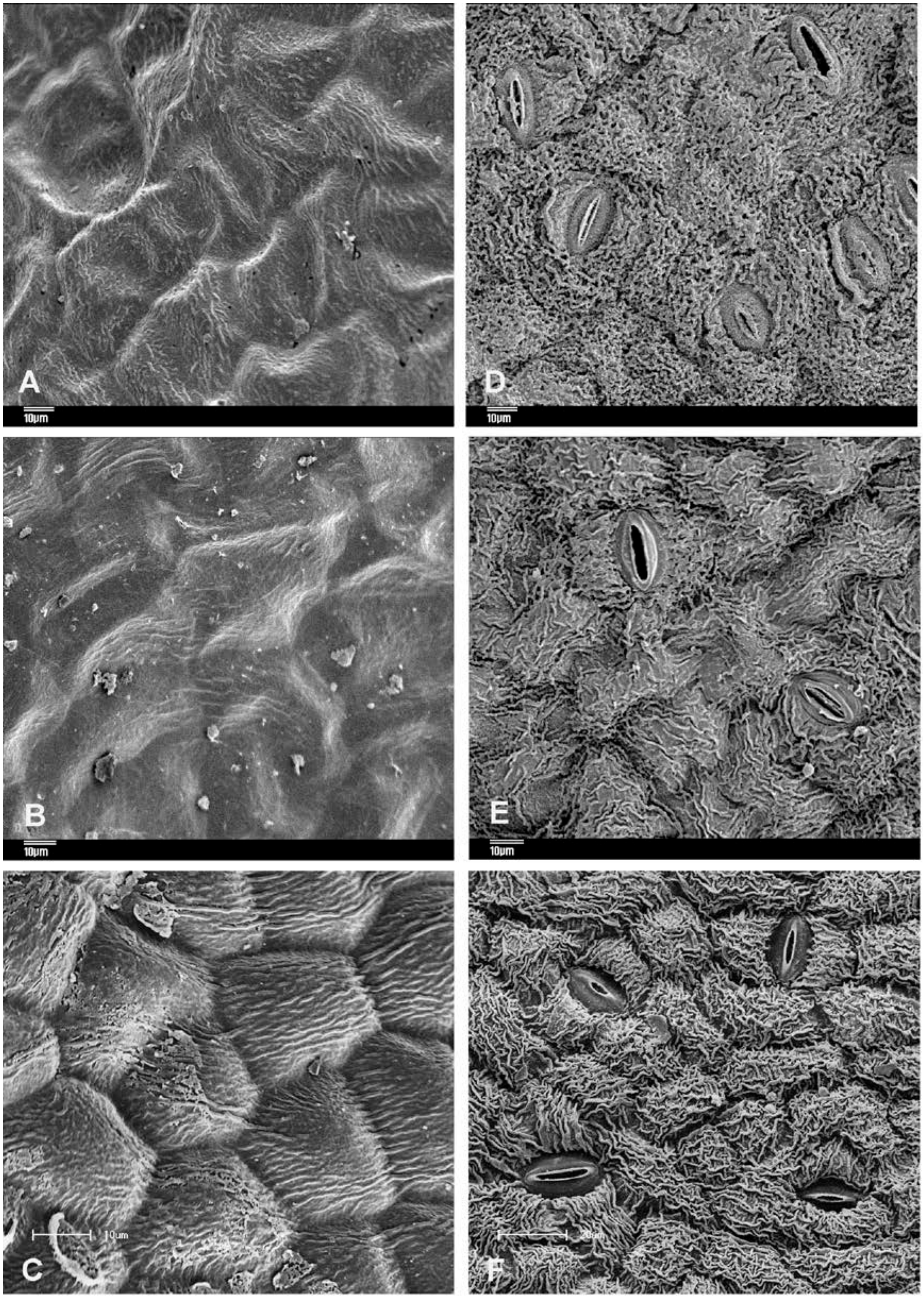


Fig. 4.3.5.3. *Cryptolepis cryptolepioides* leaf epidermal surfaces: (A, B) adaxial epidermal cells with tabular periclinal walls, wavy, sunken anticlinal walls and slightly striated cuticle, (C) adaxial epidermal cells with convex periclinal walls, straight anticlinal walls and striated cuticle, (D–F) abaxial epidermis with convex periclinal walls, wavy sunken anticlinal walls, densely striated cuticle and stomata. Magnification: A, D = x800; B = x850; C = x1600; E, F = x900. Specimens: (A, D) *Burrows 1338* (SRGH); (B, E) *Venter 9183* (BLFU); (C, F) *Joubert 27* (BLFU).

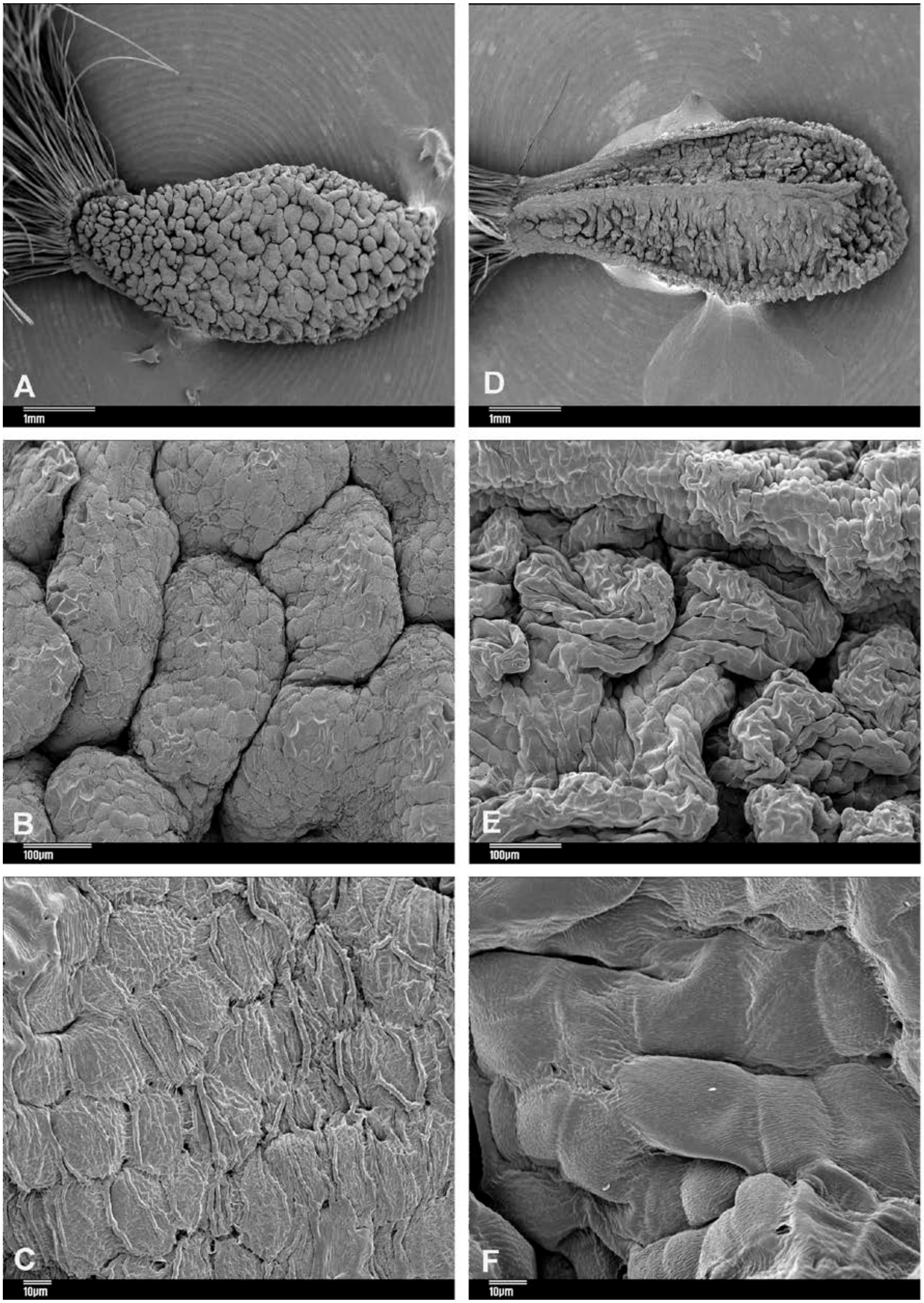


Fig. 4.3.5.4. *Cryptolepis cryptolepioides* seed surfaces: (A) adaxial view of seed covered by warts, (B) warts on adaxial seed surface, (C) cells with convex periclinal walls, slightly sunken anticlinal walls and cuticle with broad and fine striations, (D) abaxial view of seed with thickened margin, central ridge and warts in rows, (E) warts on abaxial surface, (F) cells with convex to concave periclinal walls, slightly sunken anticlinal walls and fine striations densely packed. Magnification: A, D = x19; B = x180; C = x750; E = x190; F = x1000. Specimens: (A–F) *Venter 9197* (BLFU).

4.3.6 *Cryptolepis decidua* (Planch. ex Hook.f. & Benth.) N.E.Br. in Dyer, Flora of Tropical Africa 4(1): 243 (1902). Basionym: *Curroria decidua* Planch. in Hook.f. & Benth., Flora Nigritana in Hook., Niger Flora: 457–458 (1849); Walp.: 69 (1852); Engl.: 244 (1889), 148 (1895); K.Schum.: 219 (1895b); Dinter: 364 (1920); Bullock: 361 (1954); H.Huber: 3 (1967).
Type: West Africa, Angola, *Curror s.n.* (K!, holo.).

= *Curroria decidua* subsp. ***decidua*** in Bullock, Kew Bulletin 9: 361 (1954).

A suffrutescent dwarf-shrub, with white latex, up to 1 m high. *Stems* woody, erect, branching, 5–6 mm in diameter; young stems dark reddish-brown, smooth, glabrous; older stems grey to pale brown, smooth, glabrous, brachyblasts present; interpetiolar ridges villous, colleters inconspicuous on younger branches, absent on older branches. *Leaves* opposite or fascicled, axils villous, sub-sessile to petiolate; petiole green, glabrous, slightly grooved, 0.5–2 mm long; blade oblong, occasionally oblong-obovate, 9–45 x 1–6 mm, semi-succulent, smooth, glabrous, light green, occasionally with purple spots on both surfaces; margin plane; apex obtuse to acute, occasionally mucronate, villous, not recurved; base cuneate to attenuate, occasionally obtuse; secondary and tertiary venation not visible. *Flowers* solitary on brachyblasts; pedicels 5–10(–18.5) mm long; bracts absent or 1–2 per pedicel, opposite or spirally arranged, acicular, 0.5–1 mm long, margins fimbriate with long silky trichomes. *Buds* slender, 6–8 mm long, oblong-ovoid, apices acute, slightly turned to half-turn helically twisted. *Sepals* oblong-ovate, 0.5–2(–2.5) x 0.5–1 mm, acute, margins fimbriate with long silky trichomes, colleters trichome-like. *Corolla* violet or white, 8.5–11.5 mm long; tube shortly campanulate, (2–)2.5–3 mm long, glabrous; lobes spreading, linear-oblong, 6–8.5 x 1 mm, apices obtuse. *Corona* single; primary corona inserted ± 0.8 mm from corolla tube base, slightly exserted, lobes filiform, simple, occasionally bifid, 2–3 mm long. *Stamens* inserted ± 0.3 mm from corolla tube base; anthers triangular, acute, glabrous, 0.7–1 mm long, filaments ± 0.2 mm long. *Nectaries* present, inserted ± 0.3 mm from corolla tube base. *Ovaries* 0.3–0.8 x 0.8 mm; style ± 0.3 mm long, style-head broadly pyramidal, obtuse to acutely bifid, 0.7–1 x 0.6–1 mm. *Translators* deltoid, ± 0.6 mm long, apices acute. *Follicles* erect, widely divaricate to horizontal at 110°–180°, narrowly ovoid, (25–)48–65 x 3–10 mm, light brown, apices attenuate, bases cuneate. *Seeds* oblong to broadly elliptic, 3–6 x 1–2 mm, light to dark brown, slightly warty; coma white to yellowish-white, 11–20 mm long. (Fig. 4.3.6.1.)

Diagnostic characteristics

Cryptolepis decidua is a dwarf-shrub with erect, non-twining stems. The leaves are oblong, or rarely oblong-obovate, with obtuse to acute apices, small to medium sized, 9–45 x 1–6 mm, and semi-succulent. This is the only species with semi-succulent leaves in the Southern African region, and can be distinguished from similar species from the Mandeb Circle, such as *C. gillettii, C. nugaalensis, C. somaliensis* and *C. stefaninii,* based on the combination of the following characters: the flowers are solitary on brachyblasts, with pedicels 5–18.5 mm long; colleters at the sepal bases are trichome-like and the corolla is violet or white, 8.5–11.5 mm long. The corona is single with primary corona lobes filiform, 2–3 mm long and slightly exserted from the corolla tube. Follicles are narrowly ovoid, 48–65 x 3–10 mm, apices attenuate.

Distribution and habitat

Cryptolepis decidua is restricted to the dry regions along the western part of Southern Africa. It is widespread throughout the desert and semi-desert regions of Namibia, as well as the southern parts of Angola and the northern parts of the Orange River Nama Karoo (Mucina et al., 2005) in the Northern Cape Province, South Africa (Fig. 4.3.6.2.). This species grows on rocky hillsides, on plains and along dry ravines in sandy soil and is associated with red nama sandstone, granite, quartzite, dolerite, basalt, dolomite, shale and limestone outcrops at altitudes from 550 to 1500 m. Associated species include *Colophospermum mopane* (Kirk ex Benth.) J.Léonard and *Commiphora* spp. Flowering occurs from August to May and is probably determined by rainfall.

Vernacular names

Khoisan: Girihais, giri-haib.
Afrikaans: jakkalsbos.
German: schakalbush.

Notes

Roots are used as a medicine for treating stomach ailments while the aerial parts are also used as animal feed.

Representative specimens

— **14º59' S, 12º10' E:** Angola, Mossamedes, Caraculo, 19-06-1967, *Menezes , Brites 2904* (SRGH);

— **17º22' S, 13º07' E:** Namibia, Kaokoveld, Swartbooisdrif District, 15 km W of Otjiyanyesemo, 10-04-1973, *Giess, W.* & *Van der Walt 12686* (M, PRE, WIND).

— **20º26' S, 14º55' E:** Namibia, 17 km from Kamanjab, Khorixas at Torra Bay junction, 31-10-1984, *Venter, H.J.T. 9037* (BLFU).

— **24º16' S, 18º28' E:** Namibia, 75 km S of Keetmanshoop, 28-10-1984, *Verhoeven, R.L. 165* (BLFU).

— **25º07' S, 25º22' E:** Botswana, Kanye District, Pharing, 11-1947, *Miller, O.B. B527* (K).

— **28º43'11'' S, 18º30'38'' E:** Namibia, Warmbad, Sandfontein Farm, 20-03-1986, *Beukes, G.J. 22* (BLFU).

— **28º55' S, 18º13' E:** South Africa, Northern Bushmanland, near Goodhouse, S of Orange River, 09-09-1985, *Beukes, G.J. 2* (BLFU).

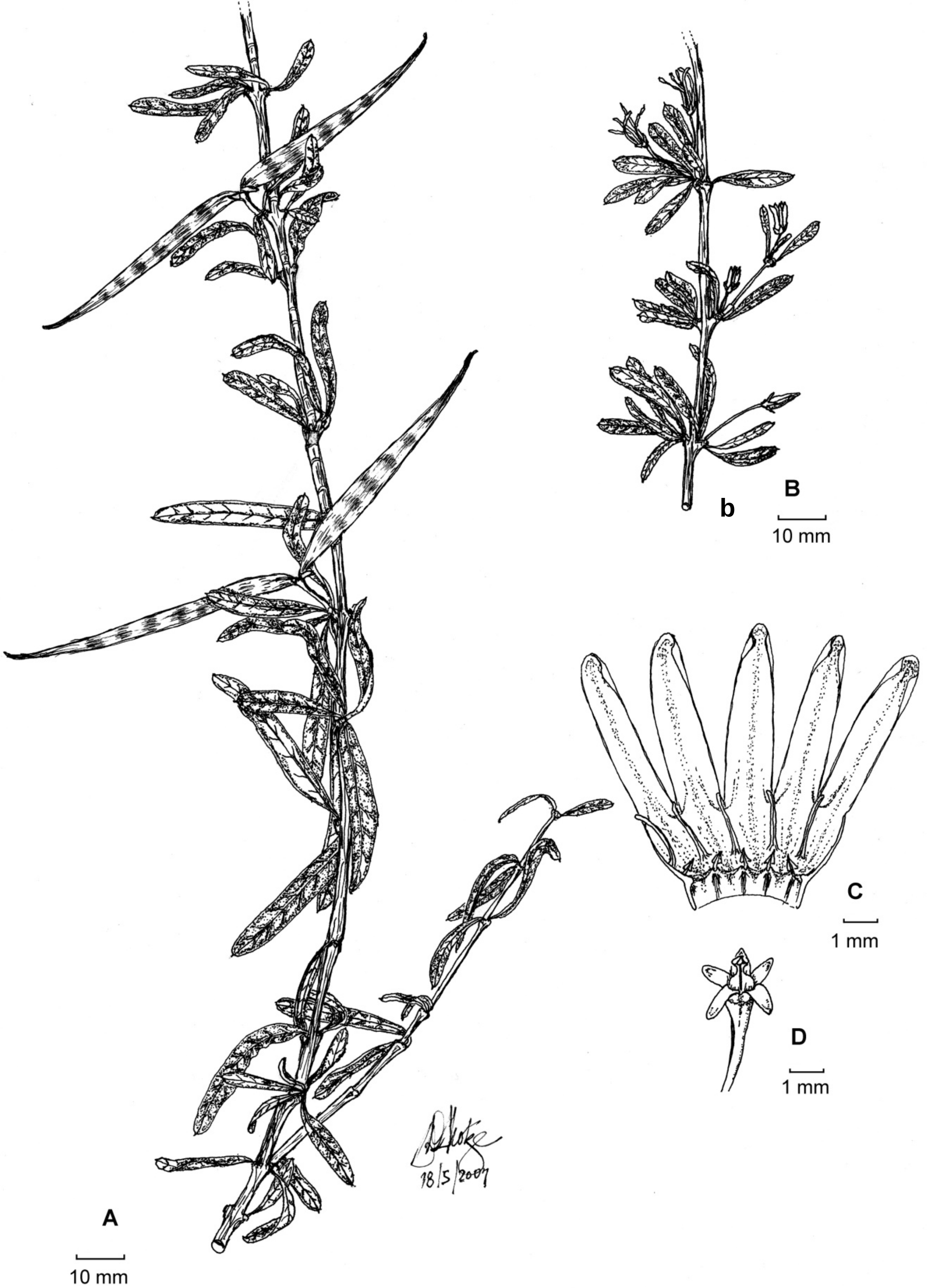


Fig. 4.3.6.1. Illustration of *Cryptolepis decidua*: (A) stem with leaves and paired follicles, (B) stem with leaves and solitary flowers, (C) corolla opened showing corolla, filiform primary corona lobes, secondary corona pockets and stamens with triangular anthers, (D) calyx and pistil of semi-inferior apocarpous ovaries, style and style-head. Specimens: (A) *Beukes 24* (BLFU)*;* (B) *Beukes 22* (BLFU); (C–D) *Beukes 32* (BLFU).

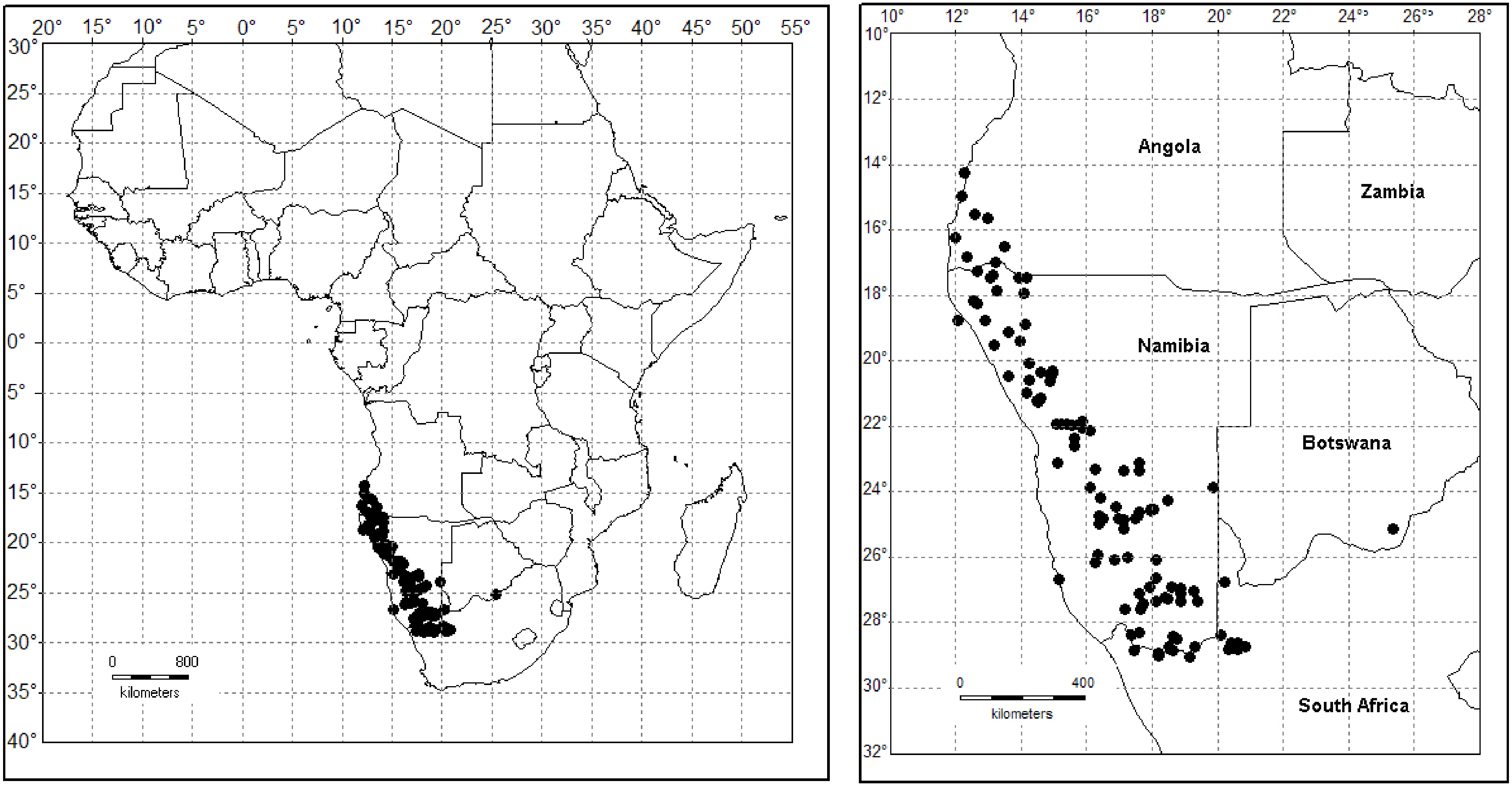


Fig. 4.3.6.2. Known distribution of *Cryptolepis decidua*.

Leaf micromorphology

The adaxial epidermis consists of more or less isodiametric, tetra- to hexagonal cells. Periclinal walls are tabular to convex while anticlinal walls are straight to slightly curved and level with periclinal walls. The cuticle is smooth and unevenly covered by wax platelets. The platelets are mainly concentrated on anticlinal wall boundaries and around stomata. (Fig. 4.3.6.3. A–C)

The abaxial epidermal cells are isodiametric and tetra- to hexagonal. Periclinal walls are tabular to convex while anticlinal walls are straight or slightly curved and sunken. The cuticle is smooth (Fig. 4.3.6.3. E–F) to slightly striate. Striations are straight, parallel and restricted to individual cells (Fig. 4.3.6.3. D). The lower epidermis is evenly (Fig. 4.3.6.3. D, F) or unevenly covered by densely packed wax platelets (Fig. 4.3.6.3. E).

The leaves are amphistomatic. Stomata are slightly sunken and randomly orientated on both surfaces. Striations on the subsidiary cells are perpendicular to the stomatal pore. Guard cells are broadly elliptic and covered by a narrow stomatal ledge. (Fig. 4.3.6.3. A–E)

Seed micromorphology

The adaxial seed surface is covered by evenly distributed protuberances that are formed by raised epidermal cells with no clearly distinguishable shape (Fig. 4.3.6.4. A–B). Epidermal cells between the protuberances are more or less isodiametric and tetragonal. Periclinal walls are convex while anticlinal walls are straight to curved and deeply sunken. The cells are covered by a heavily striated cuticle. Striations are densely packed, parallel and straight, often continuous over several cells (Fig. 4.3.6.4. C).

Adaxially the seed surface has a narrow central ridge and the margins are slightly thickened. Narrow ridges are formed by compressed epidermal cells along the seed margins (Fig. 4.3.6.4. D). Like the cells forming the protuberances on the upper seed surface, the cells forming the ridges show no clear shape (Fig. 4.3.6.4. E). Cells between the ridges and surrounding the central ridge are more or less isodiametric and tetra- to hexagonal. Periclinal walls are convex, or partially concave while anticlinal walls are straight to slightly curved and deeply sunken. The cuticle is densely striated with straight, parallel striations that cross cellular boundaries (Fig. 4.3.6.4. F).

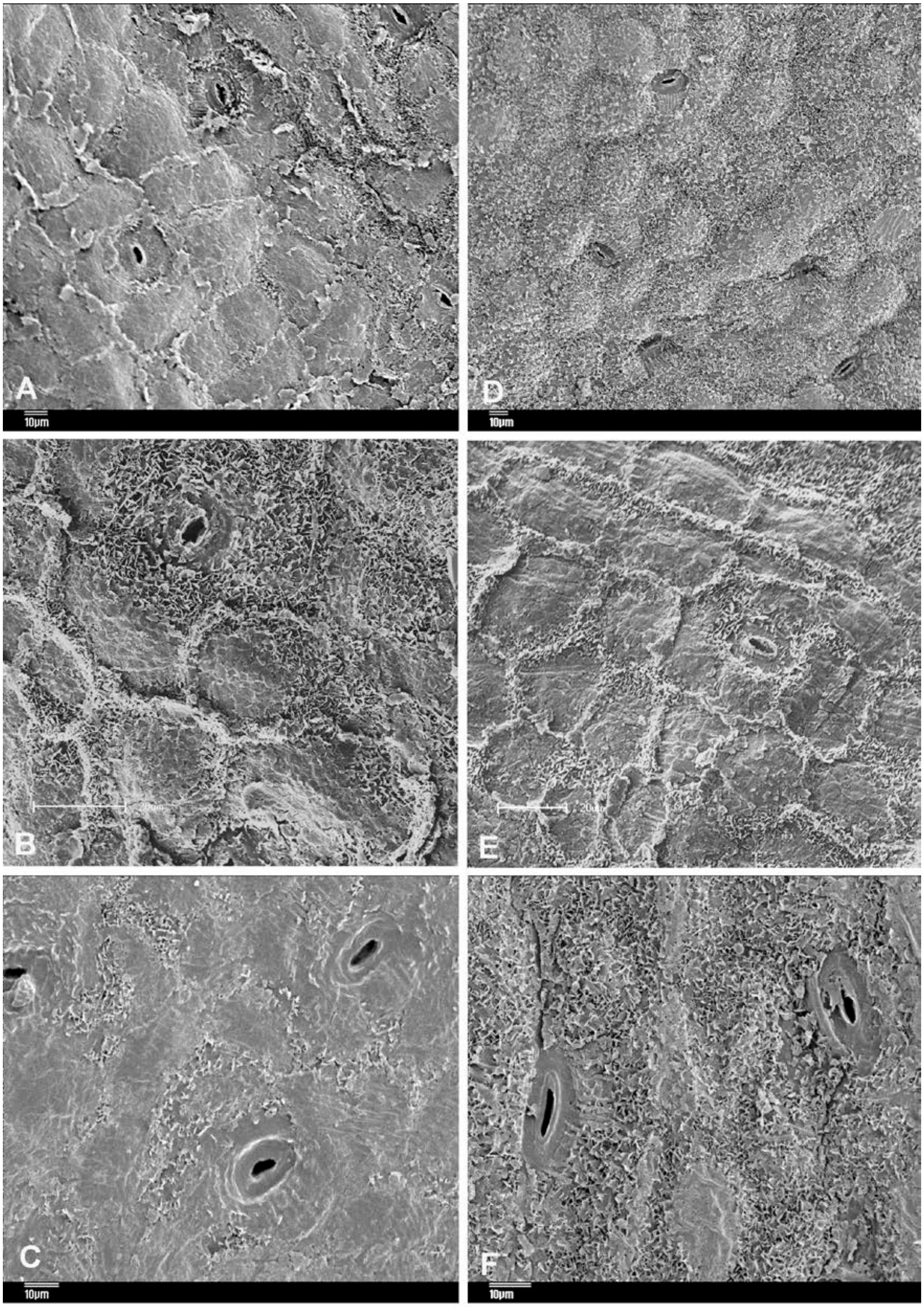


Fig. 4.3.6.3. *Cryptolepis decidua* leaf epidermal surfaces: (A–C) adaxial epidermal cells with smooth cuticle, unevenly arranged wax platelets and sunken stomata, (D, F) abaxial epidermis with slightly striated cuticle, striations parallel, a dense, even layer of wax platelets and sunken stomata, (E) abaxial epidermis with smooth cuticle, unevenly arranged wax platelets and sunken stomata. Magnification: A = x600; B = x1200; C = x900; D = x500; E = x1000; F = x1100. Specimens: (A–B, D–E) *Esterhuizen 23574* (BLFU); (C, F) *Beukes 22* (BLFU).

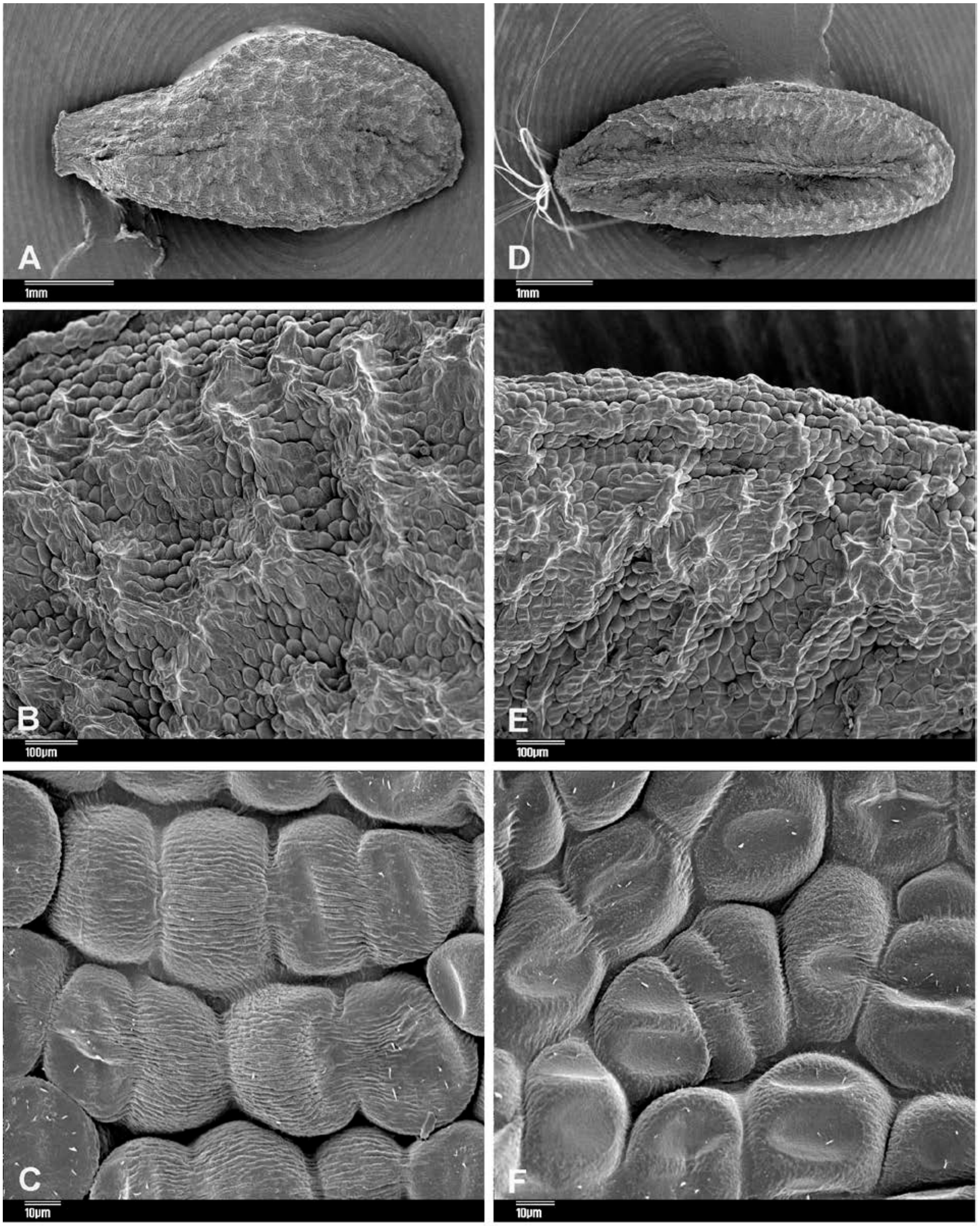


Fig. 4.3.6.4. *Cryptolepis decidua* seed surfaces: (A) adaxial view of seed, (B) protuberances on adaxial seed surface, (C) cells with convex periclinal walls, deeply sunken anticlinal walls and densely striated cuticle, (D) abaxial view of seed with thickened margin and central ridge, (E) protuberances along seed margin consisting of deformed cells, (F) cells between protuberances with convex to concave periclinal walls, deeply sunken anticlinal walls and densely striated cuticle. Magnification: A, D = x22; B = x130; C = x900; E = x120; F = x950. Specimen: (A–F) *Verhoeven 165* (BLFU).

4.3.7 *Cryptolepis delagoensis* Schltr. in Engl., Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 38: 26 (1905b); N.E.Br.: 528 (1907); Bester & L.Joubert: 200 (2011).

Types: Zulu-Natal [Mozambique], Lourenco-Marques [Maputo], *Schlechter anno 0-12-1897* (B†, holo.); South Africa, KwaZulu-Natal, Tembe Game Reserve, Ngobozana Trail, *Venter, H.J.T. 9335* (PRE!, neo. designated by Bester & L.Joubert (2011); BLFU!, isoneo.).

A twining shrub, rarely a climber or scrambler, with white latex, up to 4 m high. *Stems* woody, slender, twining, up to 4 mm diameter; young stems purplish-brown, smooth, inconspicuously puberulent; older stems greyish-brown, slightly verrucose, glabrous; interpetiolar ridges glabrous, rarely slightly scabrous, colleters present. *Leaves* decussate, axils glabrous, rarely slightly scabrous, petiolate; petiole green to purple, glabrous, grooved, 1–3 mm long; blade elliptic to broadly elliptic, rarely obovate, 11–19.5 x 4–7 mm, coriaceous, adaxial surface microscopically puberulent, yellowish-green; abaxial surface microscopically papillate, pale green; margin revolute; apex obtuse-apiculate, rarely acute, occasionally incurved; base rounded, obtuse or cuneate; venation weakly brochidodromous, 4–8 secondary veins on either side of main vein, indistinct, intersecondary veins absent, higher order venation indistinguishable. *Inflorescences* cymose, compact, few-flowered, each cyme consists of 2–6 monochasia, rarely a dichasium with each branch terminating in 2–3 monochasia, glabrous, primary peduncle 1–3(–10) mm long, secondary peduncles 1–2 mm long, pedicels 1–3 mm long; bracts opposite, densely arranged, glabrous, acicular, 0.5–1 mm long, margins glabrous to fimbriate. *Buds* slender, 2.5–3 mm long, ovoid, apices acute to apiculate, full-turn helically twisted. *Sepals* broadly ovate, ± 1 x 0.75 mm, acute, glabrous, occasionally fimbriate, colleters ovate, apices dentate. *Corolla* white to cream-coloured, 3–6 mm long; tube campanulate, 1.5–2 mm long, glabrous; lobes spreading, linear-oblong, 1.5–3.5 x 0.7 mm, apices obtuse. *Corona* single; primary corona inserted ± 1 mm from corolla tube base, included, lobes sub-clavate, apices truncate, rarely acute, fleshy, ± 0.5 mm long, glabrous, apices connivent over gynostegium. *Stamens* inserted 0.4–0.7 mm from corolla tube base; anthers hastate, apices acicular, villous outside, ± 0.7–1 mm long, filaments ± 0.2 mm long. *Nectaries* inconspicuous, inserted ± 0.4–0.7 mm from corolla tube base. *Ovaries* ± 0.5–0.7 x 0.5 mm; style ± 0.3 mm long, style-head broadly pyramidal, acute, ± 0.5 x 0.5 mm. *Translators* narrowly elliptic, ± 0.4 mm long, apices acute. *Follicles* erect, widely divaricate at 170–180°, narrowly ovoid, 29–49 x 4.5–6 mm, dark brown, apices acute, recurved, bases cuneate. *Seeds* narrowly elliptic, 8–11 x 2.5 mm, dark reddish-brown, smooth; coma white, 13–17 mm long. (Fig. 4.3.7.1.)

Diagnostic characteristics

Cryptolepis delagoensis is a climber, scrambler or twining shrub. The leaves are elliptic to broadly elliptic or rarely obovate with obtuse, apiculate, rarely acute apices; small, 11–20 x 4–7 mm, and coriaceous, with revolute margins. Higher order venation is indistinct. The small leaf size and indistinct higher order venation distinguishes this species from the large to medium-leaved climbers and scramblers of the region. *Cryptolepis delagoensis* is distinguished from similar species with a shrubby growth form and twining branches by a combination of micromicropapillae on the abaxial leaf surface, flowers grouped in compact, few-flowered cymes, the corolla 3–6 mm long with the corona single and primary corona lobes sub-clavate and 0.5 mm long. Follicles are erect, widely divaricate at 170–180°, narrowly ovoid, 29–49 x 4.5–6.0 mm, apices acute, recurved.

Distribution and habitat

This species has a restricted distribution in Southern Africa with only six known locations, at altitudes from 50–900 m. It occurs in the northern parts of KwaZulu-Natal Province and the eastern parts of the Mpumalanga Province, along the Swaziland border (Fig. 4.3.7.2.). The distribution range extends into Mozambique. *C. delagoensis* grows in sand forest and bush-veld vegetation, and is associated with sandy soil overlying sandstone outcrops or ravine slopes. Associated species include *Cladostemon kirkii* (Oliv.) Pax & Gilg.*,* *Strophanthus gerrardii* Stapf, *Strychnos madagascariensis* Poir. and *Terminalia sericea* Burch. ex DC. Flowering occurs during summer, from December to February.

Representative specimens

— **26º28'75'' S, 32º27'12'' E:** Mozambique, Maputo District, southern end of Licuati Forest Reserve, about 30 km SW of Bela Vista, 17-12-2001, *Goyder, D.J. 5034* (K).

— **25º57' S, 31º06' E:** South Africa, Mpumalanga, near Swaziland border, near Havelock, Ida Doyer Reserve, on Schoonoord Farm (380JU), 1960, *Fourie, E. 1641* (PRE).

— **26º43' S, 30º42' E:** South Africa, Mpumalanga, 9 km S of Amsterdam, 12-12-2002, *Bruyns, P.V. 9365* (BOL).

— **27º31'10'' S, 31º03'15'' E:** South Africa, KwaZulu-Natal, Vryheid District, along road to Bhivane [Paris] Dam, 11-12-2002, *Bruyns, P.V. 9357* (BOL).

— **27º37'30'' S, 31º07'30'' E:** KwaZulu-Natal, Vryheid Coronation, Paris Dam site, along Manzana River, *Singh, Y. 372* (NH).

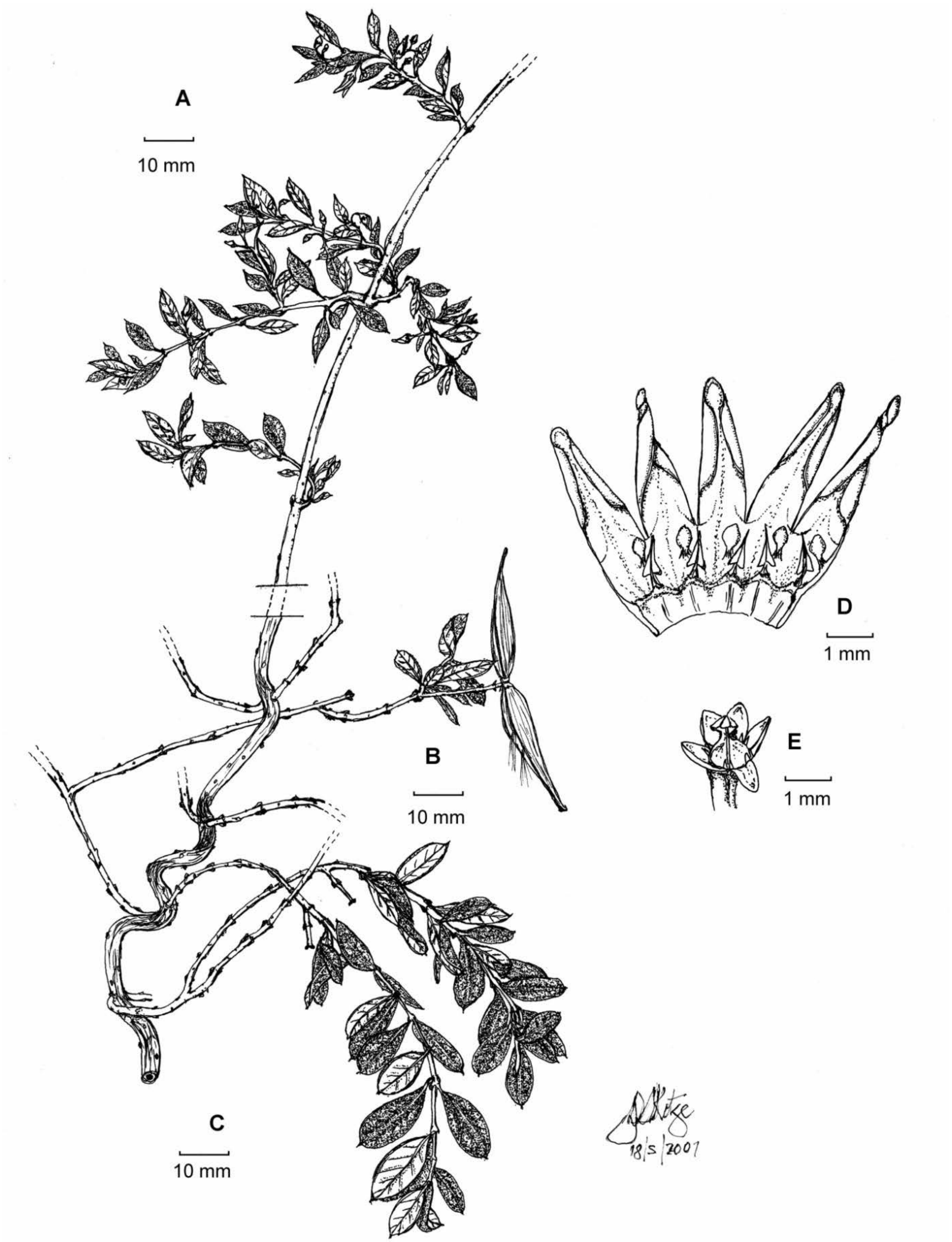


Fig. 4.3.7.1. Illustration of *Cryptolepis delagoensis*: (A, C) stem with leaves and inflorescences, (B) stem with paired follicles, (D) corolla opened showing clavate primary corona lobes, secondary corona pockets and stamens with hastate anthers, (E) calyx and pistil of semi-inferior apocarpous ovaries, style and style-head. Specimens: (A) *Bruyns 9365* (BOL)*;* (B) *Fourie 1641* (PRE); (C) *Goyder 5034* (K); (D–E) *Bruyns 9357* (BOL).

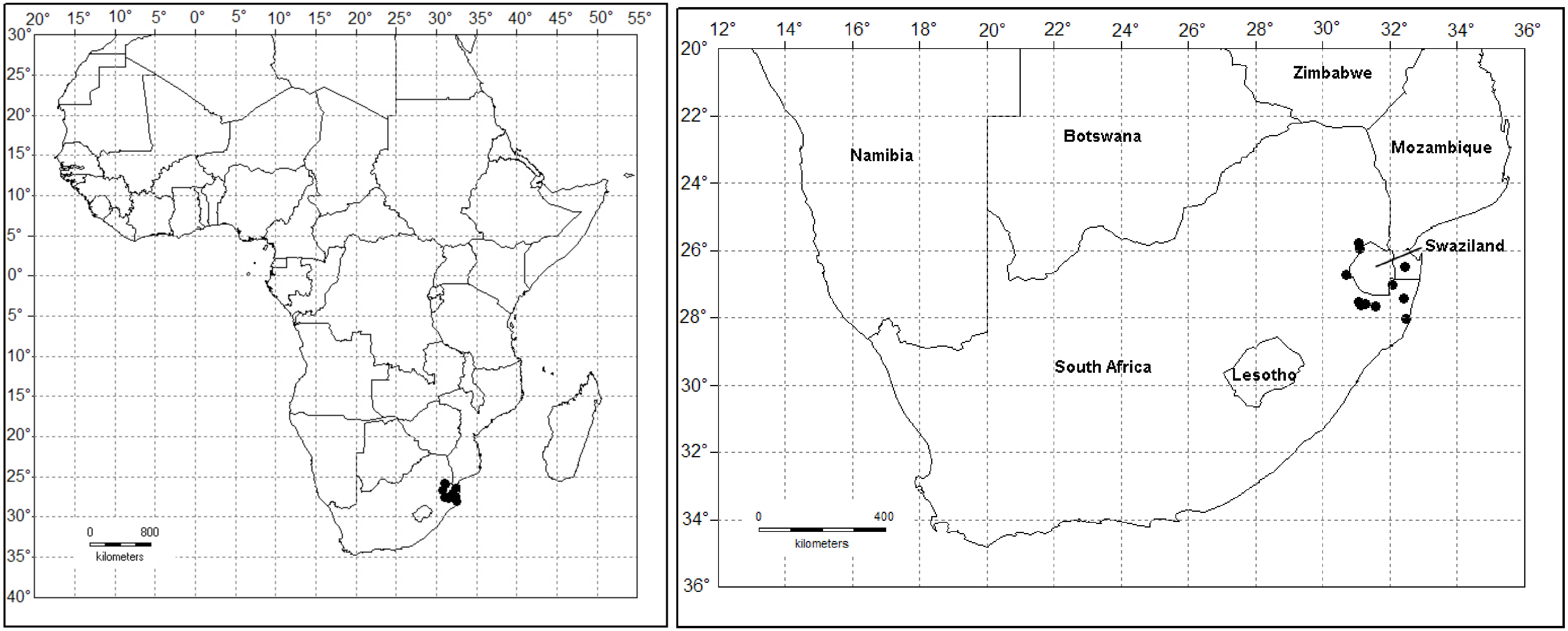


Fig. 4.3.7.2. Known distribution of *Cryptolepis delagoensis*.

Leaf micromorphology

Cells on the adaxial epidermal surface are isodiametric and penta- to hexagonal. Periclinal walls are convex while anticlinal walls are straight to slightly curved and sunken. The cuticle is striated with straight, parallel striations, continuous over intercellular boundaries (Fig. 4.3.7.3. A–C) while cuticular folds create an uneven appearance and obscure cell shape in certain parts of the leaf surface (Fig. 4.3.7.3. A).

The abaxial epidermal surface is densely covered by micropapillae, obscuring cell shape and anticlinal cell walls. Each cell's periclinal wall protrudes to form a single papilla. The cuticle is heavily striated with striations wavy and randomly orientated. Striations mainly occur on the micropapillae but also radiate from the bases of micropapillae. (Fig. 4.3.7.3. D–F)

Leaves are hypostomatic with numerous stomata level with other epidermal cells and randomly orientated (Fig. 4.3.7.3. E). Striations on the subsidiary cells generally run perpendicular to the stomatal pore. The guard cells are elliptic with a narrow stomatal ledge (Fig. 4.3.7.3. F).

Seed micromorphology

The adaxial seed surface is smooth (Fig. 4.3.7.4. A) and epidermal cells are isodiametric, tetra- to hexagonal and tightly packed. Periclinal walls are convex while anticlinal walls are straight and deeply sunken (Fig. 4.3.7.4. B, D). The cuticle is densely striated with slightly undulate striations. Near the seed margin striations are randomly orientated (Fig. 4.3.7.4. C), while cells near the centre of the seed surface have parallel to randomly orientated striations, which are continuous over intercellular boundaries (Fig. 4.3.7.4. E).

The abaxial seed surface is marginate with smooth surfaces between the narrow central ridge and seed margins (Fig. 4.3.7.5. A). Cells near the seed margin are elongate and tetra- to hexagonal. Periclinal walls are tabular, while anticlinal walls are straight and slightly sunken (Fig. 4.3.7.5. B–C). Cells near the central ridge are isodiametric or slightly elongate and penta- to hexagonal. Periclinal walls are tabular to convex while anticlinal walls are straight to slightly curved and slightly to deeply sunken (Fig. 4.3.7.5. D–E). The cuticle is densely striated with randomly orientated striations that cross intercellular boundaries (Fig. 4.3.7.5. C–E).

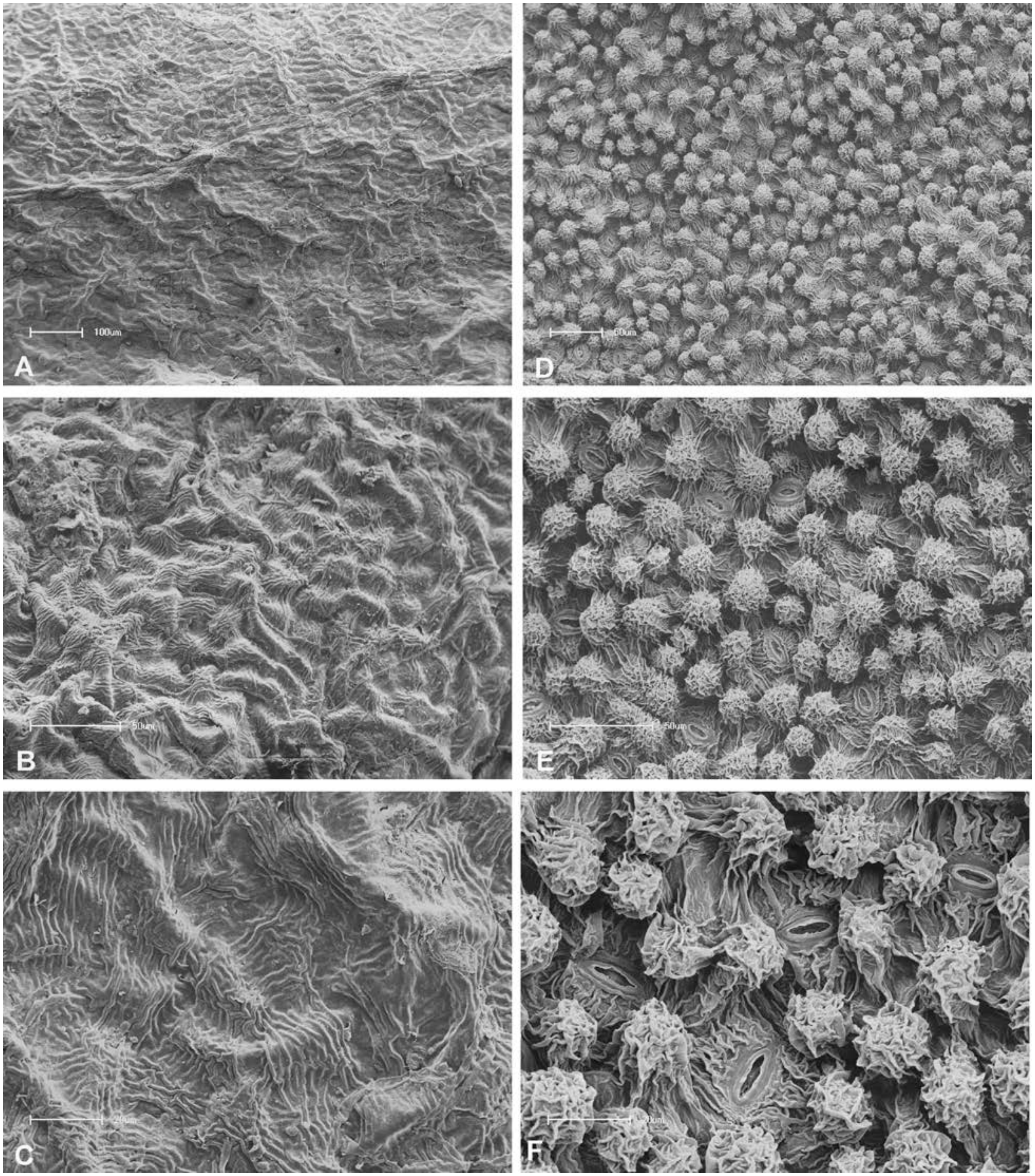


Fig. 4.3.7.3. *Cryptolepis delagoensis* leaf epidermal surfaces: (A) adaxial epidermal cells with cuticular folds, (B, C) adaxial epidermal cells with densely striated cuticle, (D–F) abaxial epidermis with globular, striate micropapillae and stomata. Magnification: A = x200; B = x700; C = x1400; D = x400; E = x800; F = x1600. Specimen: (A–F) *Venter 9335* (BLFU).

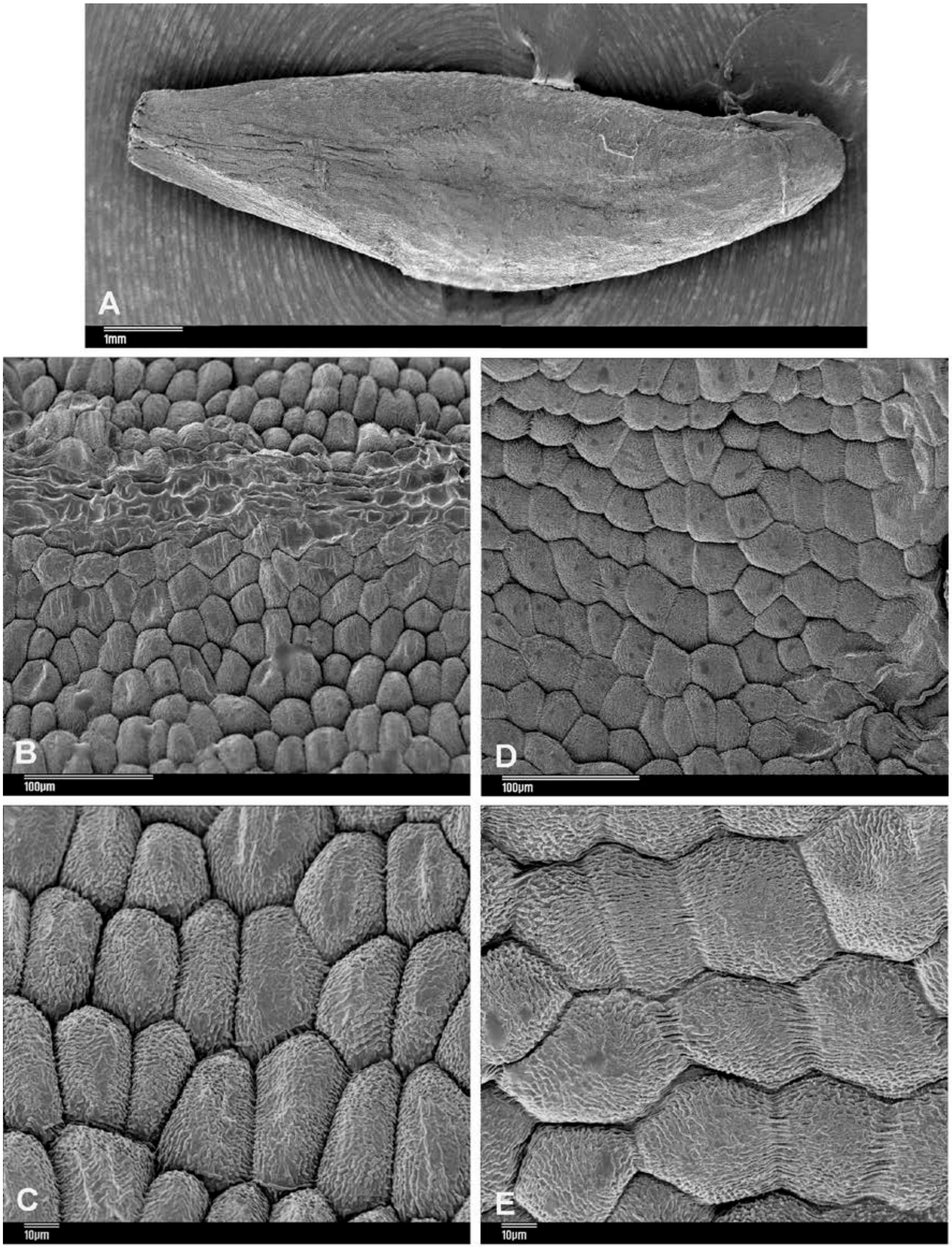


Fig. 4.3.7.4. *Cryptolepis delagoensis* seed surface: (A) adaxial view of seed, (B) adaxial seed surface with isodiametric, tetra- to hexagonal cells near seed margin, (C) cells near seed margin with cuticular striations randomly orientated and restricted to individual cells, (D) surface with isodiametric, tetra- to hexagonal cells on central part of seed, (E) cells near seed centre with parallel striations, continuous over cell boundaries. Magnification: A = x20; B = x330; C = x900; D = 350; E = x900. Specimen: (A–E) *Fourie 1641* (PRE).

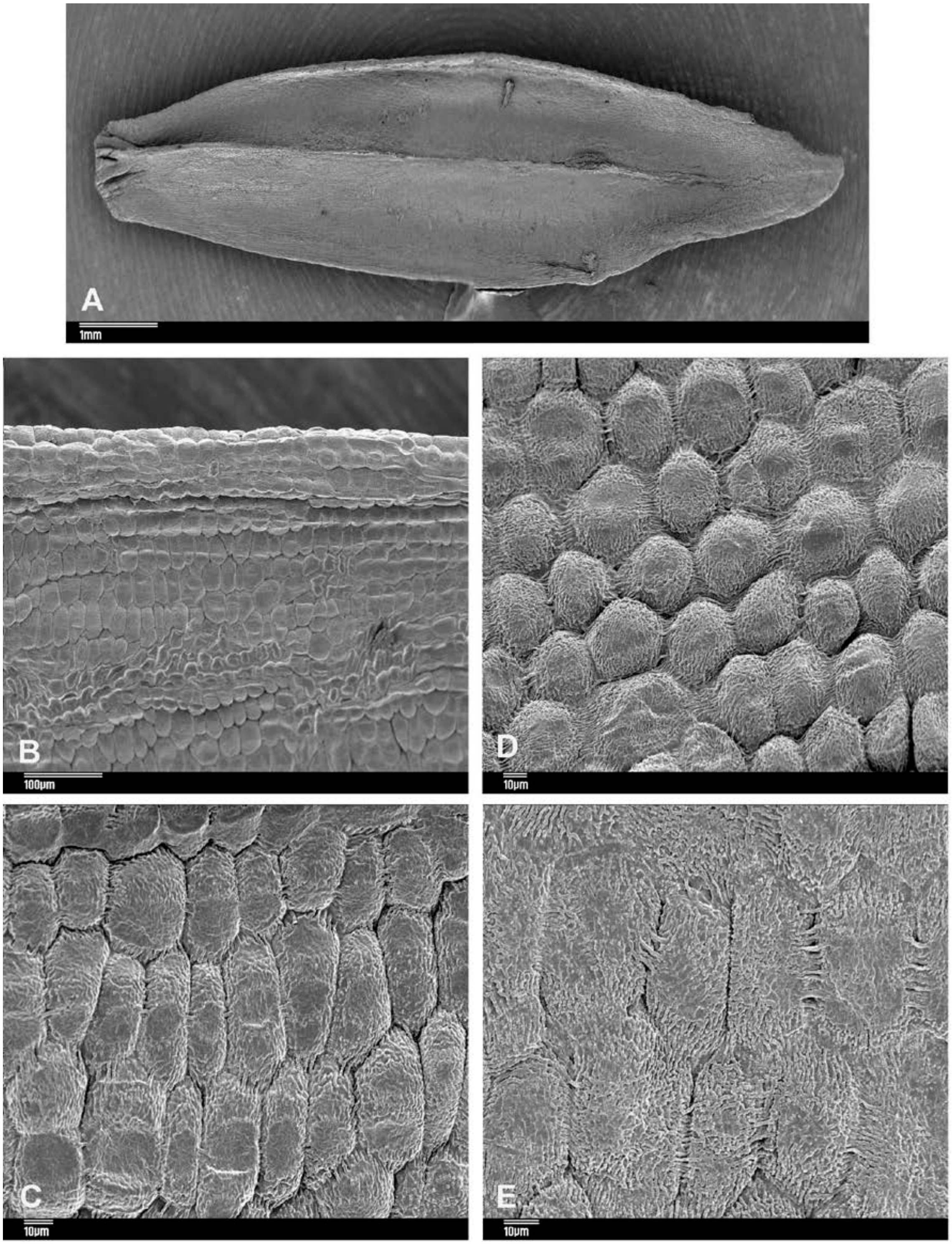


Fig. 4.3.7.5. *Cryptolepis delagoensis* seed surface: (A) abaxial view of seed with narrow central ridge, (B) abaxial surface between central ridge and seed margin smooth, (C) cells near seed margin elongate with tabular periclinal walls, (D) cells near central ridge isodiametric with convex periclinal walls, (E) cells near central ridge elongate with tabular periclinal walls. Magnification: A = x20; B = x200; C = x750; D = x600; E = x900. Specimen: (A–E) *Fourie 1641* (PRE).

4.3.8 *Cryptolepis dubia* (Burm.f.) M.R.Almeida, Flora Maharashtra 3A: 221 (2001). Basionym: *Periploca dubia* Burm.f., Flora Indica: 70 (1769).

Type: Illustration: Rheede, Hortus Malabaricus 9: t.11 (1689) (icono. designated by Burm.f. (1769)).Note 1

= *C. balansae* Baill., Bulletin Mensuel de la Societé Linnéenne de Paris 2(101): 803 (83 by error) (1889).

Type: China, Tonkin, Ju-Chap, *Balansa 2073* (P!, holo.; K!, iso.).

= *C. buchananii* Roem. & Schult., Systema Vegetabilium 4: 409 (1819); G.Don: 82 (1838); Steud.: 450 (1840); Falc.: 53, t. 5. (1842); Wight: 6, t. 494 (1843), 230, t. 182. f. 8 (1850); Dalz. & Gibs.: 148 (1861); Drury: 254 (1866); J.Stewart & Brandis: 330 (1874); Hook.f.: 5 (1883); H.Huber: 183 (1983).

Type: India, *Franciscus Buchanan [Francis Buchanan-Hamilton] s.n.* (BM!, holo.).

= *C. reticulata* (Roxb.) Wall. ex Steud., Nomenclator Botanicus sue synonymia plantarum universalis 2(1): 450 (1840); Royle: 270 (1839) *nom. nud.*; Wall. cat. no. 1640, unpublished catalogue at K. Basionym: *Nerium reticulatum* Roxb., Flora Indica: 8 (1832).

Type: Illustration: Rheede, Hortus Malabaricus 9: t.11 (1689) (icono. designated by Roxb. (1832)).Notes 2 & 3

= *C. reticulata* (Roxb.) K.Schum. in Engl. & Prantl, Die Natürlichen Pflanzenfamilien 4(2): 219 (1895b), *nom. illegit*. Basionym: *Nerium reticulatum* Roxb., Flora Indica: 8 (1832).

Type: Illustration: Rheede, Hortus Malabaricus 9: t.11 (1689) (icono. designated by Roxb. (1832)).

= *Echites reticulata* Roth, Novae Plantarum Species preasertim Indiae Orientalis: 134 (1821).

Type: No type designated, synonymy after Roth's (1821) description.

A climber, with white latex, up to 4 m high. *Stems* woody, slender, up to 25 mm in diameter; young stems light brown to greenish, smooth to slightly verrucose, glabrous; older stems dark brown, bark peeling, verrucose; interpetiolar ridges glabrous, conspicuous on young and older branches, colleters present. *Leaves* opposite, axils densely villous, petiolate; petiole green to brown, glabrous, slightly grooved, 7–17 mm long; blade elliptic, 70–145 x 25–70 mm, coriaceous, dark green, shiny adaxially, pale green to whitish abaxially, glabrous; margin plane; apex obtuse to acuminate, occasionally apiculate, glabrous, not recurved; base cuneate, rarely obtuse; venation brochidodromous, conspicuous on abaxial surface, 12–16 secondary veins on either side of main vein, intersecondary venation prominent, tertiary veins random reticulate, areoles well developed, veinlets branched. *Inflorescences* cymose, compact, many-flowered, slender, each cyme consists of 2–3 dichasia, each ending in 2–4 monochasia, primary peduncle 10–20 mm long, secondary peduncles 5–7 mm long, pedicels 2–4 mm long; bracts opposite, sparsely to densely arranged, glabrous, ovate, 1–2 mm long, margins glabrous or rarely slightly fimbriate. *Buds* slender, 6–8 mm long, narrowly ovoid, apices attenuate, full turn helically twisted. *Sepals* ovate, ± 2 x 1.3 mm, acute, glabrous, margins fimbriate, colleters ovate, apices dentate. *Corolla* cream to greenish yellow, 8–9.8 mm long; tube campanulate, 1.8–2.2 mm long, glabrous; lobes spreading, narrowly triangular, 6.2–7.5 x 2–2.2 mm, apices acute. *Corona* double; primary corona inserted ± 1 mm from corolla tube base, included, lobes clavate, fleshy, ± 0.8 mm long, glabrous, apices obtuse, connivent over gynostegium; secondary corona in corolla lobe sinuses, pocket-like, glabrous, inconspicuous. *Stamens* inserted ± 0.5 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 0.7 mm long, sessile. *Nectaries* prominent, inserted ± 0.5 mm from corolla tube base. *Ovaries* ± 0.4 x 0.8 mm; style ± 0.2 mm long, style-head broadly pyramidal, cuspidate, ± 0.2 x 0.5 mm. *Translators* narrowly elliptic, ± 0.2 mm long, apices acute. *Follicles* pendulous, widely divaricate at ± 180°, ovoid, 65–75 x 10–20 mm, greenish brown, apices attenuate, bases cuneate. *Seeds* obovate, ± 6 x 2–3 mm, dark brown, slightly warty; coma white to yellowish-white, ± 32 mm long. (Fig. 4.3.8.1.)

Diagnostic characteristics

Cryptolepis dubia is a climber from southern Asia. Large, 70–145 x 25–70 mm, coriaceous, elliptic leaves with obtuse to acuminate, occasionally apiculate apices are characteristic of this species. It is distinguished from all similar species, such as *C. africana, C. apiculata, C. capensis, C. grandiflora, C. hypoglauca, C. ibayana* and *C.*

sanguinolenta by having more than 12 secondary veins on either side of main vein, prominent intersecondary veins and well developed areoles. *Cryptolepis dubia* is further characterised by having compact many-flowered inflorescences with corollas shorter than 10 mm and double corona. Follicles are characteristically ovoid, 65–75 x 10–20 mm.

Distribution and habitat

Cryptolepis dubia is found in Bhutan, Burma, China, India, Laos, Myanmar, Nepal, Sri Lanka, Thailand and Vietnam (Fig. 4.3.8.2.). It grows in open thickets and broadleaved, deciduous forest, in forest clearings and along forest margins, on hillsides and on river banks, at altitudes from 100–1450 m. *Cryptolepis dubia* seems to be associated with granite. Flowering occurs throughout the year, with a peak in October.

Vernacular names

Adivi pala-tiga (Roxburgh, 1832)
Katu-pal-valli (Rheede, 1689)
Karanta (Stewart and Brandis, 1874).
Karunta (Roxburgh, 1832)
Nasha-gyi (also applied to *Cinnamomum nitidum, Onosma bracteatum* and *Strophanthus wallichii*) (Kress et al., 2003)
Thaman-gya (Kress et al., 2003)

Notes

1. The earliest known record of any *Cryptolepis* species is a short description and detailed illustration which is unmistakeably *C. dubia,* published by Rheede (1689). Though Rheede (1689) indicated that this species showed close affinity to *Periploca* and *Apocynum,* he offered no Latin name but in stead used the vernacular name, Katu-Pal-Valli. The first validly published name for the species depicted in this illustration is *Periploca dubia* Burm.f., which was later transferred to *Cryptolepis* by Almeida (2001). Burman made no reference to any herbarium specimens in his original publication of *P. dubia*. Consequently the illustration, Tab. 11, in Rheede's (1689) Hortus Malabaricus, vol. 9 is the iconotype of *Cryptolepis dubia* (Burm.f.) M.R.Almeida.

2. Roxburg (1814) listed the name *Nerium reticulatum* Roxb. along with two vernacular names for the species, but did not provide any description or reference to a specimen. Consequently the name published in 1814 is considered to be a *nom. nud. Nerium reticulatum* Roxb. was validly published in 1832, with a detailed description and reference to Rheede's (1689) illustration, but no reference to any herbarium specimens. Consequently the illustration, Tab. 11, in Rheede's (1689) Hortus Malabaricus, vol. 9 is also the iconotype of *Nerium reticulatum* Roxb.

3. Wallich did not indicate any type specimens when he transferred *Nerium reticulatum* Roxb. to *Cryptolepis reticulata* (Roxb.) Wall. ex Steud. but the specimens designated as *Cryptolepis reticulata* in Wallich's herbarium (several duplicates of *Wallich 1640*) have been regarded as the type material of that species. However, since Roxburgh (1832) designated the illustration by Rheede (1689) as iconotype of *Nerium reticulatum* Roxb., Wallich's collections cannot be regarded as type of *Cryptolepis reticulata* (Roxb.) Wall ex Steud. In K and G the type folders of *C. reticulata* also contain specimens of *Jenkins 263*. There is no reference to these specimens in any of the type literature and consequently the *Jenkins 263* specimens cannot be regarded as type material.

4. Hooker (1883) published a reference to the name, *Echites cuspidata* Heyne *nom. nud. in sched.* and designated this as a synonym of *Cryptolepis buchananii* Roem. & Schult. Hooker (1883) derived this name from a specimen collected in India, Bombay, and which was kept in: *Herb. Rottlerianum anno 21-06-1813 (*K).

Representative specimens

— **7º32'03" N, 80º52'57" E:** Sri Lanka, Central Province, Matale District, 4 miles [6.4 km] E of Pallegama, 10-10-1974, *Davidse, G. 7307* (K).

— **13º01'42" N, 75º53'40" E:** India, Mysore, Hassan District, Kesagodu, Alur-Belur road, 15-05-1969, *Saldanha, C.J. 13503* (K).

— **23º42' N, 82º12' E:** Nepal, [Mid-Western Region], Jajarkot, 18-06-1974, *Dobremez, J.F. & Naiandhan, N.P. 2611* (G).

— **26º55'45" N, 87º19'02" E:** Nepal, Burungdi Khola, Dhankuta District, 04-09-1967, *Williams, L.H.J.* & *Stainton 8358* (BM, K).

— **27º19'49" N, 91º33'12" E:** Bhutan, Tashigang Dzong [Fortress], 18-06-1979, *Grierson, A.J.C. & Long, D.G. 2060* (K).

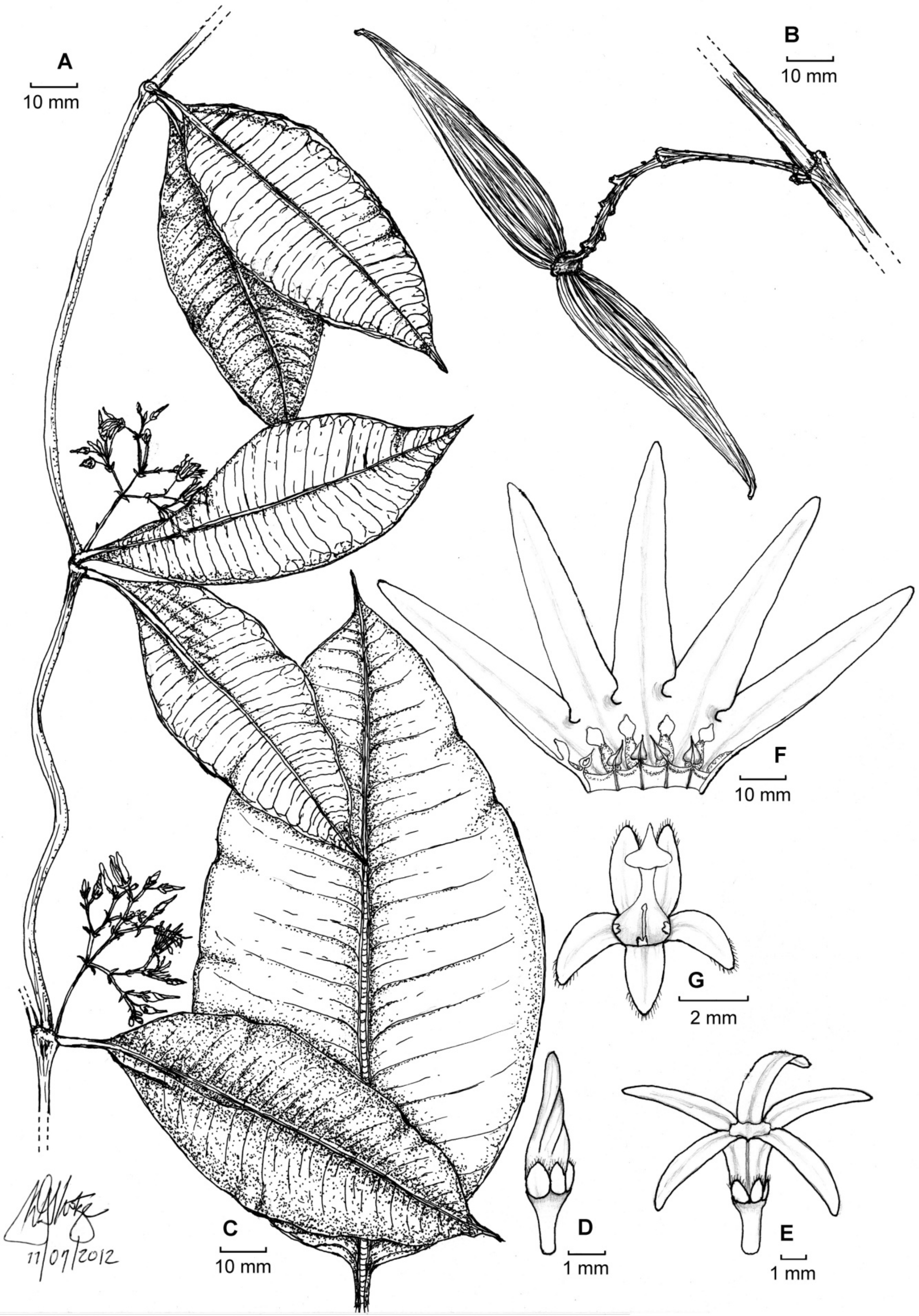


Fig. 4.3.8.1. Illustration of *Cryptolepis dubia*: (A) stem with leaves and inflorescences, (B) stem with paired follicles, (C) leaf showing intersecondary venation, (D) external view of bud, (E) external view of mature flower, (F) flower opened showing narrowly triangular corolla lobes, clavate primary corona lobes, stamens with narrowly hastate anthers and prominent nectaries, (G) calyx with colleters, apocarpous ovaries, fused style and broadly pyramidal, cuspidate style-head. Specimens: (A, D–E) *Grierson & Long 2060* (K); (B–C) *Williams & Stainton 8358* (BM); (F–G); *Dobremez 2611* (G).

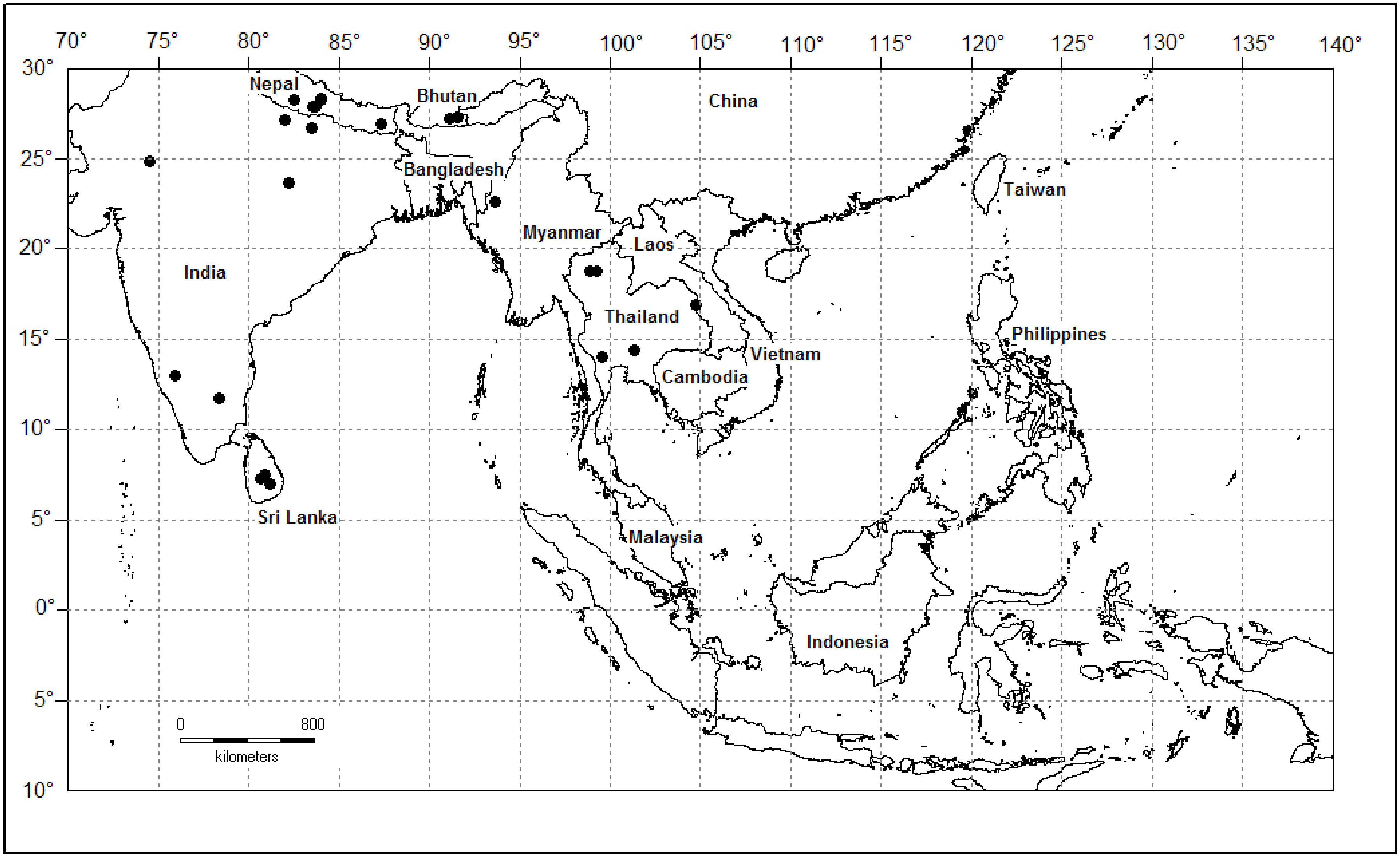


Fig. 4.3.8.2. Known distribution of *Cryptolepis dubia.* The specimen collected in Vietnam is not shown since the coordinates of the collection could not be determined.

Leaf micromorphology

Cells on the adaxial epidermal surface are isodiametric and tetra- to hexagonal. Periclinal walls are tabular while anticlinal walls are slightly curved to slightly wavy, level with the epidermal surface to slightly sunken (Fig. 4.3.8.3. A–C). The cuticle is smooth (Fig. 4.3.8.3. A, C) to slightly striated, with striations parallel and restricted to individual cells (Fig. 4.3.8.3. B). The epidermal surface is covered by densely packed wax particles (Fig. 4.3.8.3. A–B) or a continuous wax sheet covering each individual cell (Fig. 4.3.8.3. C).

Cell shape on the abaxial epidermal surface is indistinguishable. The entire surface is covered by globular, striate micropapillae which are interconnected by radiating ridges. Between micropapillae the cuticle may be slightly to heavily striated, with striations straight to wavy and randomly orientated (Fig. 4.3.8.3. D–F). Wax platelets may form a dense covering over the entire surface (Fig. 4.3.8.3. D–E) or may be completely absent (Fig. 4.3.8.3. F).

The leaves are hypostomatic with numerous stomata randomly orientated and level with the surrounding epidermal cells. Stomata are paracytic with dense, parallel striations on subsidiary cells perpendicular to the stomatal pore (Fig. 4.3.8.3. D–E) or randomly orientated (Fig. 4.3.8.3. F). The guard cells are narrowly elliptic and covered by a broad stomatal ledge (Fig. 4.3.8.3. D–F).

Seed micromorphology

The adaxial seed surface is covered by numerous protuberances which are formed by raised epidermal cells with convex periclinal walls and a smooth cuticle (Fig. 4.3.8.4. A–B, D–E). Epidermal cells between the protuberances do not have a clearly distinguishable shape. Periclinal walls are tabular while anticlinal walls are straight and slightly sunken (Fig. 4.3.8.4. C) or periclinal walls may be concave while anticlinal walls are curved and deeply sunken (Fig. 4.3.8.4 F). The cells may be covered by striated cuticle, with striations reticulate and continuous over intercellular boundaries (Fig. 4.3.8.4. C) or a coarse granular cuticle (Fig. 4.3.8.4. F).

Adaxially the seed has a narrow central ridge (Fig. 4.3.8.5. A, D). Between the ridge and seed margins numerous protuberances occur which are formed by raised, contorted epidermal cells (Fig 4.3.8.5. B, E). Cells between protuberances are isodiametric and tetra- to hexagonal. Periclinal walls may be tabular while anticlinal walls are straight and slightly sunken (Fig. 4.3.8.5. C) or periclinal walls may be concave while anticlinal walls are curved and deeply sunken (Fig. 4.3.8.5. F). The cells may be covered by striated cuticle, with striations reticulate and continuous over intercellular boundaries (Fig. 4.3.8.5. C) or a finely granular cuticle (Fig. 4.3.8.5. F).

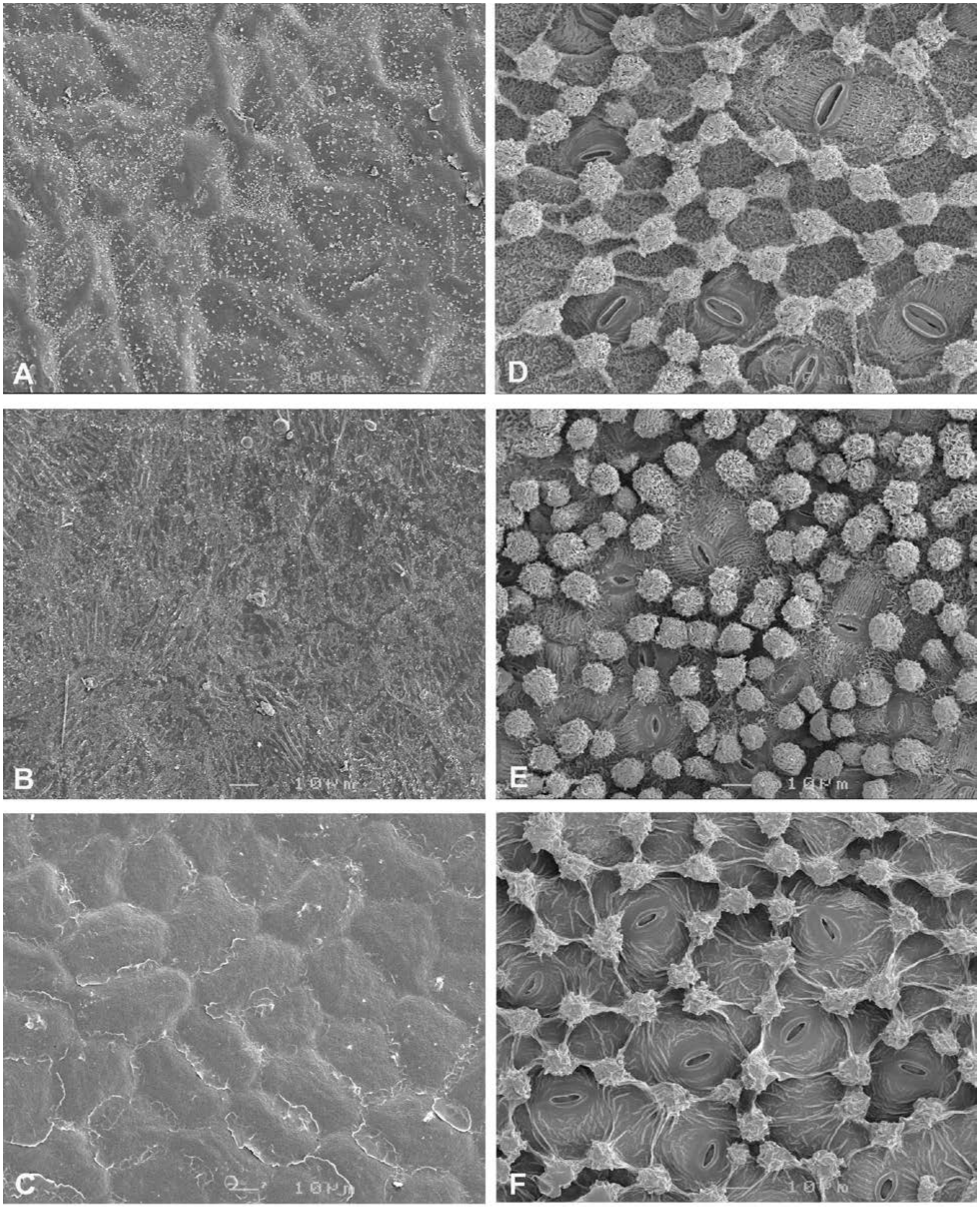


Fig. 4.3.8.3. *Cryptolepis dubia* leaf epidermal surfaces: (A) adaxial epidermal cells with smooth cuticle and wax particles, (B) adaxial epidermal cells with slightly striated cuticle and wax particles, (C) adaxial epidermal cells with smooth cuticle and continuous wax sheets, (D, E) abaxial epidermis with globular micropapillae, stomata and wax particles (F) abaxial epidermis globular, striate micropapillae, stomata and no wax particles. Magnification: A–C, E–F = x650; D = x850. Specimens: (A, D) *Davidse 7307* (K); (B, E) *Grierson & Long 2433* (K); (C, F) *Huber 19* (K).

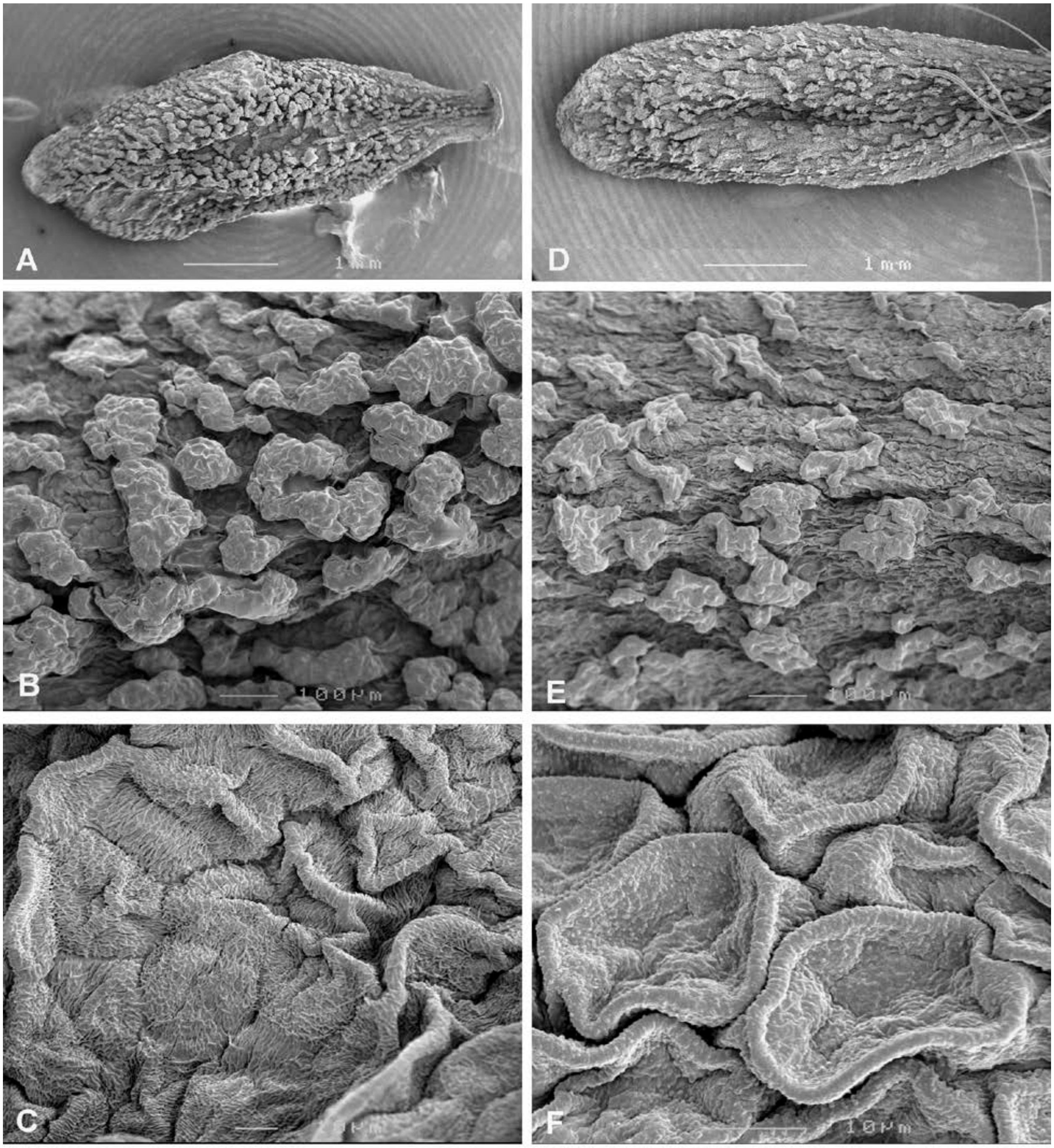


Fig. 4.3.8.4. *Cryptolepis dubia* seed surface: (A, D) adaxial view of seed, (B, E) adaxial seed surface with raised, contorted cells forming protuberances, (C) cells with tabular periclinal walls, slightly sunken anticlinal walls and striated cuticle, (F) cells with concave periclinal walls, deeply sunken anticlinal walls and coarse, granular cuticle. Magnification: A, D = x20; B, E = x120; C = x900; F = x1800. Specimens: (A–C) *Williams & Stainton 8358* (BM); (D–E) *Saldanha 15667* (K).

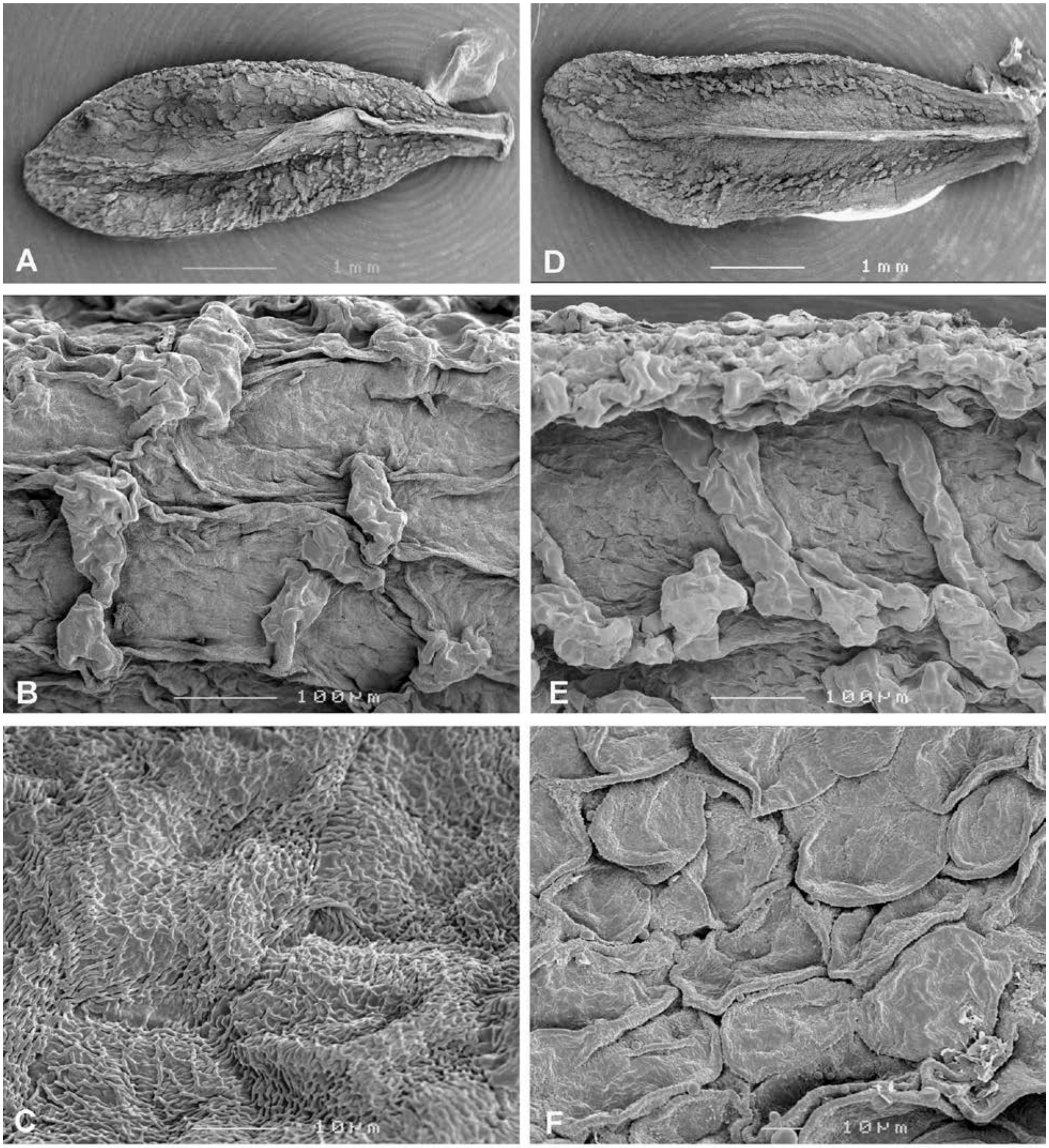


Fig. 4.3.8.5. *Cryptolepis dubia* seed surface: (A, D) abaxial view of seed, (B, E) abaxial seed surface with protuberances between central ridge and seed margin, (C) cells with tabular periclinal walls, slightly sunken anticlinal walls and striated cuticle, (F) cells with convex periclinal walls, deeply sunken anticlinal walls and finely granular cuticle. Magnification: A, D = x20; B = x220; C = x1800; E = x200; F = x900. Specimens: (A–C) *Williams & Stainton 8358* (BM); (D–F) *Saldanha 15667* (K).

4.3.9 ***Cryptolepis eburnea*** (Pichon) Venter in Venter & R.L.Verh., Annals of the Missouri Botanical Garden 88(4): 564 (2001). Basionym: *Mangenotia eburnea* Pichon, Bulletin de la Sociëte Botanique de France 101: 246 (1954).

Types: Ivory Coast, Abidjan, Adiopodoumé, *Mangenot, G-M. anno 07-06-1951* (P, holo., missing); Ivory Coast, Abidjan, Abouabou Forest, between Abidjan and Grand Bassam, *Leeuwenberg, A.J.M. 4235* (P, neo. designated by Venter (2001); BR, K!, WAG!, isoneo.).

A slender climber or scrambler, with white latex, up to 5 m high. *Stems* woody, slender, twining, up to 3 mm diameter, young stems greenish to light brown, smooth, puberulous; older stems reddish to light brown, slightly verrucose, bark peeling, glabrous or puberulous; interpetiolar ridges puberulous, inconspicuous or absent, colleters absent or inconspicuous. *Leaves* opposite, axils tomentose, petiolate; petiole pale green, puberulent, slightly grooved, 3–5 mm long; blade oblong-lanceolate to lanceolate, 40–65 x 15–25 mm, herbaceous, dark to bright green, glabrous or rarely sparsely puberulent adaxially, pale green or glaucous and papillate abaxially; margin plane; apex acuminate to attenuate, puberulent, not recurved; base rounded to truncate; venation brochidodromous, conspicuous on abaxial surface, 5–6 secondary veins on either side of main vein, intersecondary venation absent, tertiary veins predominantly perpendicular to the main vein, areole development lacking, veinlets absent. *Inflorescences* cymose, lax, few-flowered, slender, each cyme consists of 1–2 monochasia or 1 dichasium ending in 1–2 monochasia, primary peduncle 10–18 mm long, secondary peduncles 5–15 mm long, pedicels 5–10 mm long; bracts opposite, sparsely arranged, puberulent, triangular, 0.5–1 mm long, margins puberulent. *Buds* slender, 12–13 mm long, dumb-bell shaped, tubes oblong, apices conical, full turn helically twisted. *Sepals* broadly ovate, ± 1.2–1.5 x 1.5 mm, acute, densely puberulous, colleters ovate, apices truncate. *Corolla* white to greenish-cream, 15–16 mm long; tube salver-shaped, 8–11 mm long, puberulent outside, glabrous inside; lobes spreading, linear to linear-ovate, ± 5.5 x 1.5 mm, apices obtuse. *Corona* single; primary corona inserted ± 4 mm from corolla tube base, included, lobes inconspicuous, sub-clavate, fleshy, ± 0.25 mm long, glabrous, apices acute, connivent over gynostegium, spongy coronal feet prominent, extending to staminal insertion point. *Stamens* inserted ± 1.5 mm from corolla tube base; anthers hastate, attenuate, villous outside, ± 1.5 mm long, filaments ± 0.2 mm long. *Nectaries* prominent, inserted ± 1.5 mm from corolla tube base. *Ovaries* 0.7–1.5 x 1–1.7 mm; style ± 0.2 mm long, style-head broadly pyramidal, acutely bifid, ± 0.7 x 0.8 mm. *Translators* oblong, ± 0,8 mm long, apices obtuse. *Follicles* pendulous, widely divaricate at 190°–210°, cylindrical, 110–127 x 8–10 mm, dark brown, apices attenuate, bases cuneate. *Seeds* oblanceolate, ± 8 x 1.5 mm, light brown, smooth; coma yellowish-white, ± 45 mm long. (Fig. 4.3.9.1.)

Diagnostic characteristics

Cryptolepis eburnea is a slender climber or scrambler. Leaves are oblong to ovate, with acuminate to attenuate apices, large, 40–65 x 15–25 mm and herbaceous. This species is vegetatively very similar to *C. microphylla* and *C. villosa,* with all three species possessing similar growth form, leaf shape and globular micromicropapillae on the abaxial leaf surface*. Cryptolepis eburnea* is distinguished from both above mentioned species based on its diagnostic, dumb-bell shaped buds and salver-shaped corolla, with corolla tube longer than the corolla lobes and a uniquely puberulent outer surface. Though there is some overlap in leaf size, the leaves of *C. eburnea* are generally larger than those of *C. microphylla* and *C. villosa. Cryptolepis eburnea* is further distinguished from *C. villosa* based on glabrous, not villous, adaxial leaf surfaces.

Distribution and habitat

Cryptolepis eburnea occurs in West Africa from Guinea Bissau through Guinea, Sierra Leone, Liberia, Ivory Coast and Ghana (Fig. 4.3.9.2.). It grows in coastal forest and secondary bush on white sandy soil at altitudes from 0–560 m. Associated species are not known. Flowering occurs from May to February with a peak from July to August.

Representative specimens

— 5º06'18'' N, 1º14'49'' W: Ghana, Cape Coast, 07-07-1959, *Hall, J.B. 1511* (K).

— 5º11' N, 4º32' W: Ivory Coast, [Lagunes Province], about 10 km W of Jacqueville, 03-08-1970, *Leeuwenberg, A.J.M. 8083* (WAG).

— 7º41'40'' N, 8º26'20'' W: Guinea, Nzérékoré, Nimba Mountains, along restored road from Ziela to Nion, 14-08-2008, *Jongkind, C.C.H. 8341* (WAG).

— 8º13' N, 10º29' W: Sierra Leone, [Eastern Province], Mamaba District, 02-11-1914, *Thomas, N.W. 4544* (K).

— 8º45'50'' N, 11º01'29'' W: Sierra Leone, [Eastern Province], Kono District, Sukudu, 08-1923, *Dawe, M.Y. 543* (K).

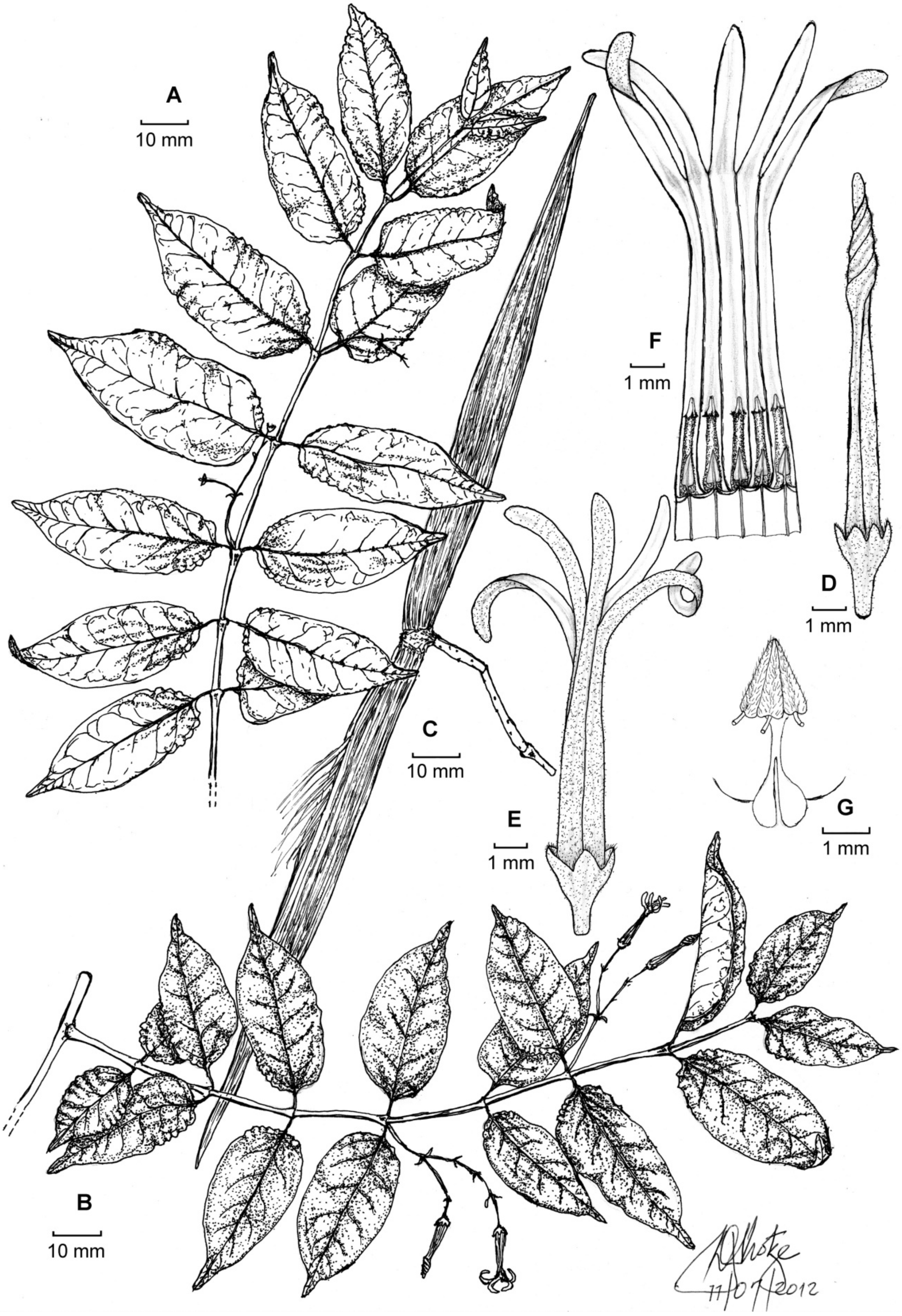


Fig. 4.3.9.1. Illustration of *Cryptolepis eburnea*: (A) stem with leaves, (B) stem with leaves and inflorescences, (C) paired follicles, (D) external view of bud, (E) external view of mature flower, (F) corolla opened showing sub-clavate primary corona lobes, prominent spongy coronal feet, stamens with narrowly hastate anthers and prominent nectaries, (G) pistil with semi-inferior, apocarpous ovaries, fused styles and anthers fused to style-head. Specimens: (A) *Leeuwenberg 8083* (WAG); (B, D–E) *Leeuwenberg 4235* (K); (C) *Thomas 4544* (K), (F–G) *Ake Assi 6990* (P).

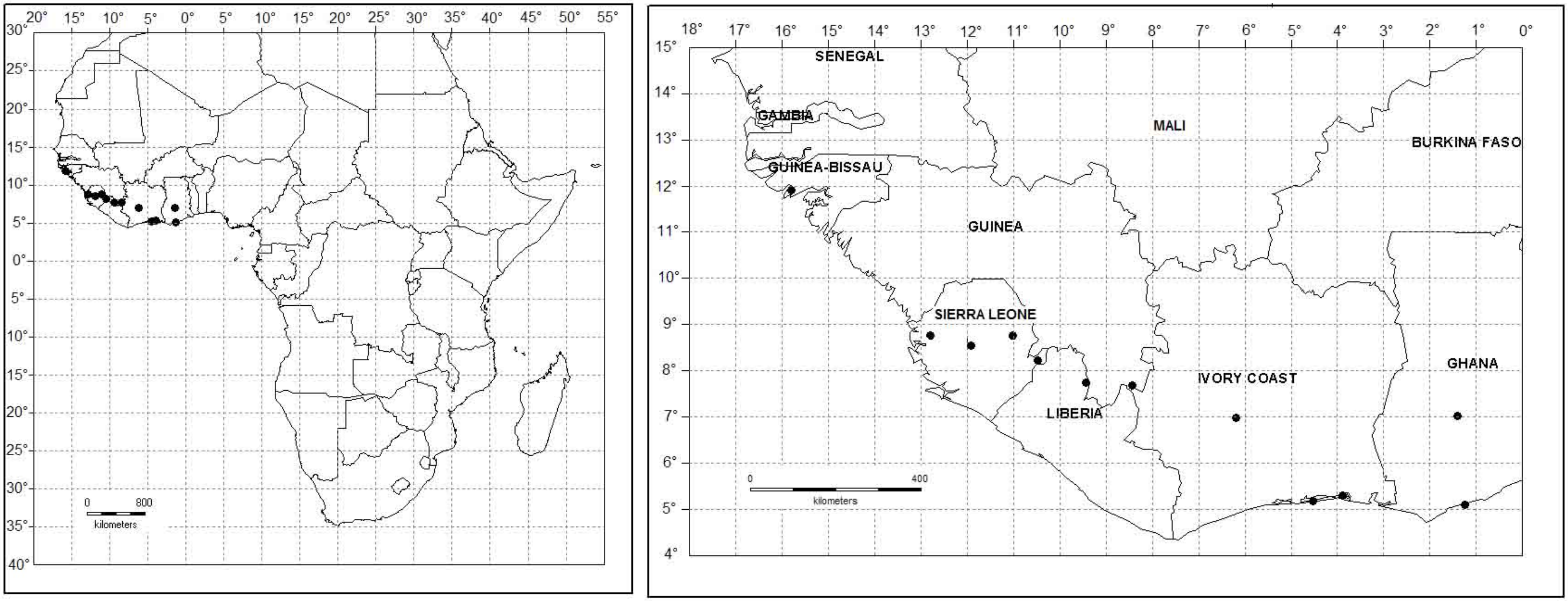


Fig. 4.3.9.2. Known distribution of *Cryptolepis eburnea*.

Leaf micromorphology

Cells on the adaxial epidermal surface are isodiametric, penta- to hexagonal. The periclinal walls are slightly convex while anticlinal walls are straight to slightly curved and slightly sunken. Cuticle is heavily striated with striations wavy, randomly orientated and restricted to individual cells or continuous over intercellular boundaries. (Fig. 4.3.9.3. A–C) Simple, unicellular trichomes are sometimes sparsely arranged along the main vein (Fig. 4.3.9.3. A–B).

The abaxial epidermal surface is densely covered by globular, striate micropapillae, connected by radiating ridges. The periclinal wall of each epidermal cell protrudes to form a single papilla. Cell shape and anticlinal cell walls are not visible. The cuticle is heavily striated with striations wavy, randomly orientated and continuous over intercellular boundaries. (Fig. 4.3.9.3. D–F)

The leaves are hypostomatic with numerous stomata level with other epidermal cells and randomly orientated. Subsidiary cells are often papillate or heavily striated with striations randomly orientated. The guard cells are elliptic with a broad stomatal ledge. (Fig. 4.3.9.3. D–F)

Seed micromorphology

The adaxial seed surface shows longitudinal ridges (Fig. 4.3.9.4. A). The epidermal cells are isodiametric, tetra- to hexagonal and tightly packed (Fig. 4.3.9.4. B–C). Periclinal walls are convex (Fig. 4.3.9.4. D–E) to concave (Fig. 4.3.9.4. C) while anticlinal walls are straight and slightly sunken (Fig. 4.3.9.4. D–E). The cuticle is densely striated with striations wavy, randomly orientated and continuous over intercellular boundaries (Fig. 4.3.9.4. D–E).

The abaxial seed surface is marginate with smooth surfaces between the narrow central ridge and seed margins (Fig. 4.3.9.5. A–C). Cells on the abaxial surface are isodiametric and tetra- to hexagonal. The periclinal walls are concave, while anticlinal walls are straight to slightly curved and raised (Fig. 4.3.9.5. D–E). The cuticle is densely striated with striations fine, straight, parallel and continuous over intercellular boundaries (Fig. 4.3.9.5. D–E).

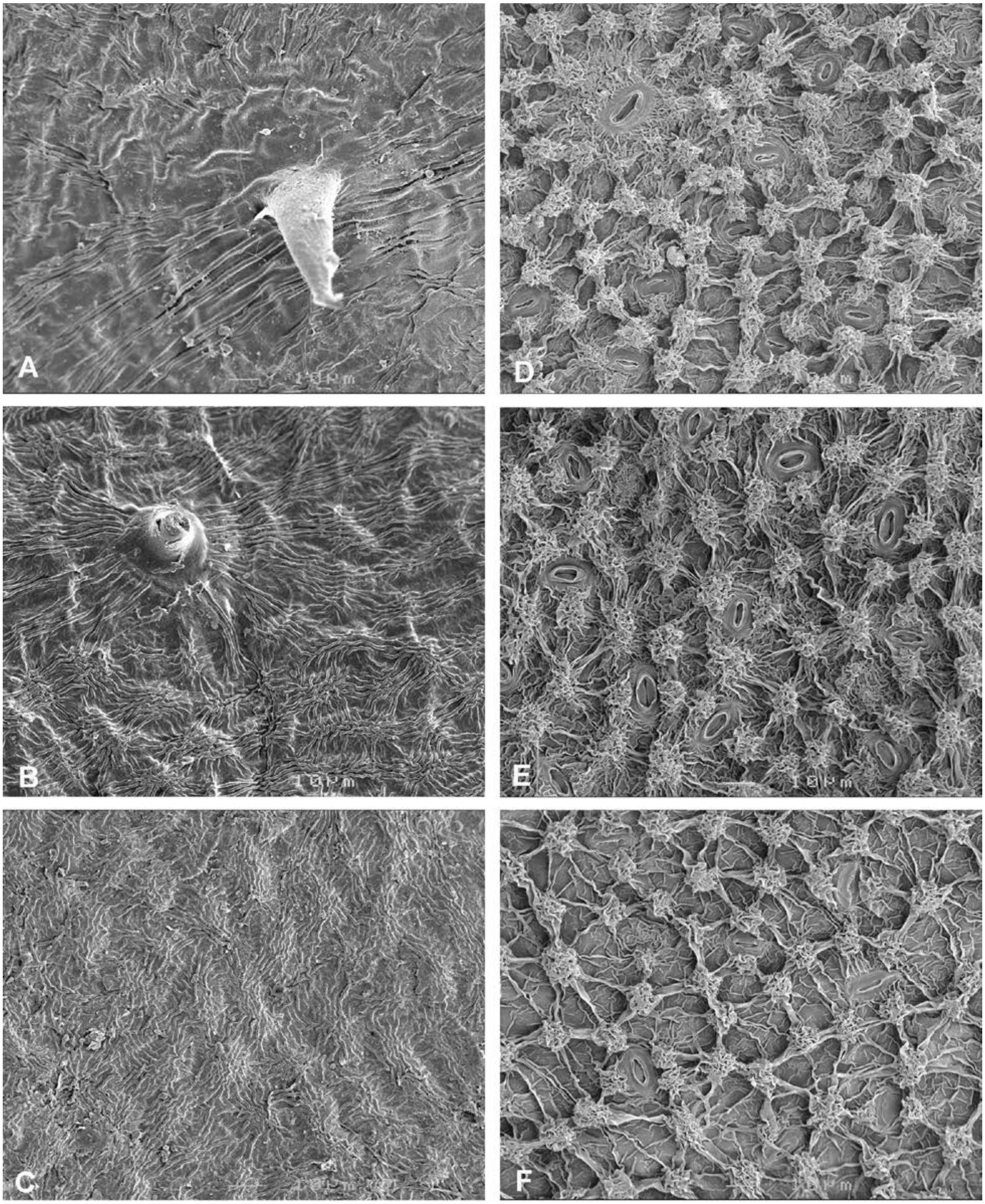


Fig. 4.3.9.3. *Cryptolepis eburnea* leaf epidermal surfaces: (A–B) adaxial epidermis with heavily striated cuticle and simple, unicellular trichomes, (C) adaxial epidermis with heavily striated cuticle, (D–F) abaxial epidermis with globular, striate micropapillae and stomata. Magnification: A–F = x650. Specimens: (A, D) *Dawe 543* (K); (B, E) *Leeuwenberg 4235* (WAG); (C, F) *Thomas 4544* (K).

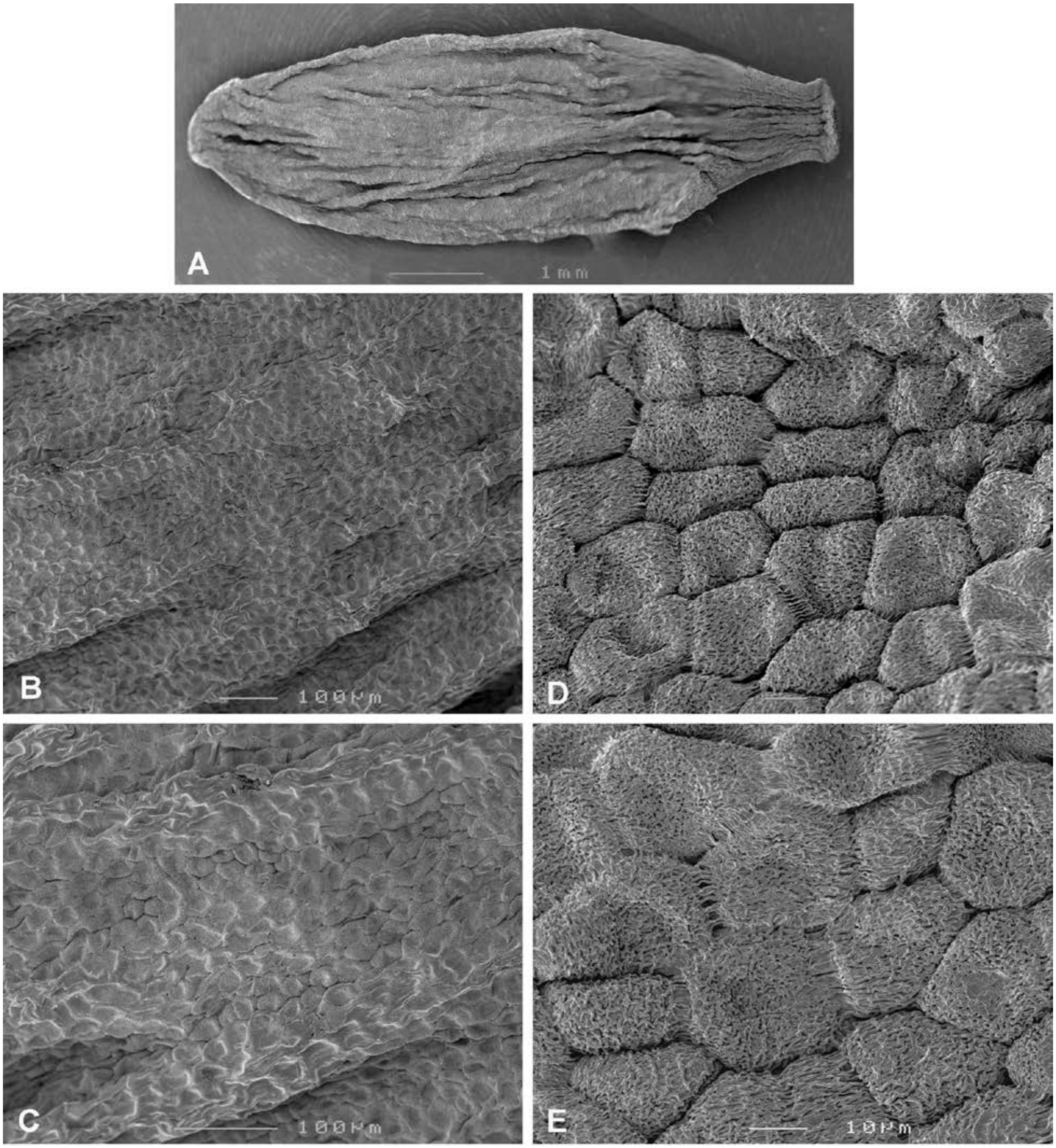


Fig. 4.3.9.4. *Cryptolepis eburnea* seed surface: (A) adaxial view of seed with longitudinal ridges, (B–C) adaxial seed surface smooth with concave periclinal cell walls, (D–E) cells tetra- to hexagonal with convex periclinal walls, slightly sunken anticlinal walls and a heavily striated cuticle. Magnification: A = x20; B = x120; C = x220; D = x900; E = x1200. Specimen: (A–E) *Thomas 4544* (K).

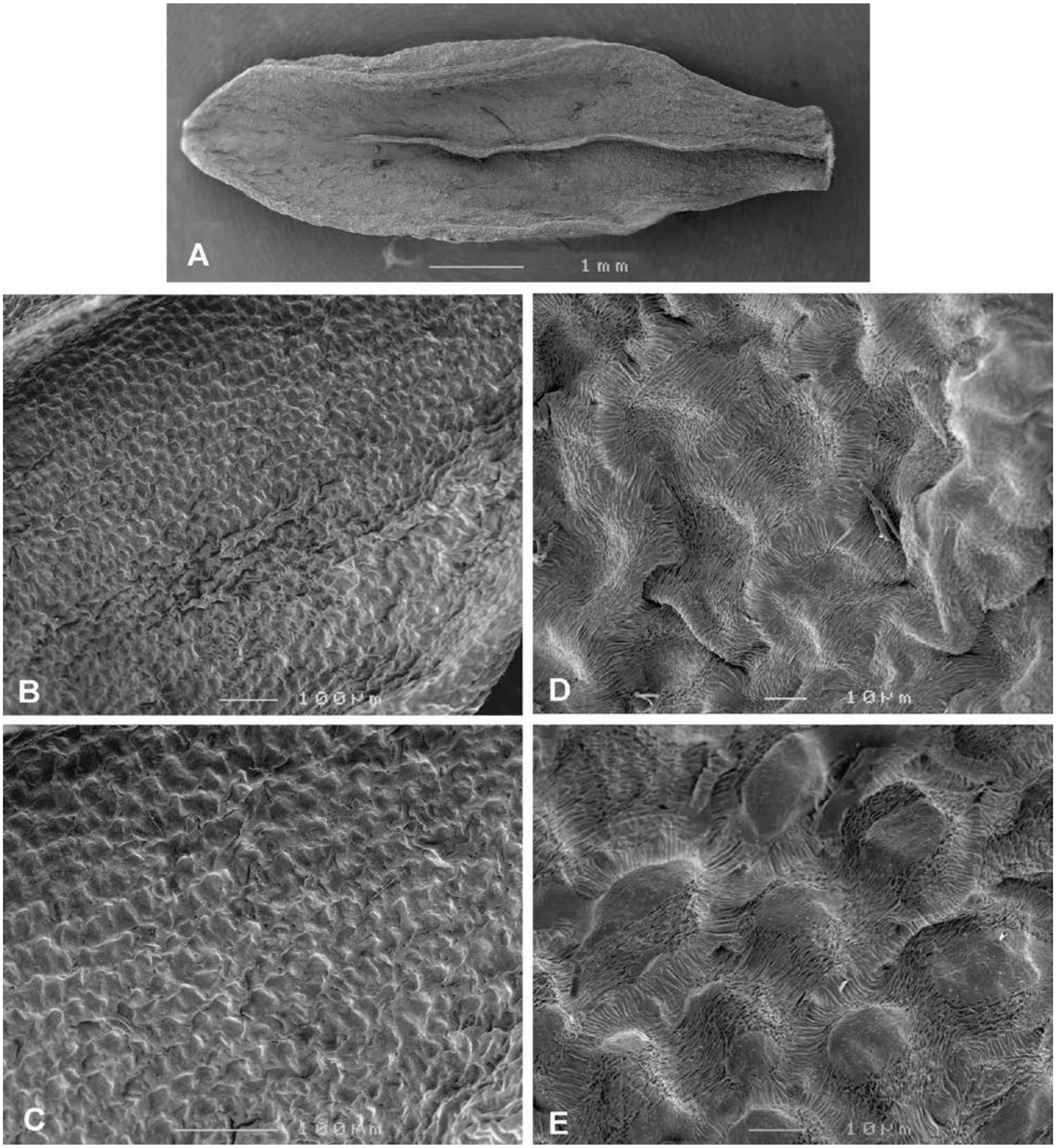


Fig. 4.3.9.5. *Cryptolepis eburnea* seed surface: (A) abaxial view of seed with narrow central ridge, (B–C) abaxial seed surface with cells isodiametric and periclinal cell walls concave, (D–E) cells with concave periclinal walls, raised anticlinal walls and densely striated cuticle. Magnification: A = x20; B = x120; C = x220; D = x900; E = x1200. Specimen: (A–E) *Thomas 4544* (K).

4.3.10 *Cryptolepis gillettii* Hutch. & E.A.Bruce, Kew Bulletin 1941: 144 (1941); Venter: 136 (2006).
Type: Somalia, Dubar, *Gillett, J.B. 4773* (K!, holo.; FT-scan!, iso.).

= *Curroria decidua* subsp. ***gillettii*** (Hutch. & E.A.Bruce) Bullock, Kew Bulletin 9: 361 (1954).
Type: Homotypic synonym.

A small, erect dwarf-shrub, with white latex, up to 0.5 m high. *Stems* woody, erect, robust, diameter unknown; young stems light brown, smooth, puberulent; older stems grey, smooth, glabrous, brachyblasts present; interpetiolar ridges glabrous, absent on older branches, inconspicuous on younger branches; colleters inconspicuous. *Leaves* opposite to fascicled, axils villous, sub-sessile; blade oblong to oblong-obovate, 20–35 x 2–3 mm, semi-succulent, pale green, scabrid; margin plane; apex obtuse, mucronate, puberulent, not recurved; base cuneate; venation inconspicuous. *Flowers* solitary; pedicels 2–4 mm long, puberulent; bracts opposite, 2 per pedicel, puberulent, acicular, 1.5–2 mm long, margins puberulent. *Buds* slender, ± 5 mm long, ovoid, apices apiculate, full turn helically twisted. *Sepals* light green, linear-lanceolate, 2 x 0.5 mm, puberulent, apices acute; colleters ovoid, apices dentate. *Corolla* greenish-yellow, herbaceous, 7–11 mm long; tube campanulate, 2–3 mm long, glabrous; lobes spreading, linear, 5–8 x 1 mm, apices obtuse, fimbriate. *Corona* single; primary corona inserted ± 1 mm from corolla tube base, filiform, ± 0.8 mm long, included in corolla tube. *Stamens* inserted ± 0.5 mm from corolla tube base; anthers hastate, acuminate, glabrous, ± 0.6 mm long, filaments ± 0.1 mm long. *Nectaries* prominent, inserted ± 0.5 mm from corolla tube base. *Ovaries* ± 0.5 x 0.5 mm; style ± 0.3 mm long; style-head broadly pyramidal, acuminate, ± 0.3 x 0.7 mm. *Translators* spatulate (Venter, 2006), size unknown*.* *Follicles* erect, divaricate at 160°, cylindrically-ovoid, ± 60 x 5 mm, apices attenuate, bases cuneate, light brown. *Seeds* linear, 7–10 x 1–1.5 mm, dark brown, surface warty; coma yellowish-white, 20–25 mm long. (Fig. 4.3.10.1.)

Diagnostic characteristics

Cryptolepis gillettii is an erect dwarf-shrub. The leaves are oblong to oblong-obovate, medium-sized, 20–35 x 2–3 mm and semi-succulent. This species is distinguished from most species with similar growth form and leaves based on a combination of solitary flowers and filiform, not clavate, corona lobes. *Cryptolepis gillettii* is most similar to *C. decidua* and *C. intricata,* which also have solitary flowers with filiform corona lobes. *Cryptolepis gillettii* is distinguished from both above mentioned species based on primary corona lobes which are shorter than 1 mm and included in the corolla tube, as opposed to corona lobes longer than 2 mm and slightly exserted from the corolla tube in *C. decidua* and *C. intricata.* In addition to coronal features, *C. gillettii* is distinguished from *C. decidua* based on its ovate colleters at the sepal bases and greenish-yellow corolla, as opposed to trichome-like colleters and violet to white corolla in the latter species. *Cryptolepis gillettii* is distinguished from *C. intricata* based on slightly scabrid, not puberulous abaxial leaf surfaces, slightly larger flowers with corolla longer than 7 mm and a single corona as opposed to the double corona of *C. intricata.*

Distribution and habitat

Cryptolepis gillettii is endemic to Somalia where it seems to be rare as only the type material is known (Fig. 4.3.10.2.). It was found in open scrub at an altitude of 300 m. Associated species are unknown. The only collected plant flowered in January.

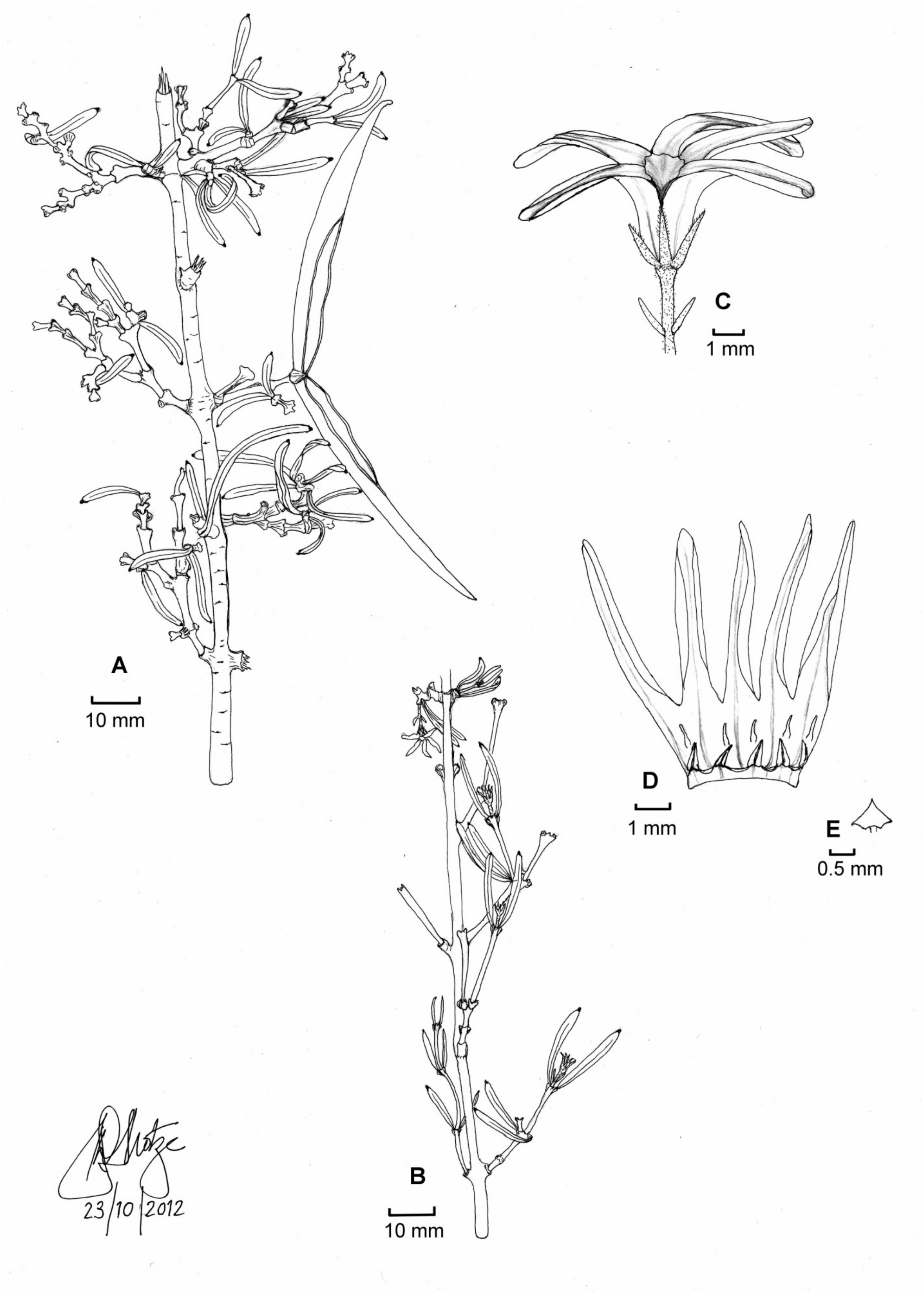


Fig. 4.3.10.1. Illustration of *Cryptolepis gillettii*: (A) stem with leaves and fruit, (B) stem with leaves and flowers, (C) external view of mature flower, (D) flower opened showing filiform corona lobes, stamens with hastate anthers and prominent nectaries, (E) broadly pyramidal style-head. Specimen: (A–E) *Gillett 4773* (K).

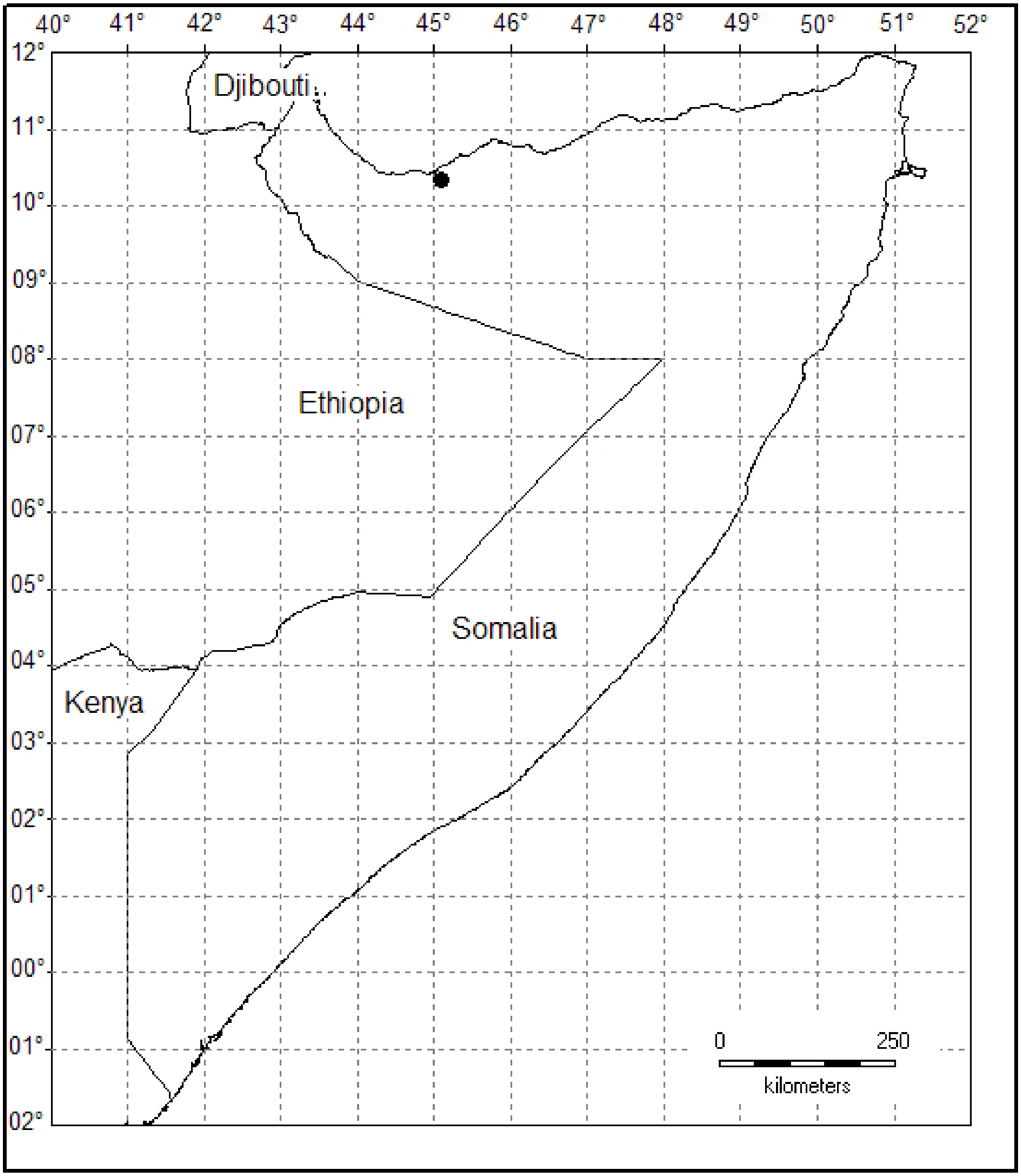


Fig. 4.3.10.2. Known distribution of *Cryptolepis gillettii*.

Leaf micromorphology

The adaxial epidermis is densely covered by simple, unicellular, triangular trichomes and a heavily folded cuticle, resulting in no cell shape or cell wall structure being visible (Fig. 4.3.10.3. A–B). The cuticle is striated with striations straight, parallel and continuous over intercellular boundaries (Fig. 4.3.10.3. C). The cuticle covering trichomes is smooth (Fig. 4.3.10.3. C). Trichomes of *C. gilletii* are similar in shape to those of *C. arbuscula*, though in the latter species trichomes are covered by a nodular cuticle (Fig. 4.3.3.3).

The abaxial epidermis has sparsely distributed simple, triangular trichomes while epidermal cells are isodiametric and tetra- to hexagonal. Periclinal walls are tabular to convex while anticlinal walls are straight or slightly curved level with the epidermal surface (Fig. 4.3.10.3. D–E). The cuticle on epidermal cells is striated with striations straight, parallel and continuous over intercellular boundaries, while on the trichomes the cuticle is slightly nodular. Wax platelets are sometimes sparsely distributed over the abaxial surface (Fig. 4.3.10.3. E–F).

The leaves are amphistomatic. Stomata are slightly sunken and randomly orientated on both surfaces. Striations radiate from the stomatal pore. Guard cells are narrowly elliptic and covered by a broad stomatal ledge. (Fig. 4.3.10.3. A–F)

Seed micromorphology

Seed unknown.

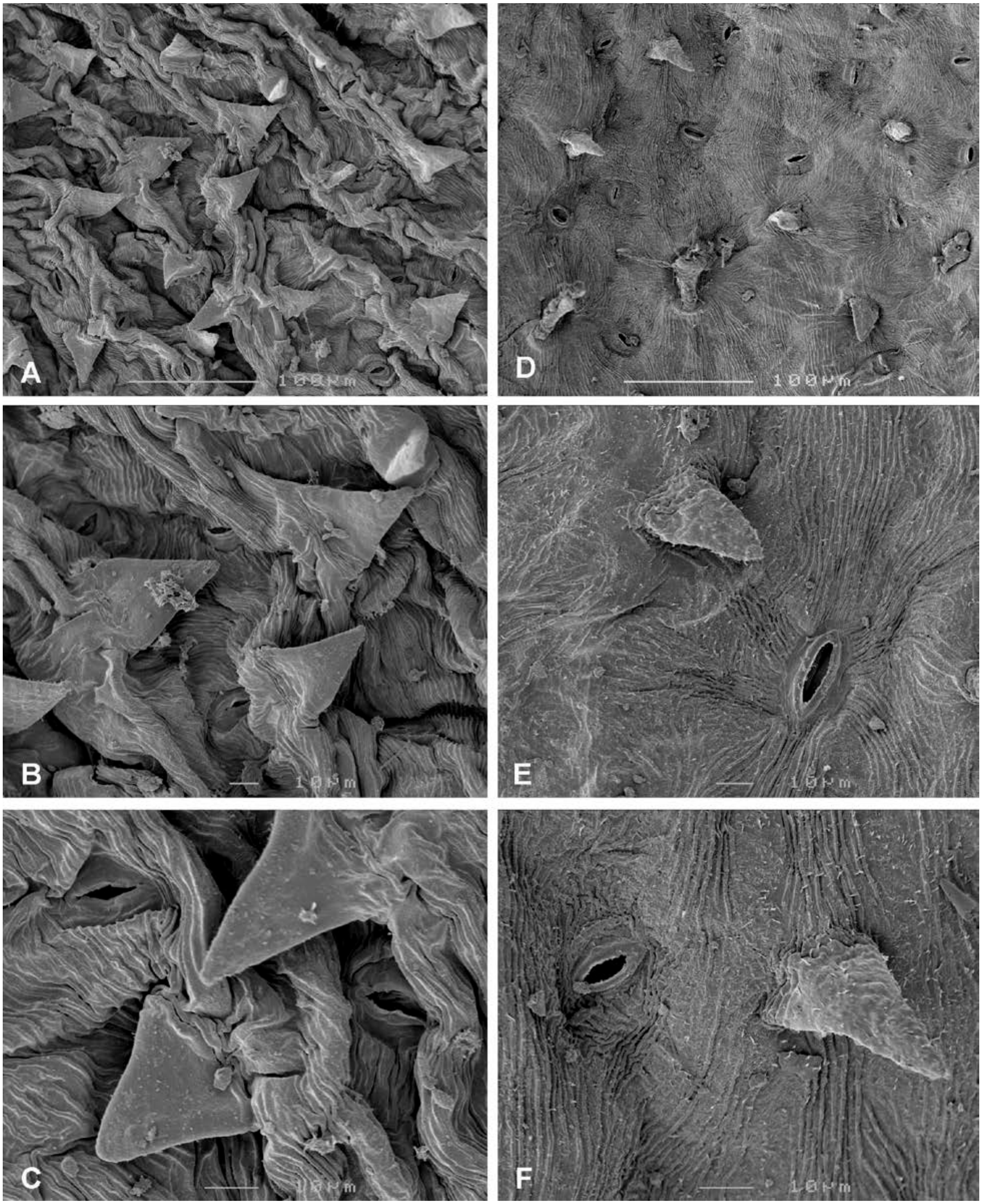


Fig. 4.3.10.3. *Cryptolepis gillettii* leaf epidermal surfaces: (A–B) adaxial epidermal cells with folded cuticle, triangular trichomes and slightly sunken stomata, (C) adaxial epidermal cells with striated cuticle, triangular trichomes and slightly sunken stomata, (D–F) abaxial epidermis with isodiametric cells, sparsely distributed triangular trichomes, slightly sunken stomata and sparsely arranged wax platelets. Magnification: A, D = x300; B = x650; C, F = x1200; E = x850. Specimen: (A–F) *Gillett 4773* (K).

4.3.11 *Cryptolepis gossweileri* S.Moore, Journal of Botany, London 47: 214 (1909); C.Norman: 91 (1929).

Type: Angola, *Gossweiler 3428* (BM!, holo.; LISC!, iso.).

A small dwarf-shrub with woody, perennial rootstock, with white latex, up to 0.25 m high. *Stems* annual, woody, erect, slender, up to 2 mm diameter; young stems reddish to light brown, smooth, puberulous to scabrous; older stems brown, smooth, puberulous; interpetiolar ridges puberulous, inconspicuous to absent on younger and older branches, colleters inconspicuous. *Leaves* decussate, axils scabrous, petiolate; petiole green to greenish-brown, puberulous, slightly grooved, 1–1.5 mm long; blade orbicular to broadly elliptic, 15–20 x 10–19 mm, coriaceous, glaucous, sparsely to densely puberulous; margin plane, occasionally slightly undulate; apex rounded, rarely attenuate, apiculate, slightly puberulous, recurved; base rounded; venation brochidodromous, conspicuous on lower leaf surface, 3–4 secondary veins on either side of main vein, intersecondary venation absent, tertiary veins random reticulate, areoles incomplete, veinlets absent. *Inflorescences* cymose, compact, few- to many-flowered, each cyme consists of 1–3 monochasia or 1–3 dichasia each ending in 1–3 monochasia, primary peduncle 1–2 mm long, secondary peduncles 5–7 mm long, pedicels 3–5 mm long; bracts opposite, densely arranged, glabrous, acicular, 1.5–2 mm long, margins glabrous. *Buds* robust, 10–15 mm long, oblong, apices obtuse, half turn helically twisted. *Sepals* ovate, ± 3.5 x 1.5 mm, acute, glabrous, colleters conical. *Corolla* violet-red, 11–12 mm long; tube narrowly urceolate, ± 5.5 mm long, glabrous outside and inside; lobes spreading, narrowly elliptic, ± 6.5 x 2 mm, apices acute. *Corona* single; primary corona inserted ± 2.5 mm from corolla tube base, included, lobes sub-clavate, ± 0.3 mm long, glabrous, apices obtuse, connivent over gynostegium, spongy coronal feet prominent, extending to staminal insertion point. *Stamens* inserted ± 1 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 1 mm long, filaments ± 0.2 mm long. *Nectaries* prominent, inserted ± 0.5 mm from corolla tube base. *Ovaries* ± 0.5 x 0.4 mm; style ± 0.2 mm long, style-head broadly pyramidal, acute, ± 0.6 x 0.3 mm. *Translators* narrowly elliptic, ± 0.5 mm long, apices emarginate. *Follicles* unknown. *Seeds* unknown. (Fig. 4.3.11.1.)

Diagnostic characteristics

Cryptolepis gossweileri is a dwarf-shrub with woody, perennial rootstock, up to 0.25 m high. The leaves are orbicular to broadly elliptic, small, 15–20 x 10–19 mm, with apices rounded or rarely attenuate and apiculate, bases rounded. Venation is conspicuous on the abaxial leaf surface, with no intersecondary veins and areole development incomplete. This species is distinguished from all other species based on its growth form, leaf shape and compact, few- to many flowered inflorescences of violet-red flowers, with corollas 10–15 mm long, urceolate corolla tubes, single corona and primary corona lobes sub-clavate, 0.3 mm long.

Distribution and habitat

Cryptolepis gossweileri is endemic to Angola, where it has been collected between Fort Princess Amelia and the Cubango River (Fig. 4.3.11.2.). This species grows on poor, rocky soil in forb thickets at an altitude of 1550 m. Associated species are unknown. Flowering occurs from December to January.

Voucher specimen

— 16º33' S, 17º50' E: Angola, between Fort Princeza Amelia and Cubango [River], 13-12-1905, *Gossweiler, J. 2390* (BM, K, LISC).

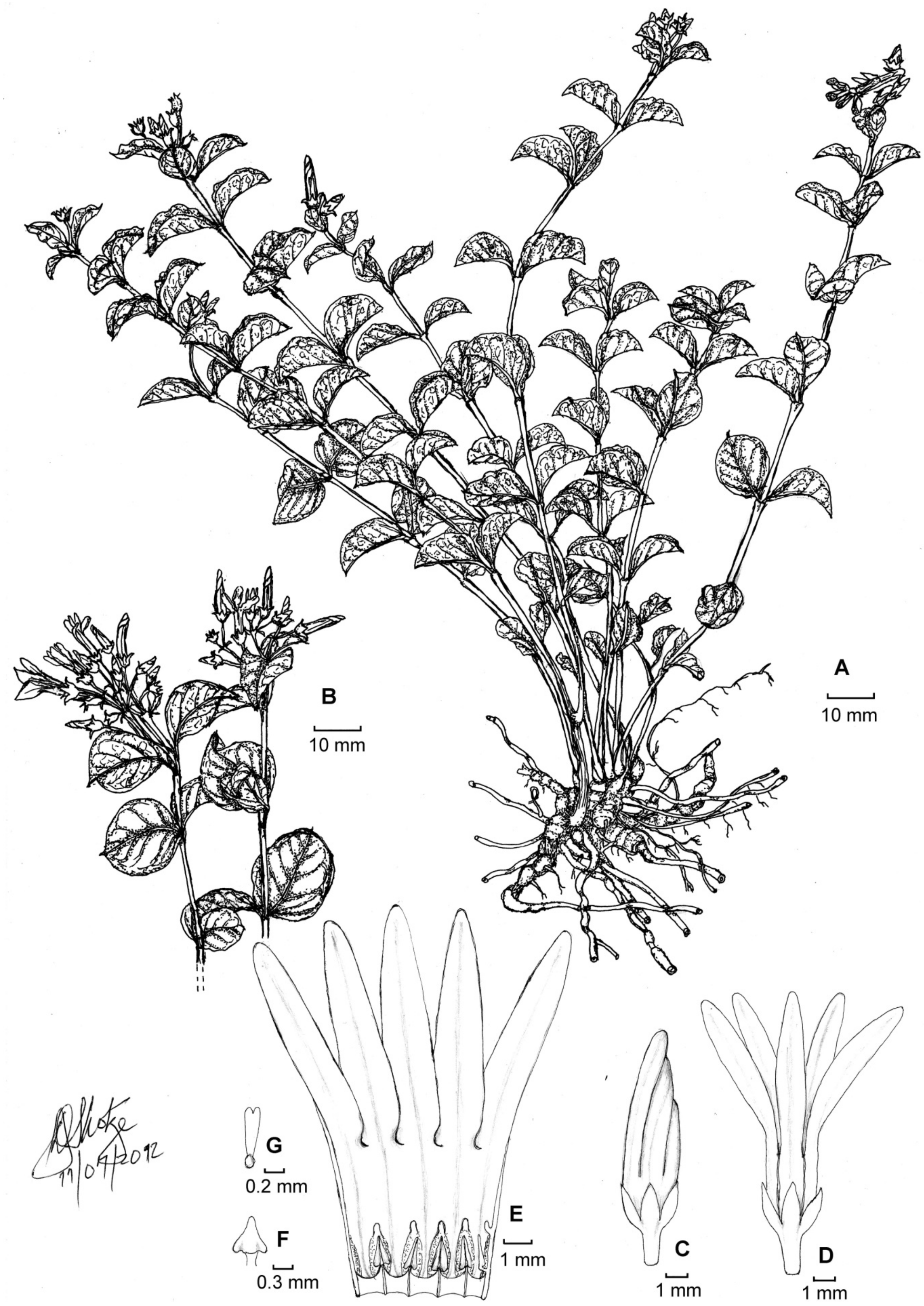


Fig. 4.3.11.1. Illustration of *Cryptolepis gossweileri*: (A) plant habit with woody rootstock, (B) stems with leaves and inflorescences, (C) external view of bud, (D) external view of mature flower, (E) corolla opened showing sub-clavate primary corona lobes, prominent spongy coronal feet, stamens with narrowly hastate anthers and nectaries, (F) broadly pyramidal style-head, (G) translator with emarginate apex. Specimens: (A) *Gossweiler 2390* (BM); (B–D) *Gossweiler 3428* (BM); (E–F) *Gossweiler 3428* (LISC).

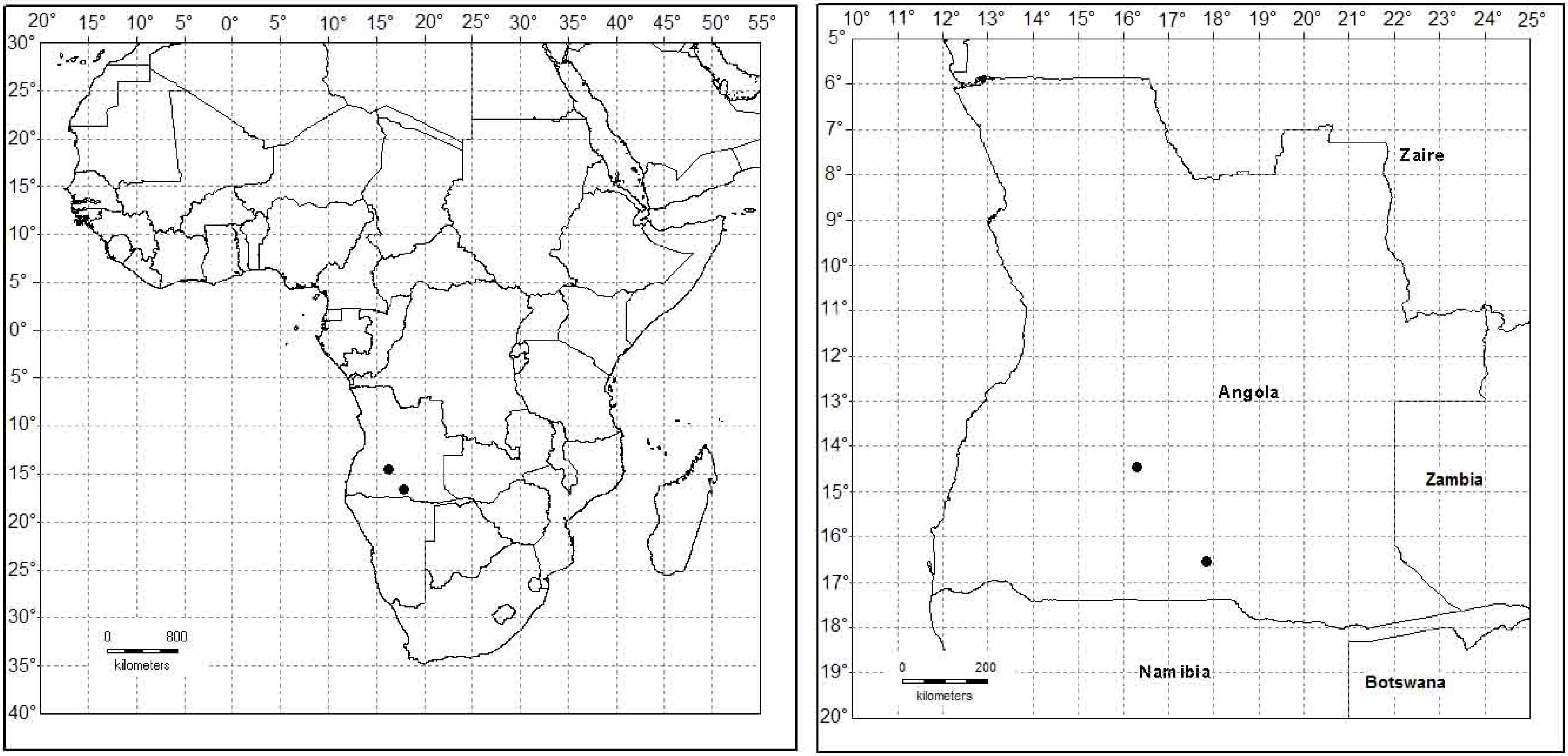


Fig. 4.3.11.2. Known distribution of *Cryptolepis gossweileri*.

Leaf micromorphology

Cells on the adaxial surface are more or less isodiametric but variable in shape. Periclinal walls are tabular, while anticlinal walls are wavy or curved and slightly sunken. The cuticle is striate with straight, parallel striations restricted to individual cells. (Fig. 4.3.11.3. A–C)

The abaxial epidermis consists of isodiametric cells with variable shape. Periclinal walls are tabular to slightly convex and anticlinal walls show tight, frequent, U-shaped curves of shallow amplitude and are deeply sunken. The cuticle is striate with fine, straight, parallel striations which are restricted to individual cells or rarely crossing intercellular boundaries. (Fig. 4.3.11.3. D–E)

The leaves are amphistomatic with numerous stomata randomly orientated and level with other epidermal cells. Stomata are paracytic with the cuticle over subsidiary cells smooth or slightly striated, in which case striations are parallel or perpendicular to the stomatal pore. The guard cells are broadly elliptic and covered by a broad stomatal ledge. (Fig. 4.3.11.3. A–F)

Seed micromorphology

Seeds unknown.

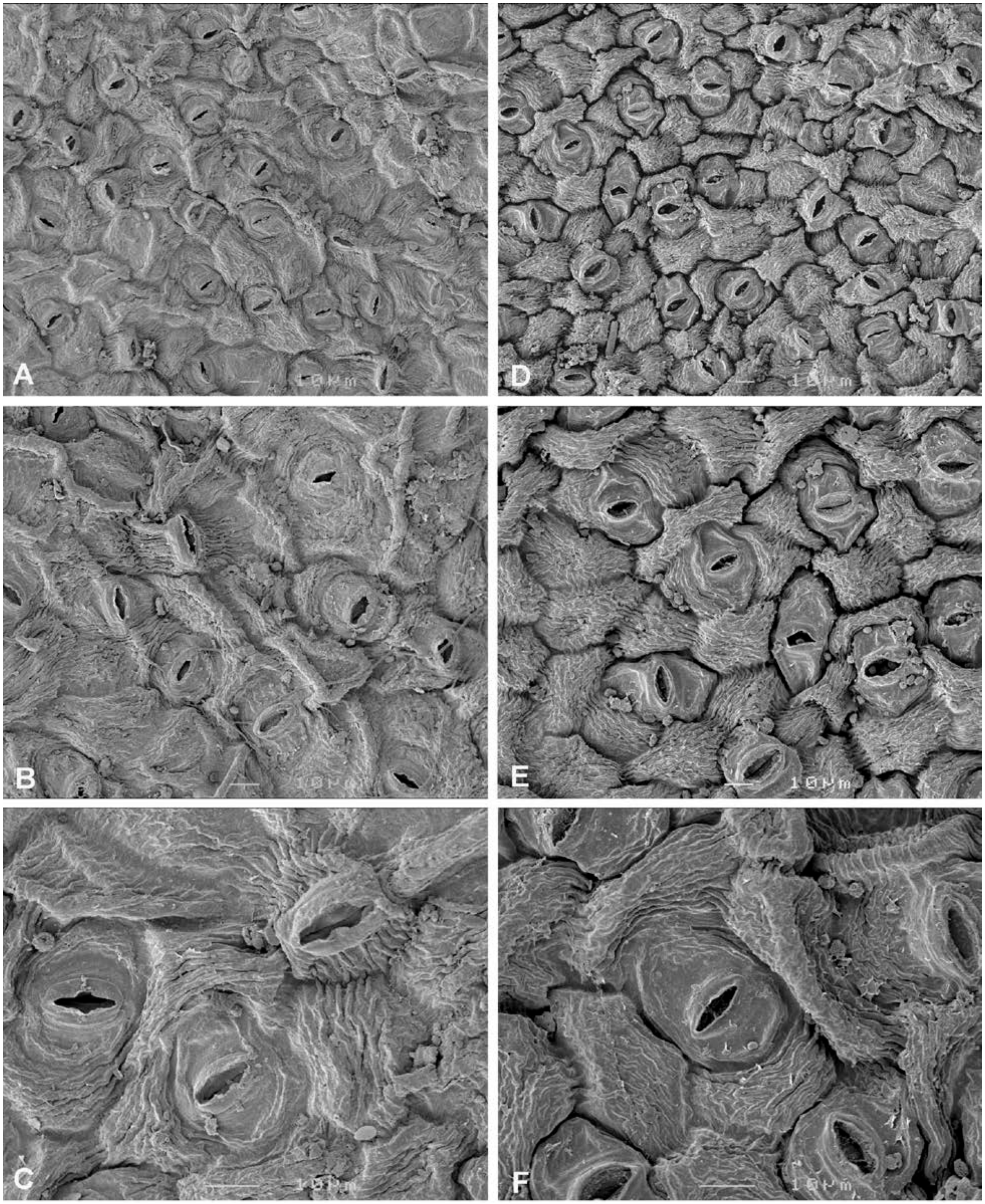


Fig. 4.3.11.3. *Cryptolepis gossweileri* leaf epidermal surfaces: (A–C) adaxial epidermis with tabular periclinal cell walls, curved anticlinal walls, striated cuticle and numerous stomata, (D–F) abaxial epidermis with tabular to slightly convex periclinal cell walls, deeply sunken anticlinal walls, striated cuticle and numerous stomata. Magnification: A, D = x400; B, E = x650; C, F = x1200. Specimen: (A–F) *Gossweiler 2390* (BM).

4.3.12 *Cryptolepis grandiflora* Wight, Icones Plantarum India Orientalis 3(2): 3, t. 831 (1846); 169, t. 155b, f. E (1850); Drury: 254 (1866); K.Schum.: 219 (1895b).

Type: *Wight 2243* (E-scan (E00179158)! lecto. here designated; E-scans [2 sheets: E00179159; E00179157]!, isolecto.). Notes 1, 2 & 3

A climber with white latex. *Stems* woody, slender; up to 3 mm diameter; young stems light brown, smooth to slightly verrucose, glabrous; older stems grey, bark peeling, smooth to slightly verrucose; interpetiolar ridges glabrous, conspicuous on young and older stems, colleters conspicuous. *Leaves* opposite, axils slightly tomentose, petiolate; petiole brown, glabrous, slightly grooved, 5–15 mm long; blade elliptic, 60–80 x 25–40 mm, herbaceous, dark green adaxially, pale green abaxially, glabrous; margin plane; apex acuminate, rarely obtuse, apiculate, glabrous, not recurved; base obtuse; venation eucamptodromous, conspicuous on abaxial surface, 4–6 secondary veins on either side of main vein, intersecondary venation absent, tertiary veins ± perpendicular to the main vein, areole development imperfect, veinlets simple to branched. *Inflorescences* cymose, lax, few-flowered, robust, each cyme consists of 2–3 monochasia, each ending in 1–2 monochasia, primary peduncle 15–40 mm long, secondary peduncles 10–20 mm long, pedicels 5.5–7 mm long; bracts often deciduous, opposite, sparsely arranged, glabrous, triangular, 1–2 mm long, margins glabrous. *Buds* robust, 12–14 mm long, oblong, apices attenuate, full turn helically twisted. *Sepals* broadly ovate, 3–3.5 x 2–2.5 mm, acute, glabrous, colleters conical. *Corolla* white to cream, 16–18 mm long; tube campanulate, ± 4 mm long, glabrous outside and inside; lobes spreading, linear, ± 12 x 1.5 mm, apices acute. *Corona* double; primary corona inserted ± 3 mm from corolla tube base, included; lobes clavate, fleshy, ± 0.8 mm long, glabrous, apices obtuse, connivent over gynostegium; secondary corona in corolla lobe sinuses, pocket-like, inconspicuous, glabrous. *Stamens* inserted ± 0.8 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 1 mm long, filaments ± 0.2 mm long. *Nectaries* prominent, inserted ± 0.8 mm from corolla tube base. *Ovaries* ± 0.7 x 0.9 mm; style ± 0.2 mm long, style-head broadly pyramidal, acute, ± 0.6 x 1.1 mm. *Translators* narrowly elliptic, ± 0.6 mm long, apices acute. *Follicles* pendulous, reflexed at 190°, ovoid-cylindrical, 97–127 x 9–11 mm, brown, apices attenuate, bases cuneate. *Seeds* oblanceolate, ± 10 x 1.5 mm, dark brown, longitudinal ridges on upper surface; coma yellowish-white, ± 42 mm long. (Fig. 4.3.12.1.)

Diagnostic characteristics

Cryptolepis grandiflora is a climber from India. It has large, 60–80 x 25–40 mm, elliptic, herbaceous leaves with acuminate or obtuse, apiculate apices. This species is distinguished from similar species by a combination of robust inflorescences with triangular bracts, 1–2 mm long. *Cryptolepis grandiflora* is further distinguished from similar, herbaceous leaved species, such as *C. africana, C. capensis* and *C. sanguinolenta*, by robust flower buds, 12–14 mm long, with attenuate, not clavate, apices, double corona and corona lobes clavate, ± 0.8 mm long. This species is distinguished from similar, coriaceous leaved species, such as *C. dubia, C. hypoglauca* and *C. ibayana*, by the absence of intersecondary venation, imperfect areole development and corolla longer than 16 mm. *Cryptolepis grandiflora* is most similar to *C. apiculata*, both species having imperfect areole development, robust inflorescences with triangular bracts, robust buds, corollas longer than 16 mm and double coronas. *Cryptolepis grandiflora* is distinguished from *C. apiculata* based on the former's herbaceous leaves with eucamptodromous areole development, as opposed to coriaceous leaves with brochidodromous areole development in *C. apiculata.* In addition, the primary corona lobes of *C. grandiflora* are 0.8 mm long, as opposed to primary corona lobes of 1–1.5 mm long in *C. apiculata.* The two species also occupy different distribution ranges with *C. grandiflora* being endemic to India and *C. apiculata* restricted to East Africa.

Distribution and habitat

Cryptolepis grandiflora is found in the southern parts of India (Fig. 4.3.12.2.). It grows in thickets and forest at altitudes from 200–250 m. Associated species are not known. Flowering occurs from October to February, with a peak in November.

Notes:

1. In his publication of *Cryptolepis grandiflora*, Wight (1846) did not refer to any specimens, but the publication includes an illustration of the plant, including inflorescences and fruit. Two collections have been identified as possible lectotypes of this species. In Edinburgh Herbarium three duplicate sheets numbered *Wight 2243* have been labelled as types, whereas in Kew Herbarium, one specimen numbered *Wight 1894* is labelled as the type. The *Wight 2243* (E) specimens contain both inflorescences and fruit and therefore correspond to the illustration accompanying the type description (Wight, 1846). The *Wight 1894* (K) specimen contains only

inflorescences and can therefore not be unequivocally connected to the illustration accompanying the type description. The three specimens of *Wight 2243* (E) should therefore be regarded as lectotype and two isolectotypes.

2. Hooker (1883) published a reference to the name, *Echites coriaceae* Heyne *nom. nud*. *in sched.* and designated this as a synonym of *Cryptolepis grandiflora* Wight. Hooker (1883) derived this name from a specimen collected in India, Madras, and which was kept in: *Herb. Rottlerianum anno 02-03-1804* (K!). However, since *Echites coriaceae* Heyne was never validly published it cannot be regarded as a synonym of *C. grandiflora,* and is consequently removed from the list of synonyms of the latter species.

3. Wallich's Catalogue contains a reference to *Cryptolepis wightiana.* This name is a *nom. nud. in sched.* derived from a specimen, Wall. *Cat. No. 4457* (K-W), collected in India and positively identified as *Cryptolepis grandiflora.* Since this name was never validly published, it is removed from the list of synonyms of the latter species.

Representative specimens

— 08º54'45" N, 77º16'22" E: India, Tamil Nadu [State], Tirunelveli District, Courtallum [Courtallam], 1885, *Beddome, R.H. 8* (BM).

— 11º15'40" N, 78º34'05" E: India, Tamil Nadu [State], Tiruchi [Tiruchirappalli] District, between Thuraiyur and Sobanapuram, near Forest Rest House, 27-11-1978, *Matthew, K.M. , Manickam, V.S. & Manoharn, C. 19337* (K).

— 12º40'26" N, 79º58'30" E: India, Tamil Nadu [State], Kancheepuram District, Chingleput [Chengalputta], 16-03-1901, *Bourne, A.G. 2530* (K).

— 14º20'37" N, 78º53'55" E: India, Tamil Andhra Pradesh [State], Raylaseema Region, Balli Valley, 10-1886, *Gamble, J.S. 18168* (K).

— 13º56'42" N, 79º21'10" E: India, Tamil Andhra Pradesh [State], Raylaseema Region, Kodur, 02-1883, *Gamble, J.S. 11191* (K).

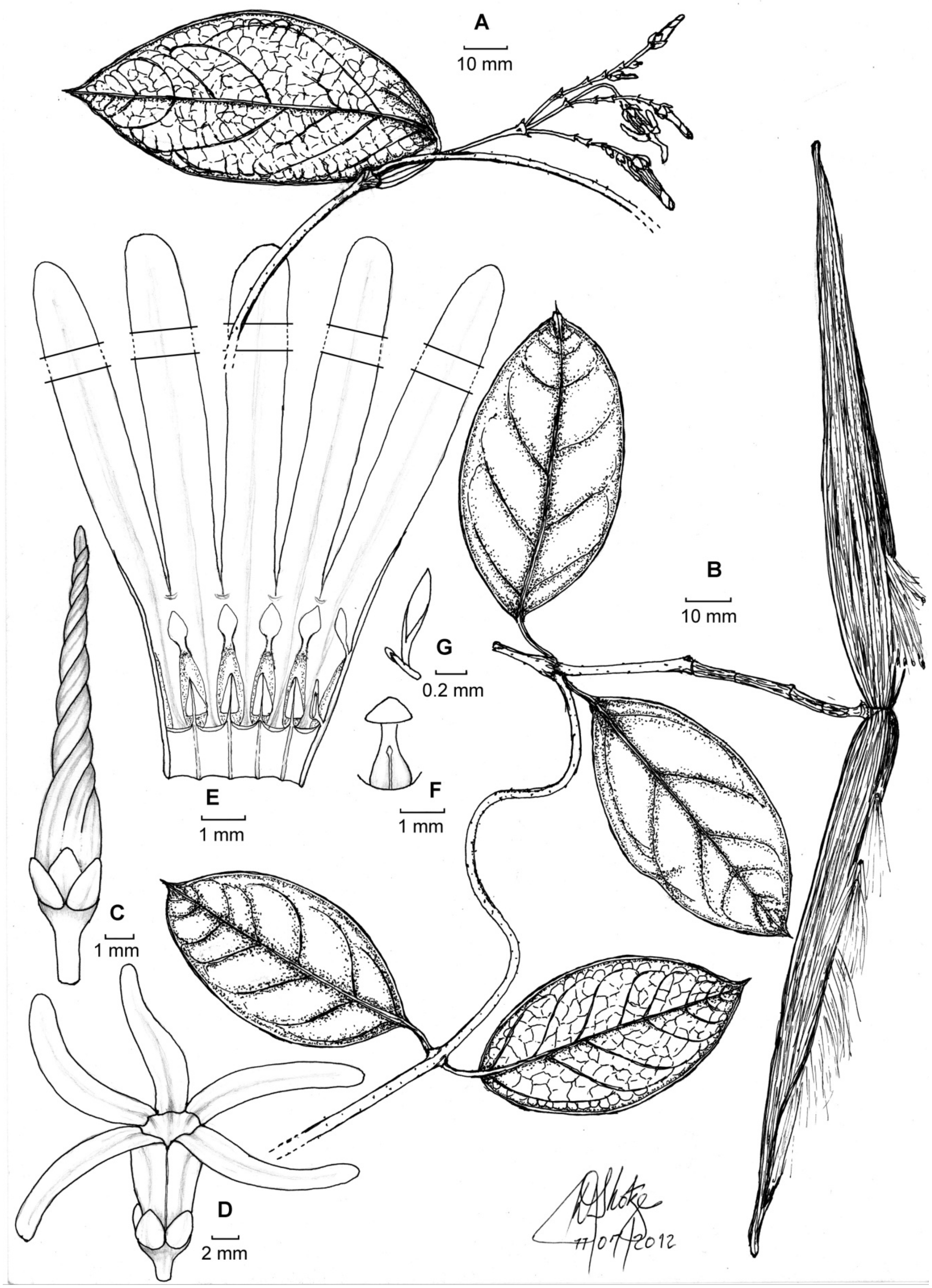


Fig. 4.3.12.1. Illustration of *Cryptolepis grandiflora*: (A) stem with leaf and inflorescence, (B) stem with leaves and paired follicles, (C) external view of bud, (D) external view of mature flower, (E) corolla opened showing clavate primary corona lobes, secondary corona pockets, stamens with narrowly hastate anthers and prominent nectaries, (F) gynoecium consisting of two semi-inferior, apocarpous ovaries, fused style and broadly pyramidal style-head, (G) translator. Specimens: (A, C–D) *Gamble 11191* (K); (B) *Bourne 2539* (K); (E–G) *Beddome 8* (BM).

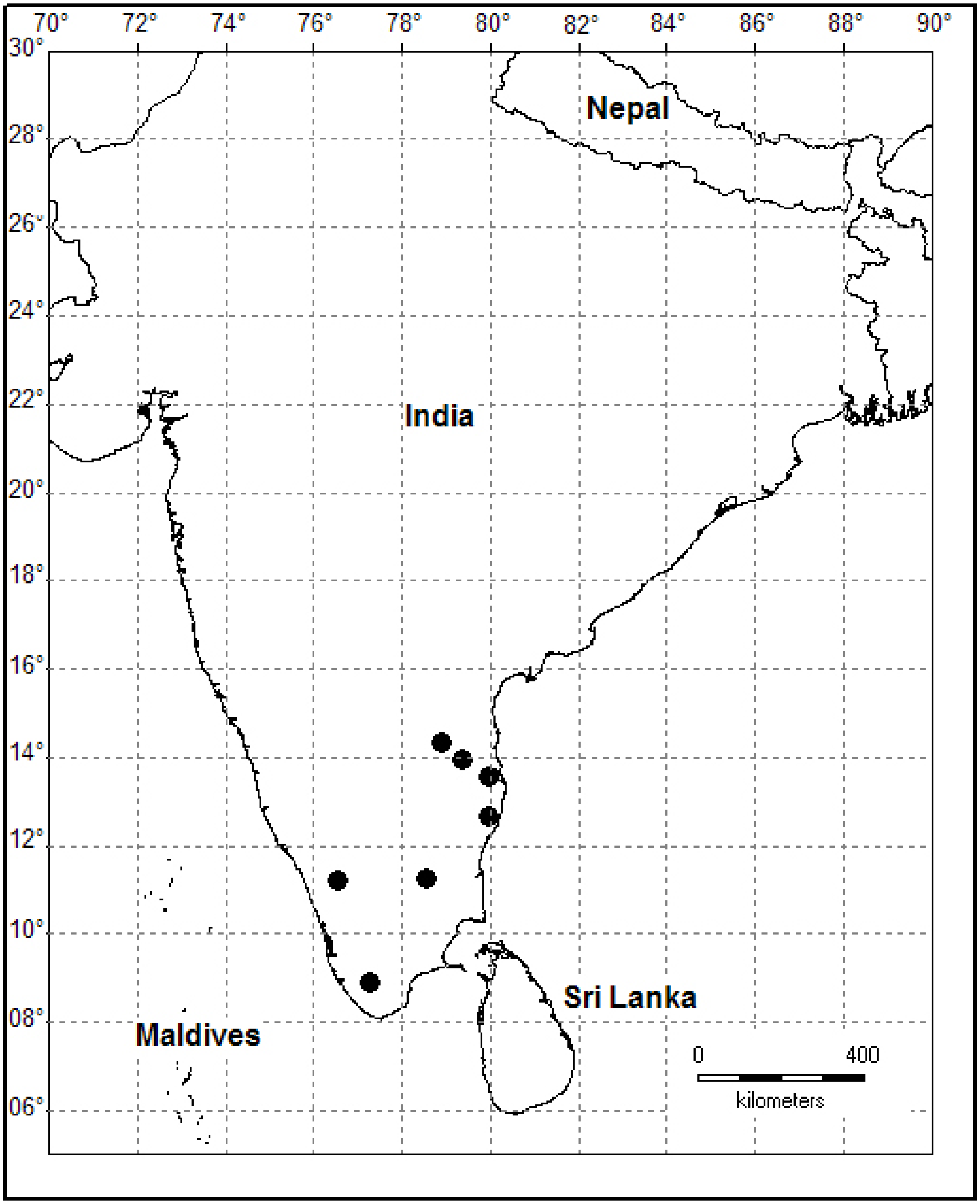


Fig. 4.3.12.2. Known distribution of *Cryptolepis grandiflora*.

Leaf micromorphology

Cells on the adaxial epidermal surface are isodiametric and tetra- to hexagonal. Periclinal walls are tabular while anticlinal walls are straight and level with the epidermal surface. The cuticle is slightly and finely striated. Striations may be straight to slightly wavy, parallel or radiating from the central surface of each cell, and continuous over intercellular boundaries. (Fig. 4.3.12.3. A–C)

Abaxial epidermal cells are isodiametric and tetra- to hexagonal. Periclinal walls are tabular while anticlinal walls are straight and level with the epidermal surface. The cuticle is striated, with striations randomly orientated and wavy, crossing intercellular boundaries. (Fig. 4.3.12.3. D–F)

Leaves are hypostomatic. Stomata are numerous, randomly orientated and level with surrounding epidermal cells. The guard cells are broadly elliptic with broad stomatal ledges. The cuticle covering the guard cells is smooth. (Fig. 4.3.12.3. D–F)

Seed micromorphology

The upper seed surface is sparsely covered by longitudinal ridges (Fig. 4.312.4. A). The ridges are formed by raised epidermal cells of indistinct shape (Fig. 4.3.12.4. B). Epidermal cells between ridges are elongated to isodiametric and tetra- to hexagonal. Periclinal walls are tabular to slightly convex while anticlinal walls are straight and slightly sunken (Fig. 4.3.12.4. C–D). The cells are covered by granular cuticle (Fig. 4.3.12.4. E).

Abaxially the seed has a narrow central ridge. The surface between the ridge and seed margin is smooth (Fig. 4.3.12.5. A–B). Cells are isodiametric and tetra- to hexagonal. Periclinal walls are tabular to convex or rarely partially concave while anticlinal walls are straight and slightly sunken (Fig. 4.3.12.5. C–D). The cuticle is coarsely granular (Fig. 4.3.12.5. E).

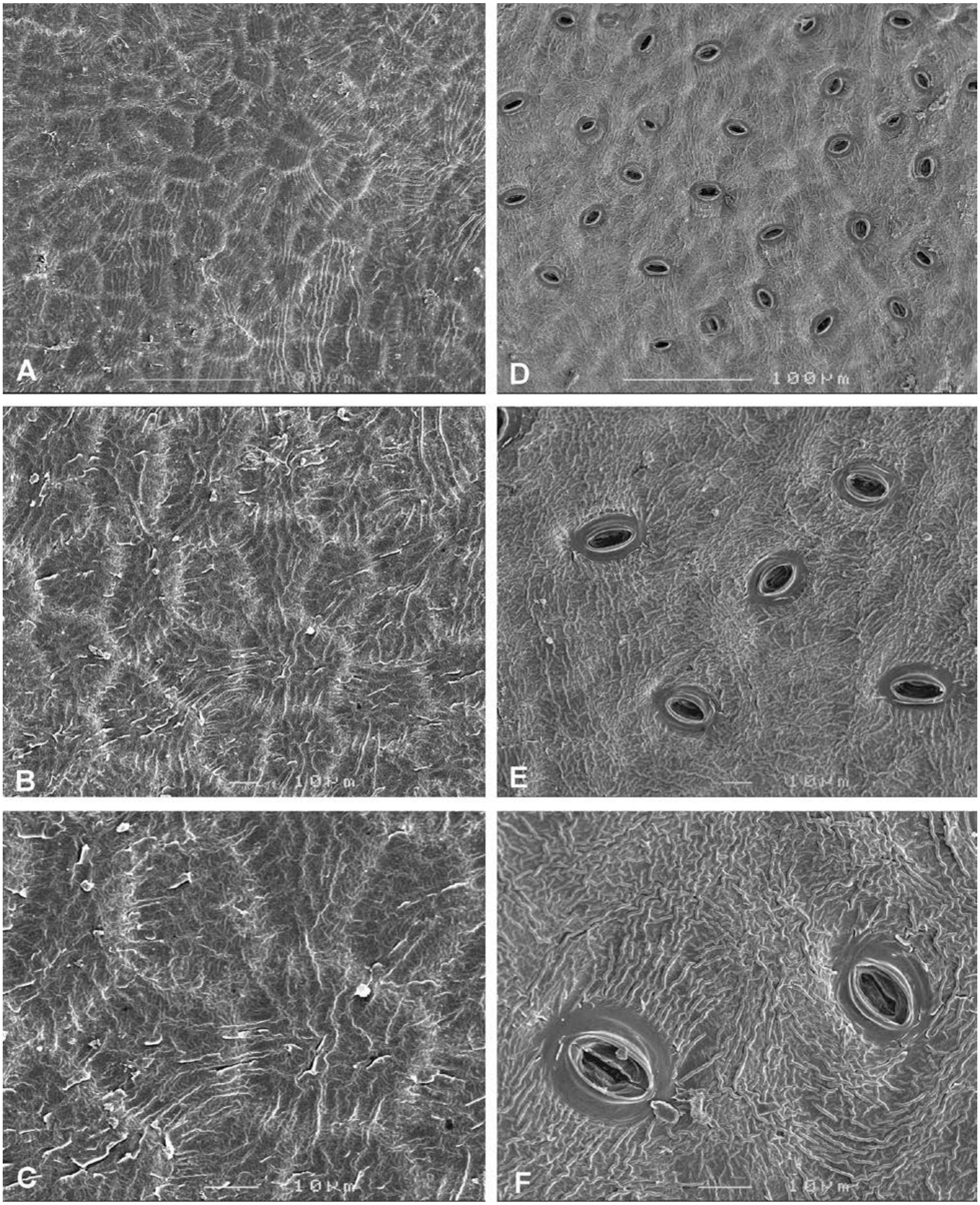


Fig. 4.3.12.3. *Cryptolepis grandiflora* leaf epidermal surfaces: (A–C) adaxial epidermal cells with tabular periclinal walls, straight anticlinal walls and slightly striated cuticle, (D–F) abaxial epidermis with tabular periclinal walls, straight anticlinal walls, striated cuticle and numerous stomata. Magnification: A, D = x300; B, E = x650; C, F = x1200. Specimen: (A–F) *Matthew, Manickam & Manoharan 19337* (K).

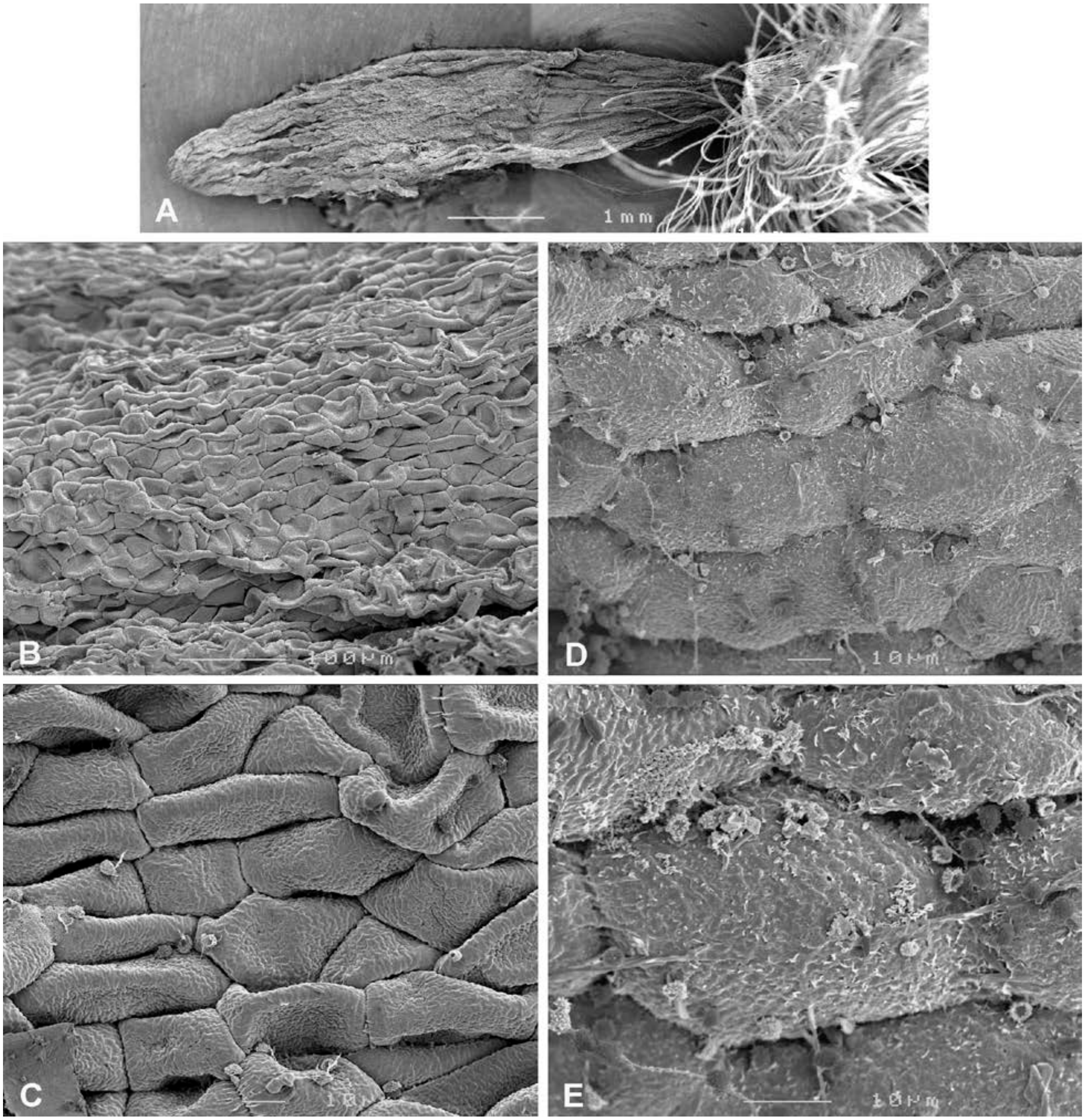


Fig. 4.3.12.4. *Cryptolepis grandiflora* seed surface: (A) adaxial view of seed showing longitudinal ridges, (B) adaxial seed surface smooth, (C, D) cells tetra- to hexagonal with convex periclinal walls and slightly to deeply sunken anticlinal walls, (E) cells covered by a granular cuticle. Magnification: A = x20, B = x220, C–D = x900, E = x1800. Specimens: (A–C) *Gamble 18168* (K); (D–E) *Bourne 2530* (K).

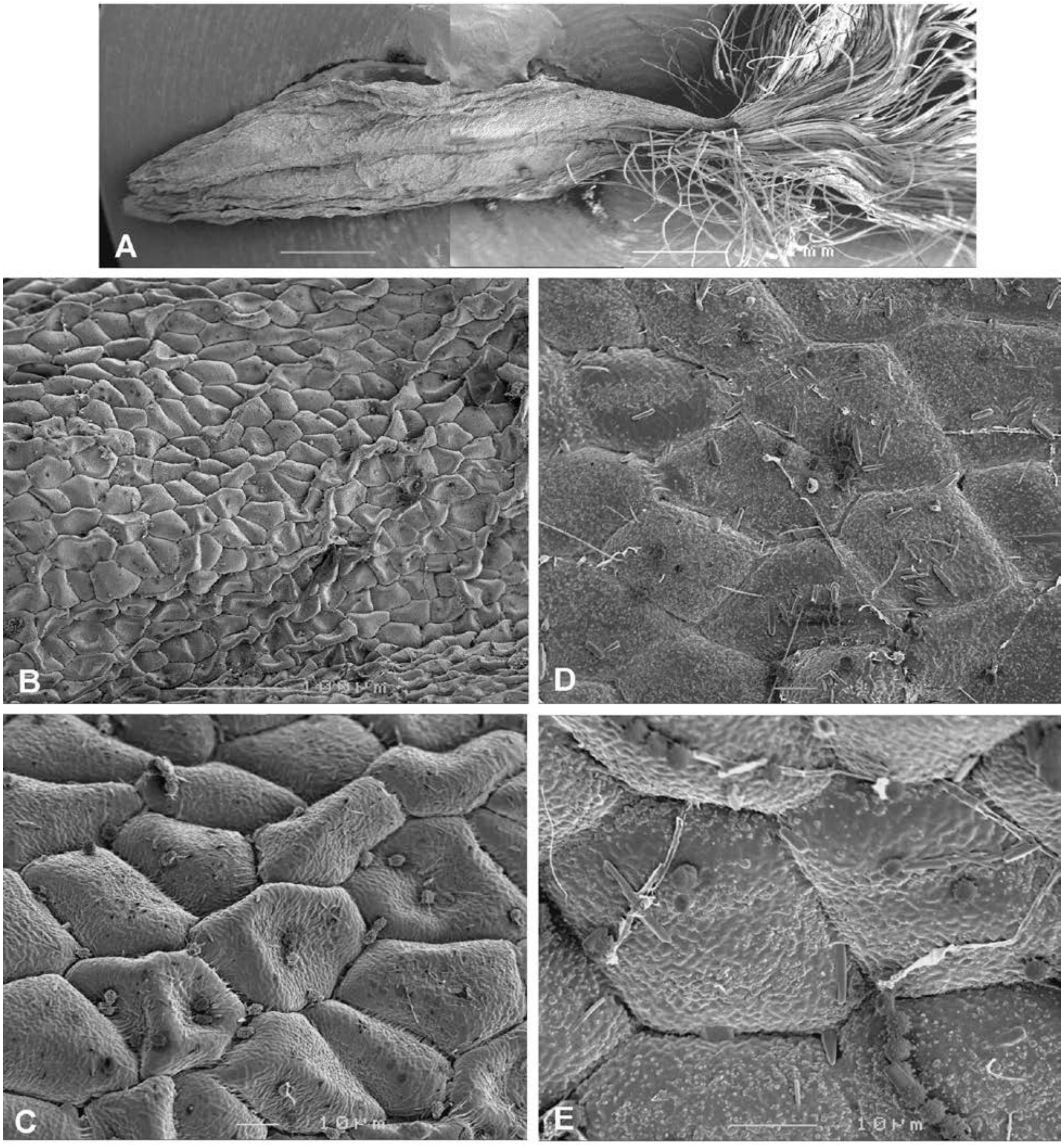


Fig. 4.3.12.5. *Cryptolepis grandiflora* seed surface: (A) abaxial view of seed with coma, (B) abaxial surface between central ridge and seed margin smooth, (C) cells with convex to partially concave periclinal walls, (D) cells with tabular periclinal walls (E) cells covered by a granular cuticle. Magnification: A = x20; B = x220; C, D = x900; E = x1800, D = x900. Specimens: (A–C) *Gamble 18168* (K); (D–E) *Bourne 2530* (K).

4.3.13 *Cryptolepis hypoglauca* K.Schum., Pflanzenwelt Ost-Africas C: 320 (1895a)[Note1], 219 (1895b); N.E.Br.: 244 (1902); Brenan: 64 (1949), Venter: 129 (2012).
Type: Tanzania, Amboni, *Holst, C. 2728* (B†, holo.; K!, lecto. designated by Venter (2012)).

A climber, with white latex, up to 6 m high. Stems woody, slender; young stems light brown, smooth to slightly verrucose, 1–2 mm diameter; older stems purplish, slightly verrucose, bark peeling, glabrous; interpetiolar ridges glabrous, conspicuous, colleters conspicuous. *Leaves* opposite, axils glabrous to slightly puberulous, sessile to semi-amplexicaul or rarely petiolate; petiole, when present, green, glabrous, slightly grooved, 2–3 mm long; blade broadly elliptic, rarely obovate or orbicular, 70–150 x 28–95 mm, coriaceous, dark green adaxially, pale grey abaxially, glabrous; margin plane; apex obtuse, rounded or emarginate, acuminate, glabrous, not recurved; base obtuse to cordate; venation brochidodromous, conspicuous on abaxial surface, 4–5 secondary veins on either side of main vein, intersecondary venation absent, tertiary veins weakly percurrent, conspicuous, areoles well developed, veinlets branched. *Inflorescences* cymose, lax, few-flowered, rarely many-flowered, robust, each cyme consists of 1–2 dichasia, each ending in 1–4 monochasia, primary peduncle 15–80 mm long, secondary peduncles 5–30 mm long, pedicels 2–5 mm long; bracts opposite, sparsely to very densely arranged, glabrous narrowly triangular, ± 1 mm long, margins glabrous to fimbriate. *Buds* robust, 4–6 mm long, broadly ovoid, apices apiculate, full turn helically twisted. *Sepals* ovate to narrowly ovate, 1.8–2 x 0.8–1 mm, acute, margins slightly fimbriate, colleters conical to ovate with dentate apices. *Corolla* tube and corona lobes yellow to green, corolla lobes pale pink, mauve or reddish brown, corolla 5.5–9 mm long; tube campanulate, 2.5–3.5 mm long, glabrous outside and inside; lobes spreading, ovate, 3–5.5 x 2–2.5 mm, apices attenuate. *Corona* double; primary corona inserted ± 2 mm from corolla tube base, included, lobes broadly fusiform, fleshy, 0.5–0.7 mm long, glabrous, apices apiculate, connivent over gynostegium; secondary corona in corolla lobe sinuses, pocket-like, inconspicuous, glabrous. *Stamens* inserted ± 1 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 0.8–0.9 mm long, filaments ± 0.2 mm long. *Nectaries* prominent, inserted ± 1 mm from corolla tube base. *Ovaries* 0.8–1 x 0.6–0.7 mm; style ± 0.2 mm long, style-head broadly pyramidal, acute, ± 0.6 x 1 mm. *Translators* narrowly elliptic, ± 0.6 mm long, apices acute. *Follicles* pendulous, widely divaricate at 180°–200°, cylindrical, 100–130 x 2–4 mm, dark brown, apices attenuate, bases cuneate. *Seeds* oblanceolate, 10–11 x 1–2 mm, dark brown, smooth; coma white to yellowish-white, ± 30 mm long. (Fig. 4.3.13.1.)

Diagnostic characteristics

Cryptolepis hypoglauca is a climber. The leaves are broadly elliptic, rarely obovate or orbicular, large, 70–150 x 28–95 mm, coriaceous with apices obtuse, rounded or emarginate and acuminate. This species is easily distinguished from other large leaved climbers based on a combination of the following characters: sessile to shortly petiolate leaves, petioles shorter than 3 mm, leaf bases usually cordate, buds broadly ovoid, apiculate and the corolla lobes pale pink, mauve- or reddish-brown, contrasting with the yellow to green corolla tube and corona lobes.

Notes

1. The name, *Cryptolepis hypoglauca* K.Schum., was published by Schumann (1894, 1895b). Since none of these publications contain a description, diagnosis or reference to a description or diagnosis of the species, none of these publications can be considered as valid publication of the new name. The name was validly published for the first time by Schumann (1895a).

Distribution and habitat

Cryptolepis hypoglauca is mainly found in Kenya and Tanzania, with two collections known from Cameroon and the Central African Republic (Fig. 4.3.13.2.). It grows in coastal and lowland evergreen to semi-deciduous forest on poor to moist, humic soil overlying coastal limestone or igneous rock at altitudes from 0–800 m. Associated species include *Combretum schumannii* Engl., *Gyrocarpus americanus* Jacq., *Tamarindus indica* L., *Diospyros squarrosa* Klotzsch, *D. abyssinica* (Hiern) F.White, *Adansonia digitata* L., *Lecaniodiscus fraxinifolius* Baker, *Drypetes natalensis* Hutsch., *Cola clavata* Mast., *Cola minor* Brenan, *Ricinodendron* sp., *Craibia* sp., *Manilkara* sp., *Haplocoelopsis* sp., *Drypetes* sp., *Salacia* sp. and *Dichapetalum* sp. Flowering occurs throughout the year with a peak from June to August.

Representative specimens

— 6º19' N, 16º22' E: Central African Republic, Bozoum District, 01-06-1935, *Tisserant, R.P.C. 3334* (BM).

— 9º55'51'' N, 13º46'17'' E: Cameroon, Bossum, 06-1914, *Michael 9689* (K).

— 4º10' S, 39º37' E: Kenya, Ras Kikadini, 16-08-1982, *Robertson, S.A. 3357* (EA, K).

— 4º38'31'' S, 39º22'49'' E: Kenya, Kwale District, Shimoni, 20-08-1953, *Drummond, R.B.* & *Hemsley, J.H. 3917* (K, LISC).

— 10º30' S, 39º02' E: Tanzania, Masasi District, Ndanda Mission, 18-03-1991, *Bidgood, S., Abdallah, R. & Vollesen, K. 2086* (EA).

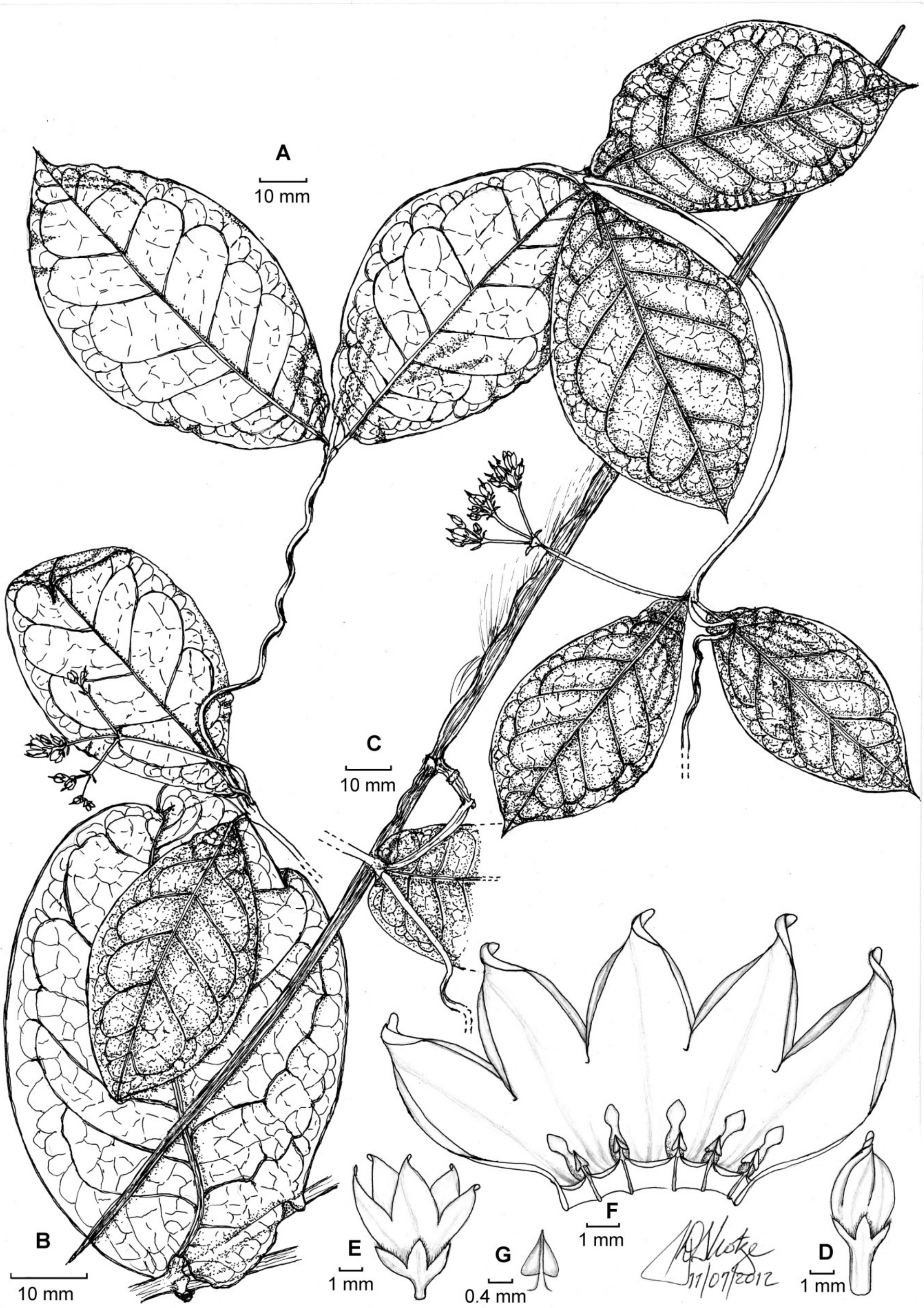


Fig. 4.3.13.1. Illustration of *Cryptolepis hypoglauca*: (A) stem with atypical petiolate leaves and lax inflorescences, (B) typical semi-amplexicaul leaf, (C) stem with paired follicles, (D) external view of bud, (E) external view of mature flower, (F) corolla opened, showing helically twisted corolla lobes, broadly fusiform primary corona lobes, stamens with narrowly hastate anthers and prominent nectaries, (G) glabrous stamen. Specimens: (A, D–E) *Faulkner 2561* (K); (B–C) *Drummond & Hemsley 3917* (K); (F–G) *Faulkner 3702* (K).

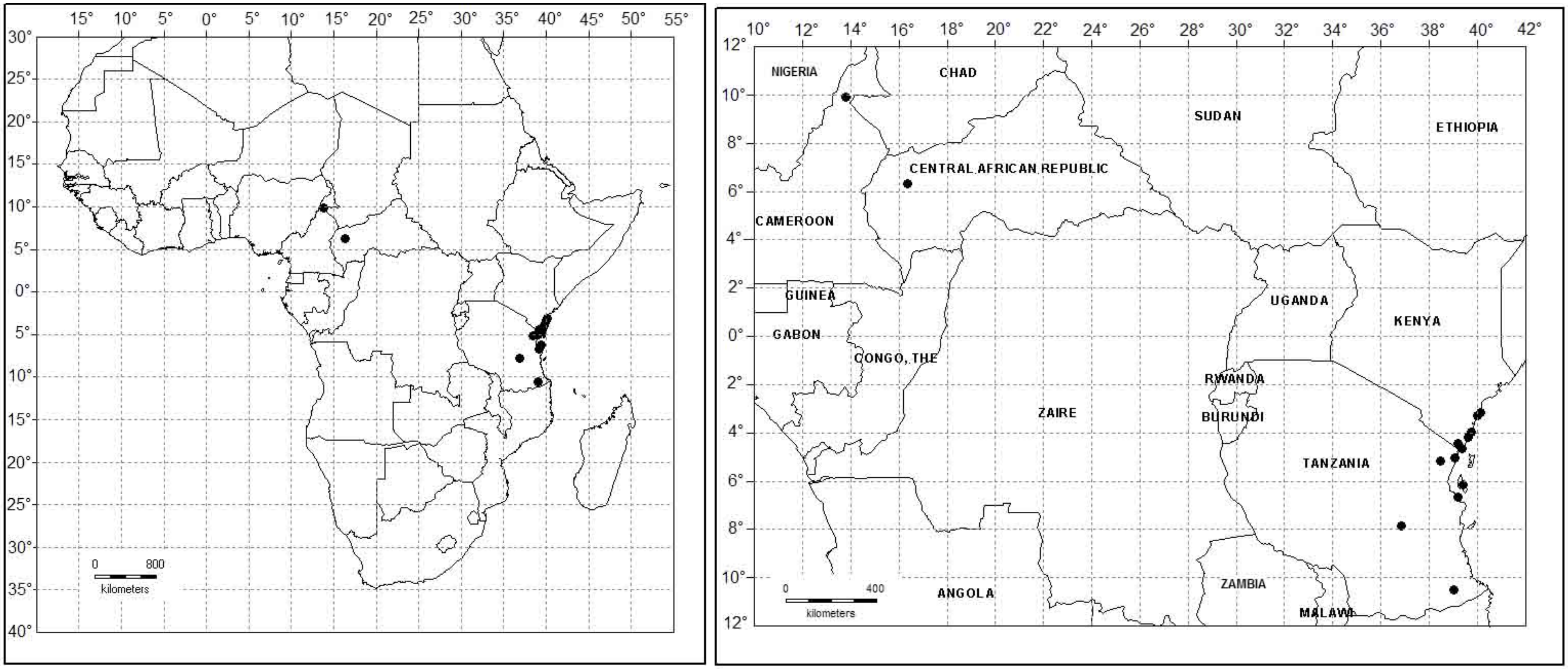


Fig. 4.3.13.2. Known distribution of *Cryptolepis hypoglauca*.

Leaf micromorphology

The adaxial epidermis consists of more or less isodiametric, penta- to hexagonal cells. Periclinal walls are slightly convex while anticlinal walls are straight to slightly curved and slightly sunken. The cuticle is sparsely striated with straight, parallel striations which are continuous over intercellular boundaries. (Fig. 4.3.13.3. A–C)

Cells on the abaxial epidermal surface are isodiametric and tetra- to hexagonal. Periclinal walls are tabular while anticlinal walls are straight and slightly sunken. The cuticle is indistinct due to the dense covering of wax platelets. (Fig. 4.3.13.4. D–F)

Leaves are hypostomatic with numerous stomata, randomly orientated and level with other epidermal cells. Subsidiary cells are densely covered by wax platelets. Guard cells are narrowly elliptic and covered by a narrow stomatal ledge. (Fig. 4.3.13.3. D–F)

Seed micromorphology

The adaxial seed surface is covered by sparsely arranged protuberances, formed by raised epidermal cells with no clearly distinguishable shape (Fig. 4.313.4. A–B, D). Epidermal cells between protuberances are more or less isodiametric and tetra- to hexagonal. Periclinal walls are concave or convex. Anticlinal walls are straight to slightly curved and deeply sunken (Fig. 4.3.13.4. C, E). The cells are covered by a coarsely granular (Fig. 4.3.13.4. C) to striated cuticle. Where striations occur, they are reticulate and continuous over intercellular boundaries (Fig. 4.3.13.4. E).

Abaxially the seed has a narrow central ridge (Fig. 4.3.13.5. A). The surface between the ridge and the seed margin is smooth (Fig. 4.3.13.5. B) except directly next to the margin where protuberances, consisting of contorted cells, occur (Fig. 4.3.13.5. D). Cells are isodiametric and tetra- to hexagonal. Periclinal walls are tabular to convex while anticlinal walls are straight and slightly sunken. The cuticle is coarsely granular to striated (Fig. 4.3.13.5. C, E), with striations reticulate and continuous over intercellular boundaries (Fig. 4.3.13.5. E).

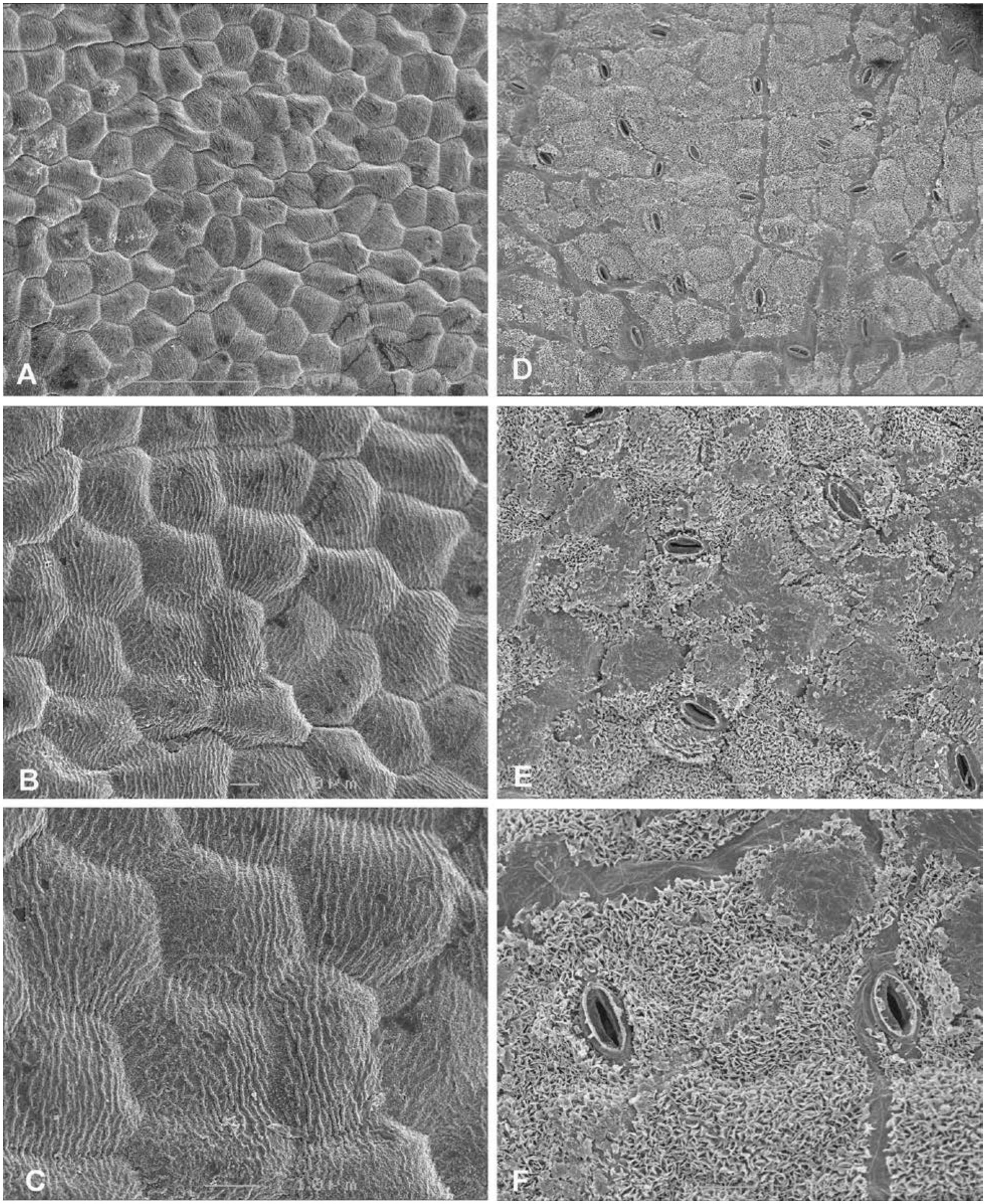


Fig. 4.3.13.3. *Cryptolepis hypoglauca* leaf epidermal surfaces: (A–D) adaxial epidermal cells with slightly convex periclinal walls, straight, slightly sunken anticlinal walls and striated cuticle, (D–F) abaxial epidermis with tabular periclinal walls, straight, slightly sunken anticlinal walls, stomata and densely packed wax platelets. Magnification: A, D = x300; B, E = x650; C, F = x1200. Specimen: (A–F) *Robertson 3357* (EA).

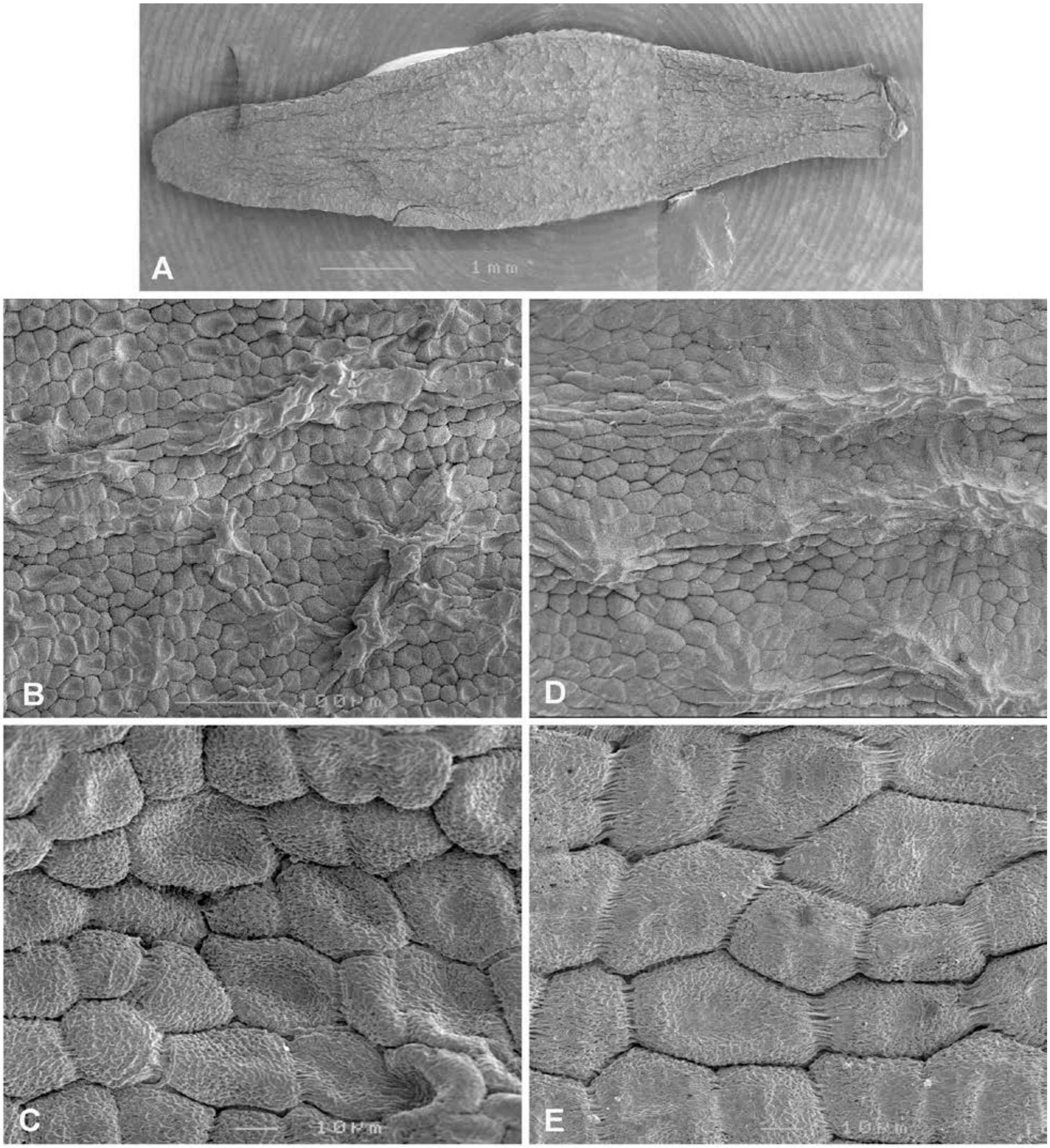


Fig. 4.3.13.4. *Cryptolepis hypoglauca* seed surface: (A) adaxial view of seed, (B, D) adaxial seed surface with inconspicuous, sparsely arranged protuberances, (C) cells tetra- to hexagonal with convex periclinal walls, slightly sunken anticlinal walls and a granular cuticle, (E) cells tetra- to hexagonal with convex periclinal walls, slightly sunken anticlinal walls and reticulate striated cuticle. Magnification: A = x20; B, D = x220; C, E = x900. Specimens: (A–C) *Drummond & Hemsley 3917* (LISC); (D–E) *Faulkner 4914* (K).

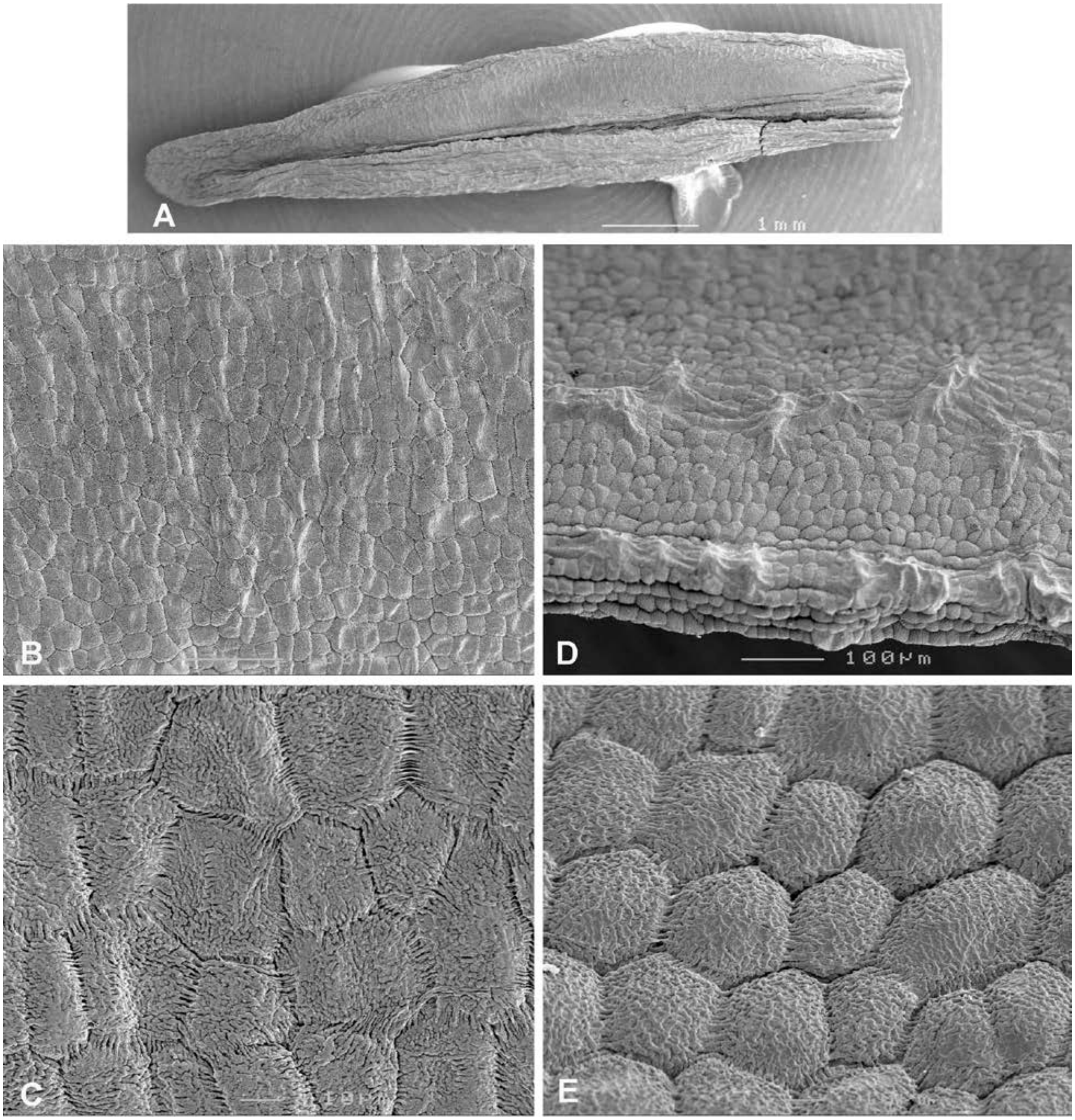


Fig. 4.3.13.5. *Cryptolepis hypoglauca* seed surface: (A) abaxial view of seed with narrow central ridge, (B) abaxial surface between central ridge and seed margin smooth, (C) cells with tabular periclinal walls and granular to striated cuticle, (D) protuberances near seed margin, (E) cells with convex periclinal walls and granular to striated cuticle. Magnification: A = x20; B, D = x120; C = x1800; E = x900. Specimens: (A–C) *Drummond & Hemsley* (LISC); (D–E) *Faulkner 4914* (K).

4.3.14 *Cryptolepis ibayana* L.Joubert & Venter, Botanical Journal of the Linnean Society 160: 355 (2009); Venter: 129 (2012).
Type: Tanzania, Mkomazi Game Reserve, Ibaya Stream, *Abdallah & Mboya 3979* (K!, holo.; EA!, iso.).

= *C. bifida* L.Joubert & Venter in L.Joubert et al., Botanical Journal of the Linnean Society 157: 343-346 (2008) *nom. illegit.* (non *Cryptolepis bifida* (Blume) P.I.Forst., Austrobaileya 4(1): 69 (1993)).
Type: Homotypic synonym.

A climber with white latex. Stems woody, slender, up to 4 mm diameter; young stems reddish-brown, smooth, glabrous; older stems purplish-brown, verrucose, glabrous; interpetiolar ridges glabrous, conspicuous, colleters conspicuous. *Leaves* opposite, axils puberulous, petiolate; petioles 5–6 mm, glabrous, grooved; blade elliptic, 45–70 x 20–30 mm, coriaceous, green above, pale green below, glabrous; margin plane; apex acuminate to obtuse and acuminate to apiculate, glabrous, recurved; base obtuse; venation brochidodromous, conspicuous on abaxial surface, 4–6 secondary veins on either side of main vein, secondary vein arches along leaf margin prominent, intersecondary venation present, tertiary veins random reticulate, conspicuous, areoles well developed, veinlets branched. *Inflorescences* cymose, sub-compact, few-flowered, slender, each cyme consists of 3–7 monochasia, primary peduncle 10–20 mm long, secondary peduncles 10–15 mm long, pedicels 2–3 mm long; bracts opposite, densely packed, glabrous, acicular, ± 1 mm long, margins glabrous. *Buds* slender, ± 4 mm long, oblong, apices attenuate, full turn helically twisted. *Sepals* ovate, ± 1 x 0.5 mm, rotund, glabrous, colleters ovoid, apices dentate. *Corolla* greenish-yellow, 6–8 mm long; tube oblong-campanulate, 2–3 mm long, glabrous outside, villous inside below stamens; lobes spreading, linear to linear-ovate, 4–5 x 1 mm, rotund. *Corona* double; primary corona inserted ± 0.8 mm from corolla tube base, included, lobes clavate, fleshy, ± 0.8 mm long, glabrous, apices obtuse, connivent over gynostegium; secondary corona in corolla lobe sinuses, pocket-like with linear, deeply bifid lobes of ± 1 mm long from pocket rims, glabrous. *Stamens* inserted ± 0.6 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 0.5 mm long, sub-sessile. *Nectaries* prominent, inserted ± 0.6 mm from corolla tube base. *Ovaries* 0.4–0.6 x 0.6–0.7 mm; style ± 0.3 mm long, style-head broadly pyramidal, ± 0.5 x 0.5 mm. *Translators* narrowly elliptic, ± 0.25 mm long. *Follicles* unknown. *Seeds* unknown. (Fig. 4.3.14.1.)

Diagnostic characteristics

Cryptolepis ibayana is a climber. The leaves are elliptic, large, 45–70 x 20–30 mm, coriaceous with apices acuminate to obtuse and acuminate or apiculate. This species is distinguished from similar, coriaceous leaved species, such as *C. apiculata, C. dubia* and *C. hypoglauca* by a combination of slender, oblong, attenuate buds of ± 4 mm long, corolla greenish-yellow, corolla tube villous below stamen insertion, secondary corona pockets and filiform lobes with deeply bifid apices arising from the pocket rims. *Cryptolepis ibayana* is distinguished from similar, herbaceous leaved species, such as *C. africana, C. capensis, C. grandiflora* and *C. sanguinolenta,* by its conspicuous venation on the abaxial leaf surface, with intersecondary veins present, areoles well developed, the corolla shorter than 8 mm and the characteristic filiform lobes with bifid apices arising from the secondary corona pocket rims.

Distribution and habitat

Cryptolepis ibayana is found in Kenya and Tanzania, where it was collected from Machakos and at the Pare Mountains (Fig. 4.3.14.2.). It grows in montane forest at altitudes around 1200 m. Both collections made of the species flowered in January.

Voucher specimen

— 2º21' S, 37º55' E: Kenya, Mbinzao Hill [Mbuinzau], 29-01-1942, *Bally, B. 1749* (K).

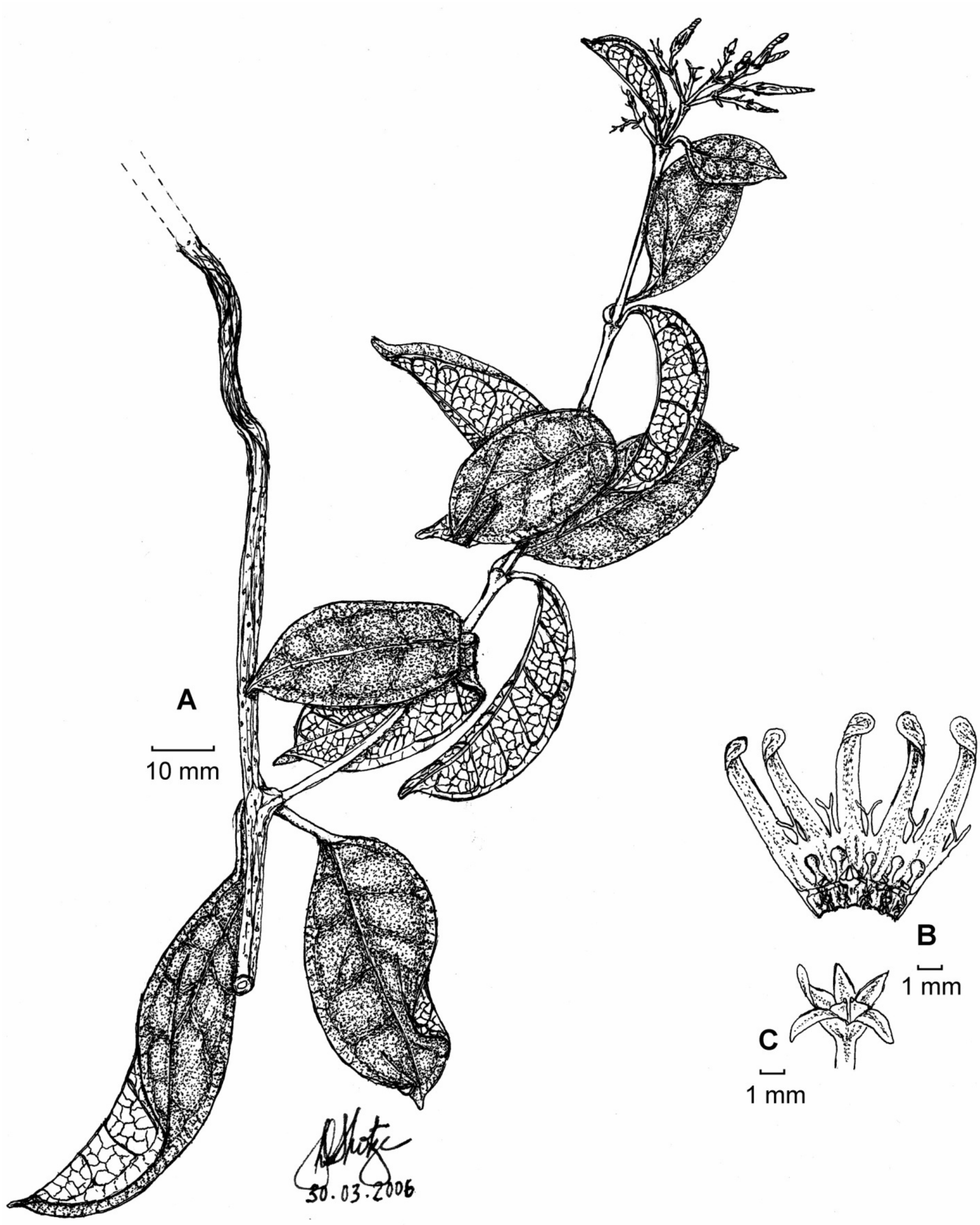


Fig. 4.3.14.1. Illustration of *Cryptolepis ibayana*: (A) stem with leaves and inflorescence, (B) flower opened, showing clavate primary corona lobes and linear, bifid lobes on secondary corona pocket rims, (C) calyx and ovaries. Specimen: *Abdallah & Mboya 3979* (K). Reproduced with permission of the Botanical Journal of the Linnean Society.

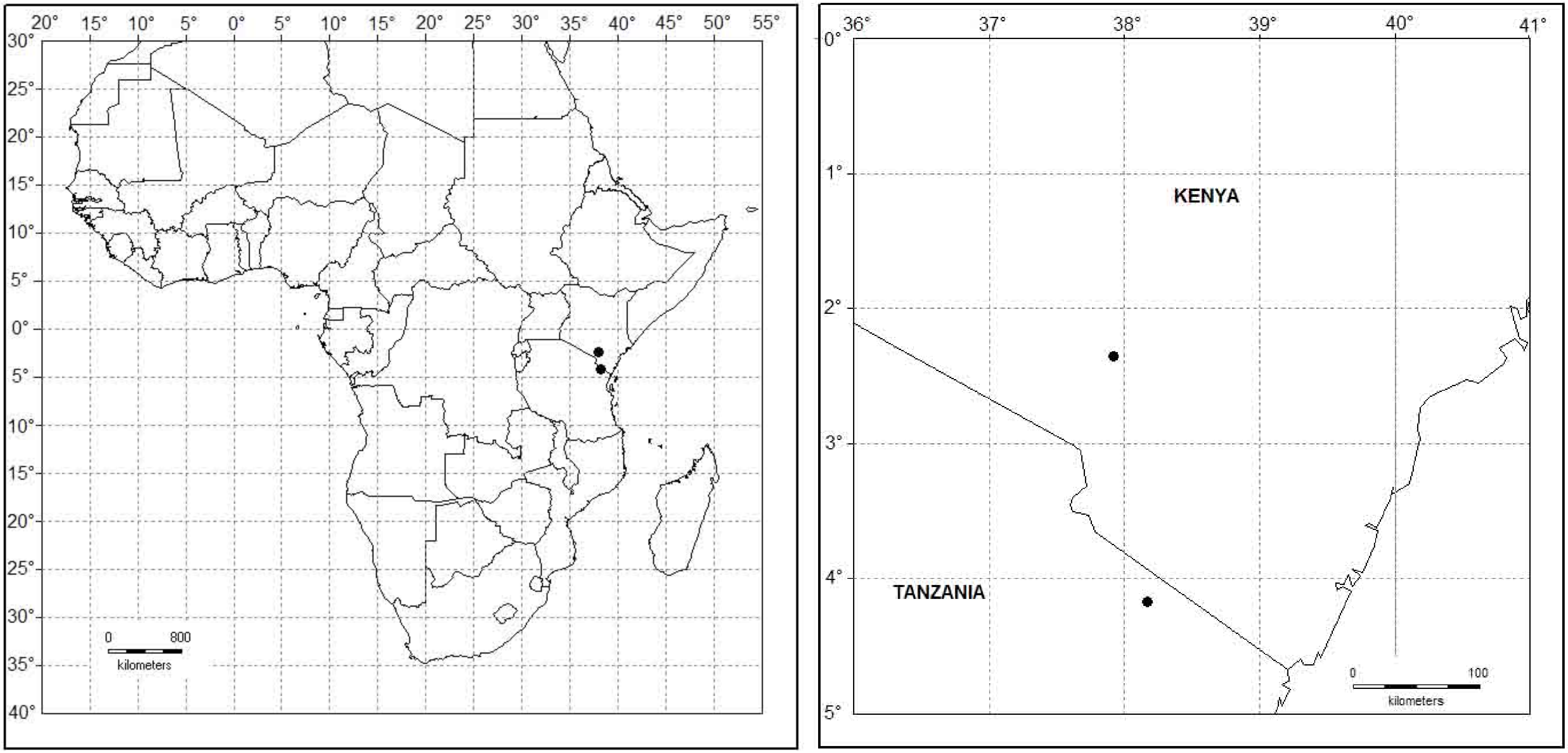


Fig. 4.3.14.2. Known distribution of *Cryptolepis ibayana*.

Leaf micromorphology

The cuticle on the adaxial epidermis is heavily folded, obscuring cell shape and anticlinal walls. The periclinal walls are tabular to slightly concave (Fig. 4.3.14.3. A–C). The cuticle is slightly striated with straight, parallel striations continuous over intercellular boundaries (Fig. 4.3.13.3. B). Cell shape and anticlinal walls on the abaxial epidermis is also obscured by cuticular folds. The periclinal walls are tabular to slightly concave. The cuticle is striated with wavy, randomly orientated striations which are continuous over intercellular boundaries (Fig. 4.3.14.3. D–F).

Leaves are hypostomatic with numerous stomata, randomly orientated and level with the surrounding epidermal cells. Stomata are paracytic with the cuticle covering subsidiary cells smooth to slightly striated, striations parallel to or radiating from the stomatal pore. The guard cells are broadly elliptic and are covered by a broad stomatal ledge. (Fig. 4.3.14.3. D–F)

Seed micromorphology

Seeds unknown.

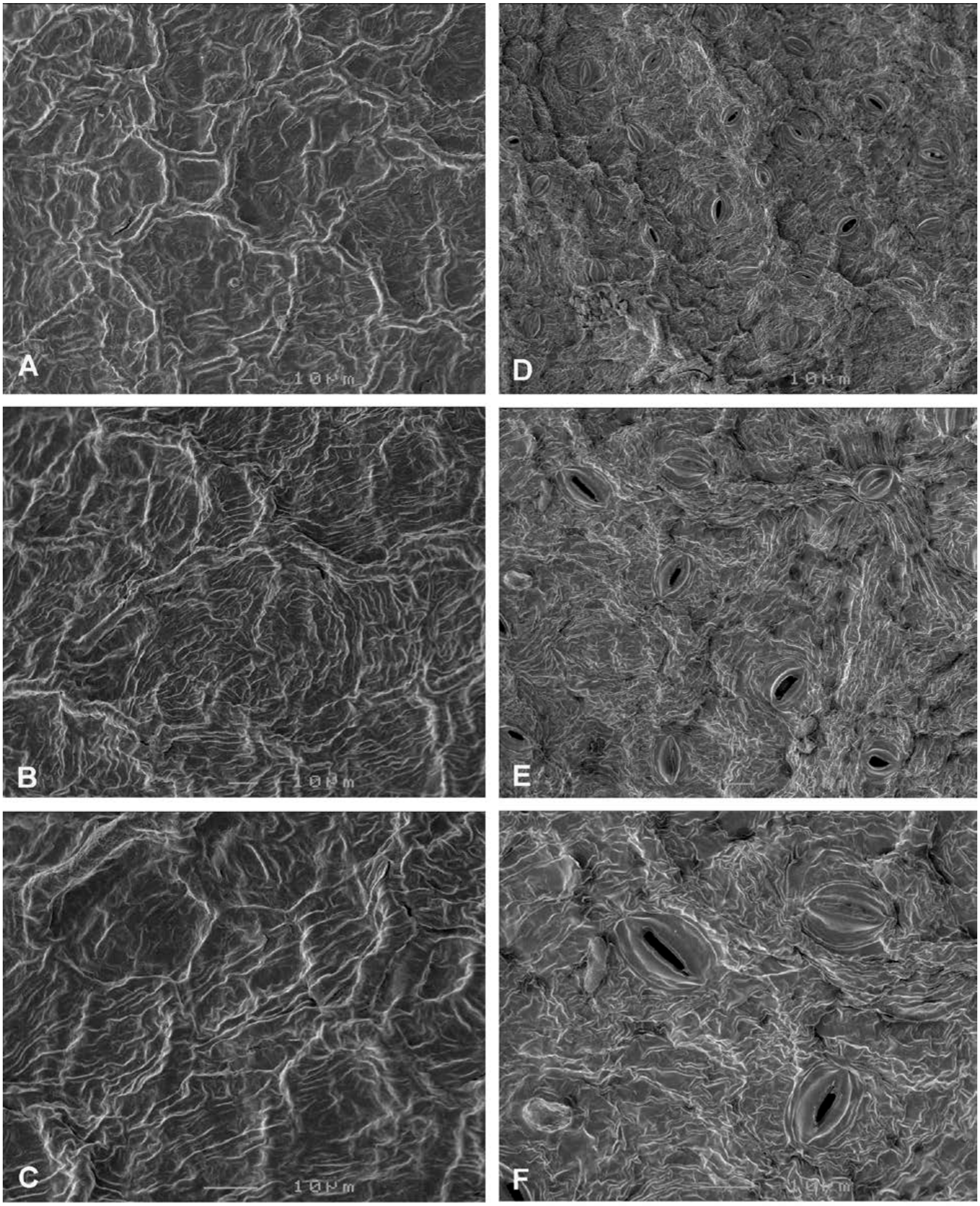


Fig. 4.3.14.3. *Cryptolepis ibayana* leaf epidermal surfaces: (A) adaxial epidermis with cuticular folds obscuring epidermal cell shape, (B–C) adaxial epidermal cells with tabular periclinal walls and slightly striated cuticle, (D) abaxial epidermis with cuticular folds, striations and numerous stomata, (E–F) abaxial epidermis with striated cuticle, and stomata. Magnification: A, D = x400; B, E = x650, C, F = x1200. Specimen: (A–F) *Abdallah & Mboya 3979* (EA).

4.3.15 *Cryptolepis intricata* (Balf.f.) Venter in Venter & R.L.Verh., Taxon 46(4): 713 (1997). Basionym: *Mitolepis intricata* Balf.f., Proceedings of the Royal Society of Edinburgh 12: 78 (1884), 166 (1888).

Types: Socotra, Haghier Mountains, *Balfour 508* (E!, lecto. here designated; BM!, OXF, isolecto.); Socotra, Kirchen, *Schweinfurth 651* (E!, syn.).

A shrub, with white latex, up to 1.3 m high. *Stems* woody, erect, slender, densely branched, stem diameter unknown; young stems light grey-brown, smooth to slightly verrucose, slightly to densely puberulous; older stems grey-brown, smooth to slightly verrucose, glabrous; interpetiolar ridges puberulous, inconspicuous on younger branches, absent on older branches; brachyblasts occasionally present, colleters present. *Leaves* opposite or occasionally fascicled, axils densely villous, sub-sessile; blade oblong, rarely obovate, 7–15 x 1.5–4 mm, semi-succulent, dark green, glossy and glabrous adaxially, pale green and puberulous abaxially; margin revolute; apex obtuse, rarely retuse, mucronate, glabrous to densely villous, not recurved; base cuneate; venation brochidodromous, 4–5 secondary veins on either side of main vein visible abaxially, indistinct adaxially, higher order venation indistinct. *Flowers* solitary, pedicels ± 1 mm long; bracts absent. *Buds* not seen. *Sepals* reddish-brown, orbicular, ± 0.5 x 0.5 mm, rounded, margins fimbriate, colleters conical, inconspicuous, translucent. *Corolla* pale yellow to cream, 6–6.5 mm long; tube campanulate, ± 2 mm long, glabrous outside and inside; lobes spreading, oblong, 3–4.5 x 1.5 mm, apices obtuse. *Corona* double; primary corona inserted ± 1 mm from corolla tube base, exserted, lobes filiform to falcate with bases ovoid, 2–3 mm long, glabrous, apices attenuate, connivent over gynostegium, slightly exserted from corolla tube; secondary corona in corolla lobe sinuses, pocket-like, glabrous, inconspicuous. *Stamens* inserted ± 0.5–0.7 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 0.5–0.7 mm long, filaments ± 0.2 mm long. *Nectaries* prominent, inserted ± 0.3 mm from corolla tube base. *Ovaries* ± 0.4 x 0.6–0.8 mm; style ± 0.2 mm long, style-head broadly pyramidal, acutely bifid, ± 0.5 x 0.7–0.8 mm. *Translators* narrowly elliptic, ± 0.4 mm, apices obtuse. *Follicles* erect, widely divaricate to reflexed at 160°–210°, narrowly ovoid, 30–38 x 5–6 mm, purplish, apices acute slightly recurved, bases cuneate. *Seeds* elliptic, 2.5 x 1.5 mm, light brown, smooth; coma yellowish-white, ± 12 mm long. (Fig. 4.3.15.1.)

Diagnostic characteristics

Cryptolepis intricata is an erect shrub. The leaves are oblong to obovate, small, 7–15 x 1.5–4 mm and semi-succulent. This species is distinguished from most species with similar growth form and leaves based on a combination of solitary flowers and filiform to falcate, not clavate, corona lobes. *Cryptolepis intricata* is most similar to *C. decidua* and *C. gillettii*, which also have solitary flowers with filiform corona lobes. *Cryptolepis intricata* is distinguished from *C. decidua* by its orbicular sepals with conical, translucent colleters, pale yellow to cream flowers and geographic location on Socotra, as opposed to oblong-ovate sepals, trichome-like colleters, violet to white corolla and distribution range of the latter species restricted to the western parts of Southern Africa. *Cryptolepis intricata* is distinguished from *C. gillettii* by its puberulous abaxial leaf surfaces, smaller flowers with corollas shorter than 7 mm, double coronas and filiform primary corona lobes 2–3 mm long, as opposed to scabrid abaxial leaf surfaces, corollas longer than 7 mm, coronas single, with primary corona lobes shorter than 1 mm in *C. gillettii.*

Distribution and habitat

Cryptolepis intricata is endemic to the island Socotra (Fig. 4.3.15.2.). It grows on plateaus and low hills and is associated with limestone at altitudes from 240–1100 m. *Cryptolepis intricata* is found in open woodland to thicket or in sheltered areas in grassland. It is associated with an *Adenium* sp., *Buxus hildebrandtii* Baill., *Cephalocrotonopsis socotrana* Pax, *Croton socotranus* Balf.f., *Jatropha uncinulata* Radcl.-Sm. and a *Lycium* sp. Flowering occurs from February to August, with a peak in April.

Representative specimens

— 12º27' N, 54º04' E: Socotra, Rhizehum, 29-10-1993, *Miller, A.G. M.12621* (E).

— 12º29'35'' N, 53º59'30'' E: Socotra, Dixsam plateau, 24-09-1998, *Miller, A.G.*, *Hyam, Al Khulaidi, Salaiman & Talib M.16022* (E).

— 12º35' N, 54º03' E: Socotra, Hagghier Mountains, below Adho Dhemalu, 22-04-1967, *Smith, A.R.* & *Lavranos, J. 492* (K).

— 12º35' N, 54º17' E: Socotra, Hamaderoh Plateau, 08-04-1967, *Smith, A.R.* & *Lavranos, J. 332* (K).

— 12º35'31'' N, 54º18'57'' E: Socotra, Homhil, 25-02-1953, *Popov, G. GP/So/160* (BM).

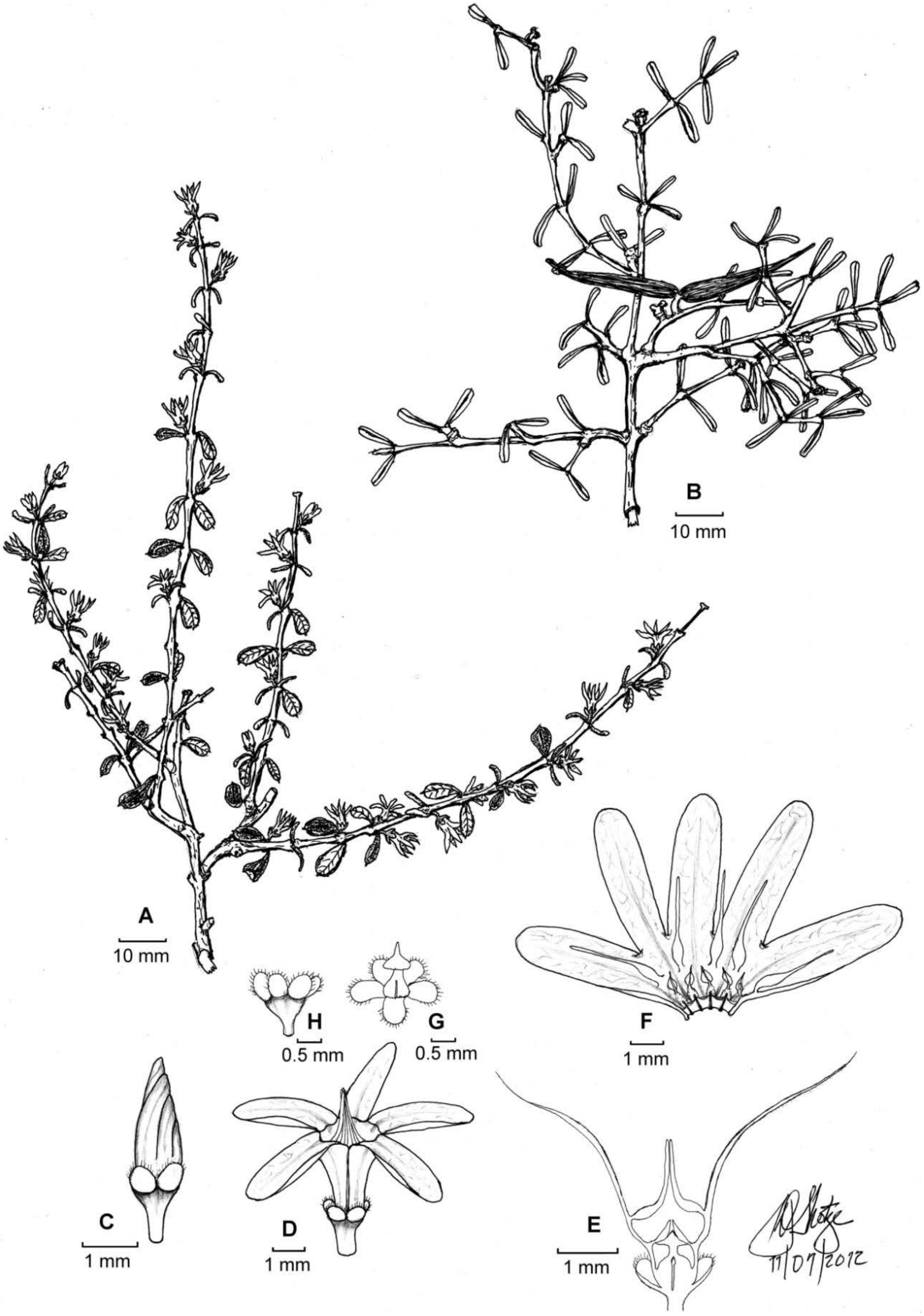


Fig. 4.3.15.1. Illustration of *Cryptolepis intricata*: (A) stem with leaves and solitary flowers, broad-leaved form, (B) stem with leaves and paired follicles, narrow-leaved form, (C) external view of bud, (D) external view of mature flower, (E) longitudinal section of flower showing corona lobes and stamens connivent over gynostegium, (F) corolla opened showing filiform primary corona lobes, stamens with narrowly hastate anthers and prominent nectaries, (G) sepals and pistil of semi-inferior apocarpous ovaries, style and style-head, (H) orbicular sepals with fimbriate margins. Specimens: (A, C–D, F, H) *Smith & Lavranos 332* (K); (B) *Smith & Lavranos 492* (K); (E, G) *Miller M.12621* (E).

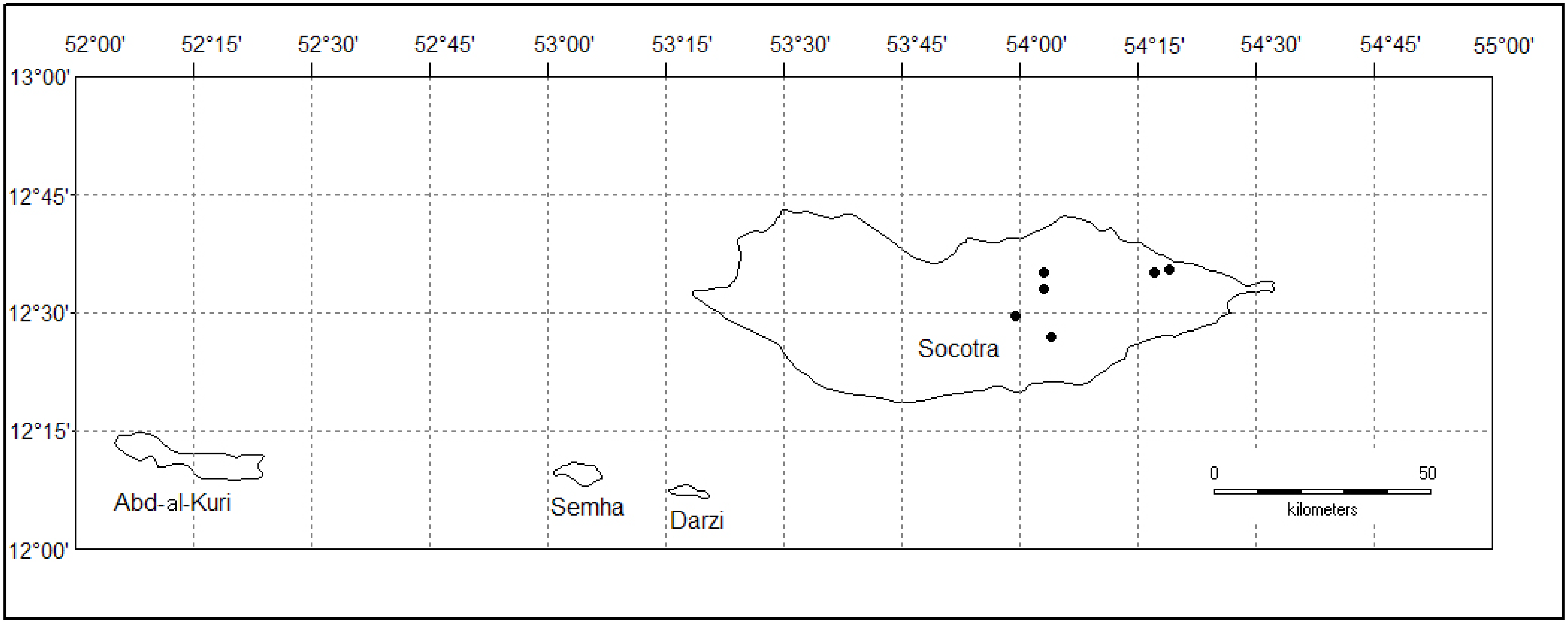


Fig. 4.3.15.2. Known distribution of *Cryptolepis intricata*.

Leaf micromorphology

Cells on the adaxial epidermal surface are isodiametric and tetra- to hexagonal. Periclinal walls are tabular to slightly convex while anticlinal wall boundaries are straight and slightly sunken. The cuticle is smooth to slightly striated with striations straight, parallel and continuous over intercellular boundaries (Fig. 4.3.15.3. A–C). The surface may be covered by a smooth wax sheet (Fig. 4.3.15.3. A).

Abaxial epidermal cells are obscured by numerous, densely packed finger shaped micropapillae, which are diagnostic for this species. The surfaces of cells and micropapillae are covered by densely packed wax platelets. (Fig. 4.3.15.3. D–F)

Leaves are hypostomatic with few stomata distributed among bases of micropapillae. Stomata have narrow stomatal ledges (Fig. 4.3.15.3. D).

Seed micromorphology

The upper seed surface shows longitudinal ridges along the seed centre, while the margins are smooth (Fig. 4.3.15.4. A). Epidermal cells range from isodiametric to slightly elongated (Fig. 4.3.15.4. B). Periclinal walls are convex or partially concave while anticlinal walls are straight to curved and deeply sunken (Fig. 4.3.15.4. C). Cuticle is slightly striated with striations wavy and randomly orientated, not crossing intercellular boundaries (Fig. 4.3.15.4. C).

The lower seed surface is smooth with a broad, indistinct central ridge (Fig. 4.3.15.4. D). Cell shape is variable, ranging from isodiametric to slightly elongated or contorted (Fig. 4.3.15.4. E). Cells near the margin have convex periclinal walls (Fig. 4.3.15.4. F) while cells near the central ridge have concave periclinal walls. The cuticle is slightly granular (Fig. 4.3.15.4. F).

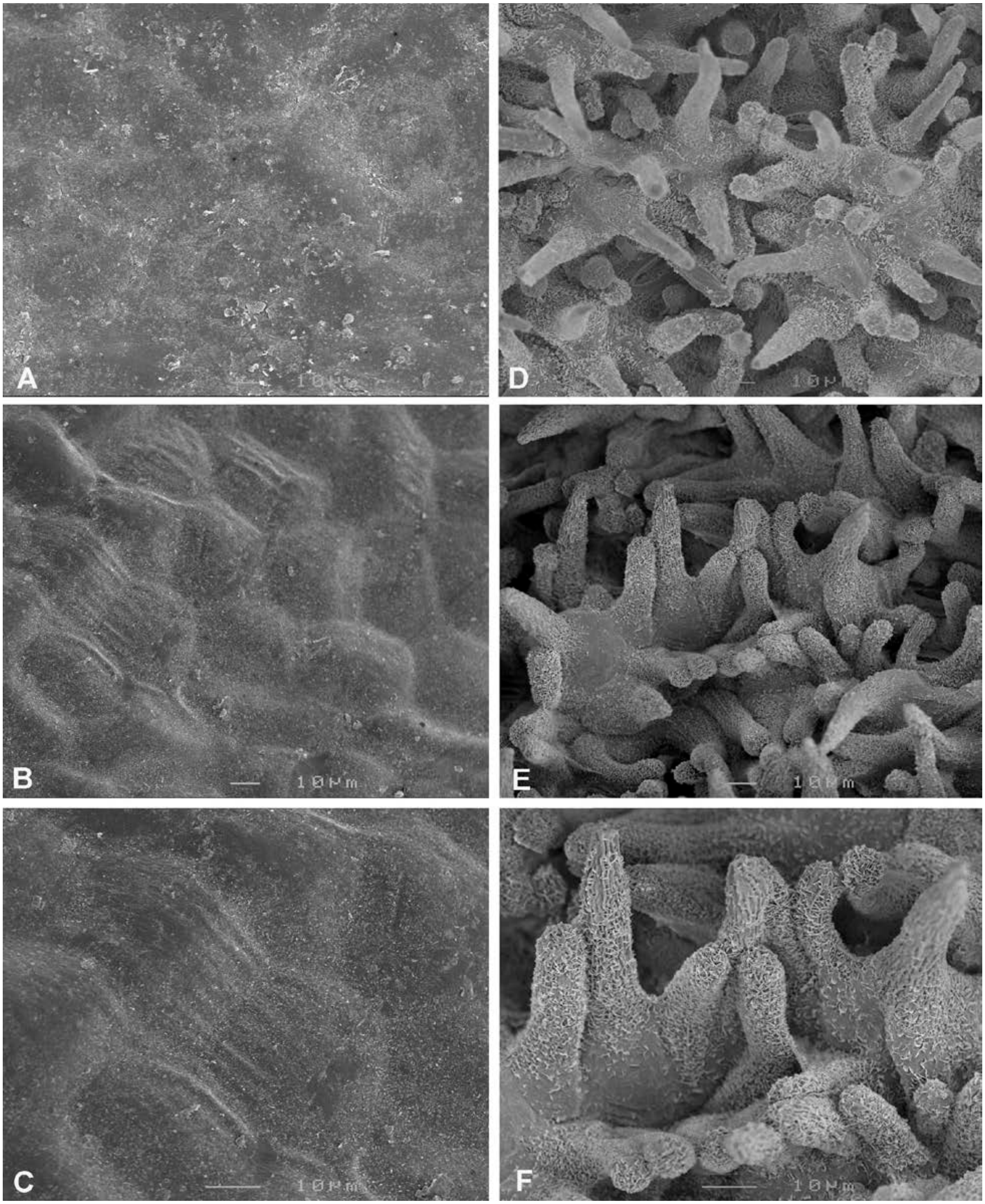


Fig. 4.3.15.3. *Cryptolepis intricata* leaf epidermal surfaces: (A) adaxial epidermal cells with tabular periclinal walls, smooth cuticle and wax sheet, (B–C) adaxial epidermal cells with slightly convex periclinal walls and slightly striated cuticle, (D) abaxial epidermis with finger-shaped micropapillae, stomata and wax platelets, (E–F) abaxial epidermis with densely packed finger-shaped micropapillae and wax platelets. Magnification: A–B, D–E = x650; C, F = x1200. Specimens: (A, D) *Smith & Lavranos 332* (K); (B–C, E–F) *Smith & Lavranos 429* (K).

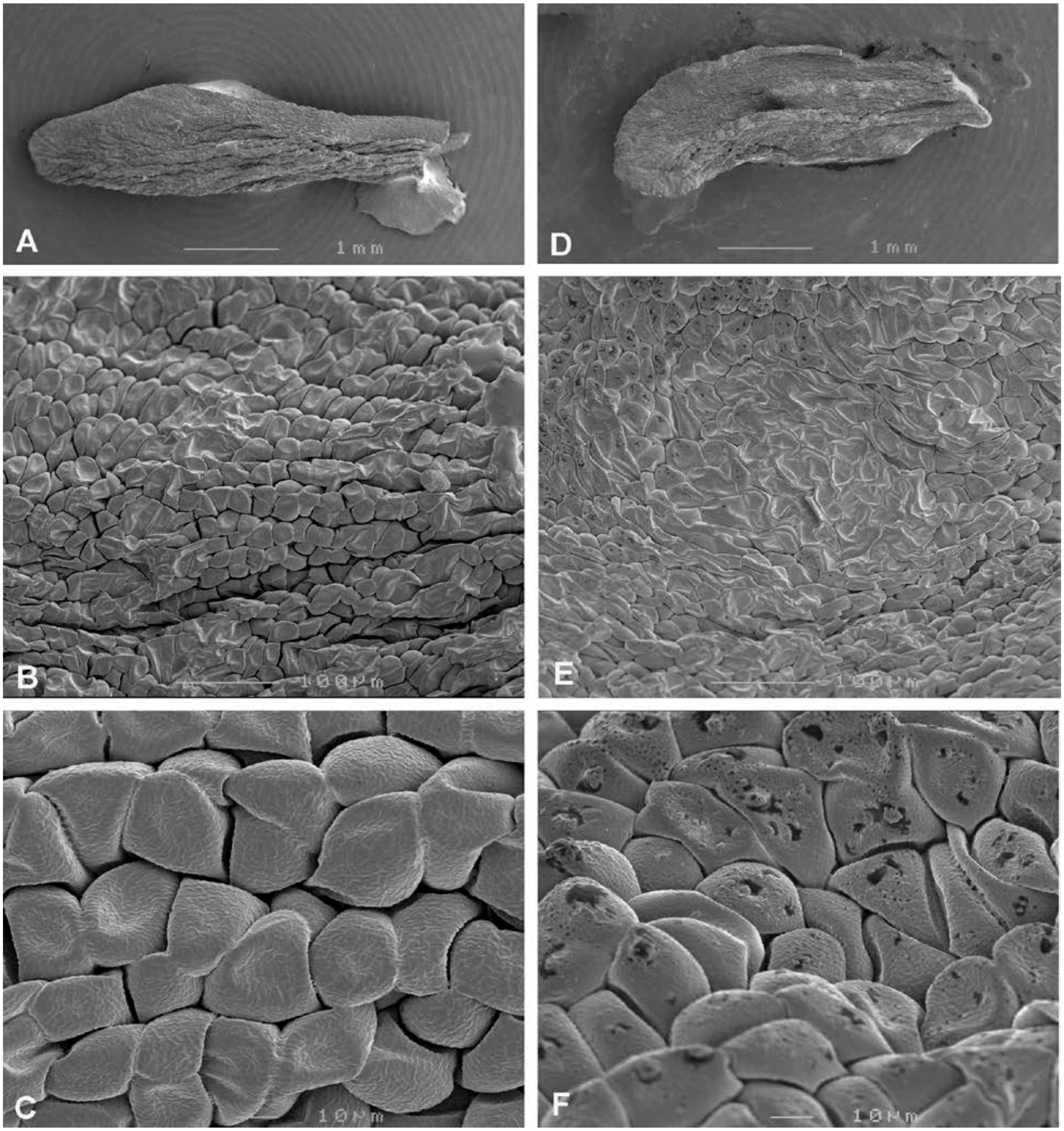


Fig. 4.3.15.4. *Cryptolepis intricata* seed surfaces: (A) adaxial view of seed, (B) adaxial seed surface smooth, (C) cells isodiametric with convex periclinal walls, deeply sunken anticlinal walls and slightly striated cuticle, (D) abaxial view of seed, (E) abaxial seed surface smooth with cells of variable shape, (F) cells isodiametric with convex periclinal walls and granular cuticle. Magnification: A, D = x20; B, E = x220; C, F = x900. Specimen: (A–F) *Smith & Lavranos 332* (K).

4.3.16 ***Cryptolepis macrophylla*** (Radcl.-Sm.) Venter in Venter & R.L.Verh., Taxon 46(4): 713 (1997). Basionym: *Curroria macrophylla* Radcl.-Sm., Hooker's Icones Plantarum 7(1): 3685 (1959).

Type: Socotra, Eastern Haghier Mountains, S of Jebel Shihali [Mountain], Wadi Dajuj, *Smith & Lavranos 515* (K!, holo.; FT-scan!, PRE!, iso.).

A tree, with white latex, 1.5–2.5(–5) m high. *Stems* woody, erect, sturdy, stem diameter unknown; nodes tumid, creating a knobbly appearance where internodes are short; young stems light brown, smooth to slightly verrucose, puberulous; older stems blackish to light grey, smooth to slightly verrucose, glabrous; interpetiolar ridges puberulous, inconspicuous on younger branches, absent on older branches, colleters exceptionally small and inconspicuous. *Leaves* opposite, axils villous, petiolate; petiole green, slightly puberulous, slightly grooved, 5–10 mm long; blade broadly elliptic to orbicular, 35–45(–70) x 21–38(–55) mm, coriaceous, slightly puberulous, dark green adaxially, pale green abaxially; margin plane; apex rounded to retuse, mucronate, slightly puberulent, not recurved; base cuneate to obtuse; venation brochidodromous, 5–6 secondary veins on either side of main vein, indistinct adaxially, visible abaxially, composite intersecondary veins absent, tertiary veins random reticulate, areole development imperfect, veinlets absent. *Inflorescences* cymose, lax, few-flowered, each cyme consists of 1–2 dichasia, primary peduncle ± 12 mm long, secondary peduncles 2.5–3 mm long, pedicels 5–7 mm long; bracts opposite, sparsely arranged, glabrous, acicular, 3–3.5 mm long, margins slightly fimbriate. *Buds* slender, ± 5 mm long, narrowly ovoid, apices clavate, full turn helically twisted. *Sepals* lanceolate, 2.5–4.5 x 0.5 mm, acuminate, glabrous to slightly fimbriate, colleters ovate, apices dentate. *Corolla* brownish, ± 8 mm long; tube campanulate, ± 1.5 mm long, glabrous outside and inside; lobes spreading, oblong, ± 6.5 x 2 mm, apices obtuse. *Corona* single; primary corona inserted ± 1 mm from corolla tube base, included, lobes clavate, ± 0.8 mm long, glabrous, apices pyramidal, connivent over gynostegium. *Stamens* inserted ± 0.7 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 0.8 mm long, sessile. *Nectaries* prominent, inserted ± 0.4 mm from corolla tube base. *Ovaries* ± 0.4 x 0.9 mm; style ± 0.2 mm long, style-head broadly pyramidal, acute, ± 0.4 x 0.7 mm. *Translators* narrowly elliptic, ± 0.3 mm long, apices acute. *Follicles* erect, widely divaricate at 180°, narrowly ovoid, 40–95 x 8–14 mm, dark brown, apices acute, bases cuneate. *Seeds* narrowly oblong, ± 6 x 1.5 mm, dark brown, slightly warty; coma yellowish-white, ± 20 mm long. (Fig. 4.3.16.1.)

Diagnostic characteristics

Cryptolepis macrophylla is a tree, 1.5–2.5(–5) m high. Stems often with tumid nodes. The leaves are broadly elliptic to orbicular, large, 35–45(–70) x 21–38(–55) mm, coriaceous with apices rounded to retuse and mucronate. This species is distinguished from two species with similar growth form, *C. arbuscula* and *C. migiurtina*, which have smaller, obovate leaves, less than 30 x 18 mm. *Cryptolepis macrophylla* is most similar to *C. socotrana*, which is a shrub, with leaves very similar in size and shape to those of *C. macrophylla. Cryptolepis macrophylla* is characterised by petiolate leaves, with petioles longer than 5 mm, lax, few-flowered inflorescences, corollas brownish and shorter than 10 mm while the primary corona lobes are clavate, with pyramidal apices and follicles are narrowly ovoid, 40–95 x 8–14 mm. *Cryptolepis socotrana* is characterised by sub-sessile leaves, compact, many-flowered inflorescences, corollas white to pale yellow, longer than 10 mm, corona lobes clavate with apices bilobed and hooded and follicles unique, broadly ellipsoid, falcate, 37–44 x 11–17 mm.

Distribution and habitat

Cryptolepis macrophylla is endemic to the island Socotra (Fig. 4.3.16.2.). It grows on limestone cliffs and steep rocky slopes among limestone boulders at altitudes from 120–600 m. *Cryptolepis macrophylla* is associated with succulent shrubland dominated by *Acacia pennivenia* Balf.f., *Adenium obesum* Roem. & Schult., *Buxus* sp., *Cissus subaphylla* (Balf.f.) Planch., *Croton* sp., *Dracaena cinnabari* Balf.f., *Euphorbia abdelkuri* Balf.f., *Euphorbia balsamifera* Aiton, *Euphorbia schimperi* C.Presl, *Jatropha* sp., *Lycium* sp., *Metaporana* sp. and *Searsia thyrsiflora* (Balf.f.) Moffett. Flowering probably during November, but information in this regard minimal.

Representative specimens

— **12º10' N, 52º15'28" E:** Abd-al-Kuri, Jebel Hassala, Quarat Saleh, [Jebel Saleh], 07-05-1967, *Smith, A.R.* & *Lavranos, J. 675* (K).

— **12º10'17" N, 52º14'29" E:** Abd-al-Kuri [Abd-al-Kuri], Foothills of Jebel Saleh, 18-02-1999, *Miller, A.G. , Alexander, Sulaiman, Talib, Hyam M. 17098* (E).

— **12º10'20" N, 52º15'41" E:** Abd-al-Kuri, Jebel Saleh, 26-10-1966, *Vurzo A27* (K).

— **12º11' N, 52º15' E:** Abd-al-Kuri [Abd-al-Kuri], Northern slope of Jebel Saleh, 09-02-1992, *Miller, A.G. & Nyberg M. 11410* (E).

— **12º32'31" N, 53º36'43" E:** Socotra, Wadi Eyek, 05-02-2000, *Miller, A.G. & Talib M. 19103* (E).

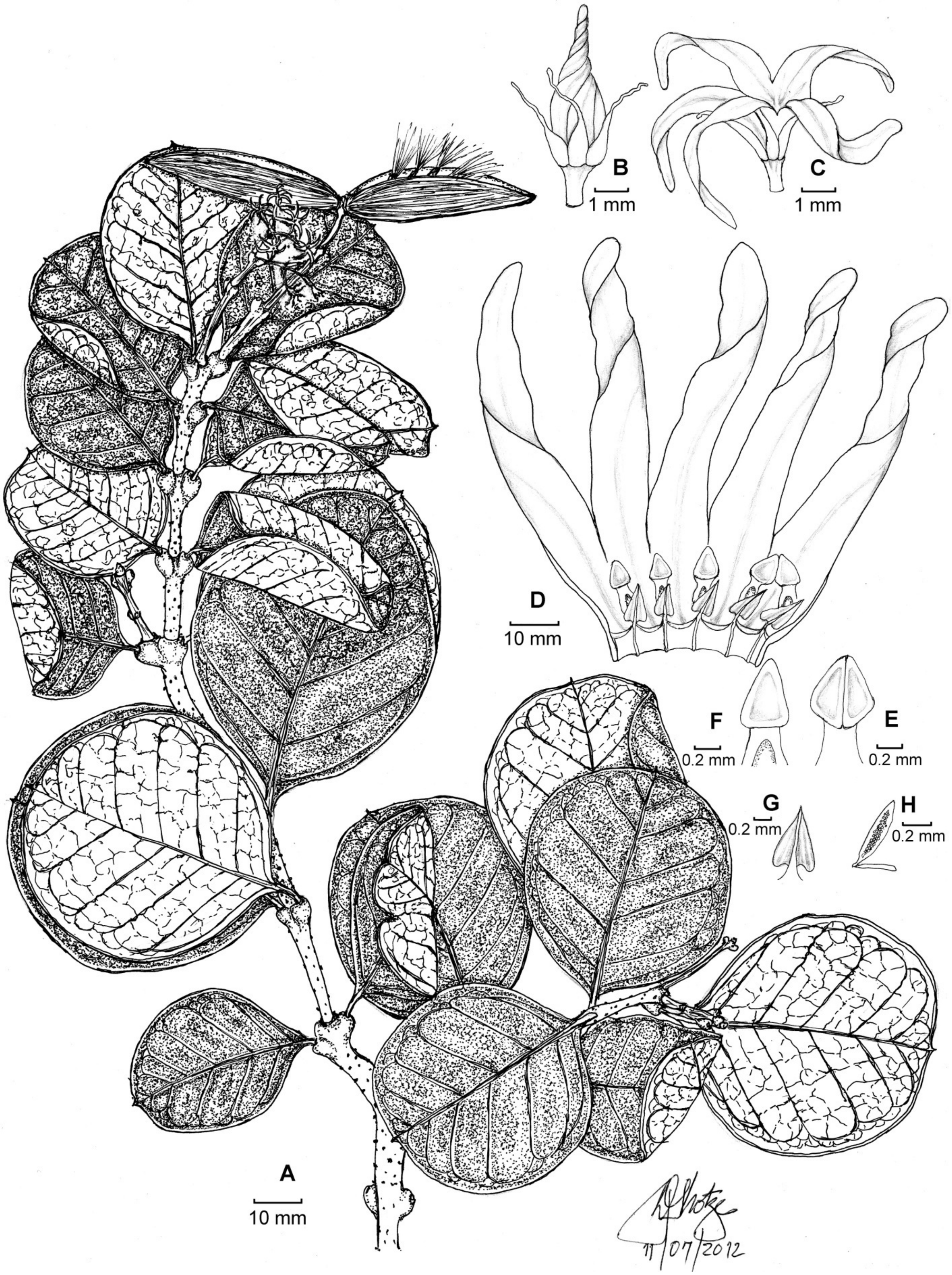


Fig. 4.3.16.1. Illustration of *Cryptolepis macrophylla*: (A) stem with leaves, inflorescence and paired follicles, (B) external view of bud, (C) external view of mature flower, (D) corolla opened showing helically twisted corolla lobes, clavate primary corona lobes with pyramidal apices, stamens with narrowly hastate anthers and prominent nectaries, (E) adaxial view of corona lobe, (F) abaxial view of corona lobe, (G) stamen, (H) translator. Specimens: (A) *Smith & Lavranos 675* (K) combined with *Vurzo 27* (K); (B–H) *Vurzo 27* (K).

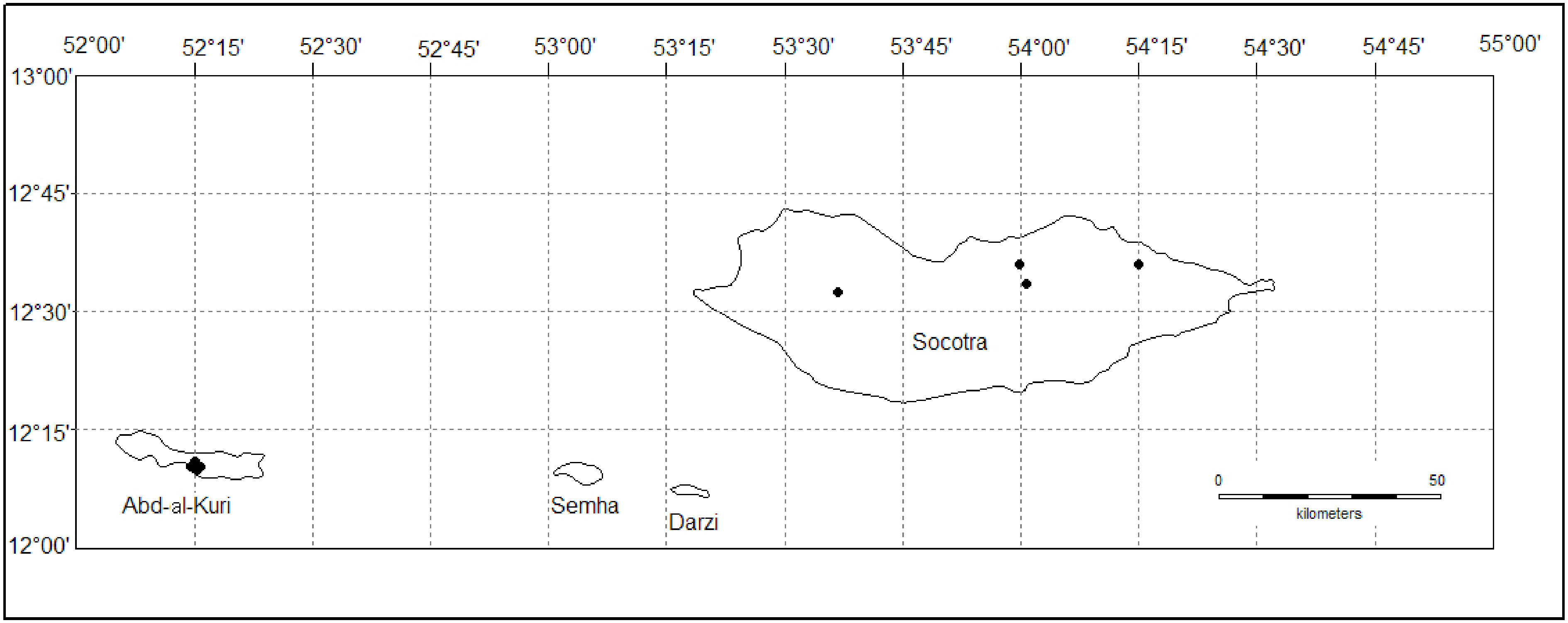


Fig. 4.3.16.2. Known distribution of *Cryptolepis macrophylla*.

Leaf micromorphology

Cells on the adaxial epidermal surface are isodiametric and tetra- to hexagonal. Periclinal walls are tabular to slightly convex while anticlinal wall boundaries are straight to slightly curved and slightly sunken. The cuticle is heavily striated, these densely packed, parallel or randomly orientated and continuous over intercellular boundaries (Fig. 4.3.16.3. A–C). A sparse and irregular covering of wax platelets may be observed (Fig. 4.3.16.3. C).

Cells on the abaxial epidermal surface are tetra- to hexagonal. Periclinal walls are tabular to slightly convex while anticlinal wall boundaries are slightly sunken. The cuticle is folded, partly obscuring cell shape. Cuticular striations are obscured by the dense covering of wax platelets. (Fig. 4.3.16.3. D–F)

Leaves are amphistomatic. Stomata on the adaxial surface are level with other epidermal cells to slightly sunken (Fig. 4.3.16.3. A–B). Subsidiary cells are covered by a slightly striated cuticle, with striations parallel or perpendicular to the stomatal pore (Fig. 4.3.16.3. C). Abaxially stomata are slightly more numerous and slightly sunken below the epidermal surface (Fig. 4.3.16.3. D–E). Subsidiary cells are densely covered by wax platelets (Fig. 4.3.16.3. F). All stomata have narrowly elliptic guard cells and narrow stomatal ledges (Fig. 4.3.16.3. C, F).

Seed micromorphology

The upper seed surface is rough with cells clustered into longitudinal ridges (Fig. 4.3.16.4. A). Cells forming ridges are contorted with no clearly distinguishable cell shape (Fig. 4.3.16.4. B). The cells are isodiametric and rounded to slightly elongated. Periclinal walls are convex and anticlinal walls are straight to curved and deeply sunken. The cuticle is densely striated with striations wavy and randomly orientated, not crossing intercellular boundaries (Fig. 4.3.16.4. C).

The lower seed surface is warty with a narrow central ridge and seed margins are thickened (Fig. 4.3.16.4. D). Cell shape on the warts is indistinct (Fig. 4.3.16.4. E). In between warts cells are isodiametric and tetra- to pentagonal. Cells near the margin have convex periclinal walls, while cells near the central ridge have concave periclinal walls. The cuticle is smooth (Fig. 4.3.16.4. F).

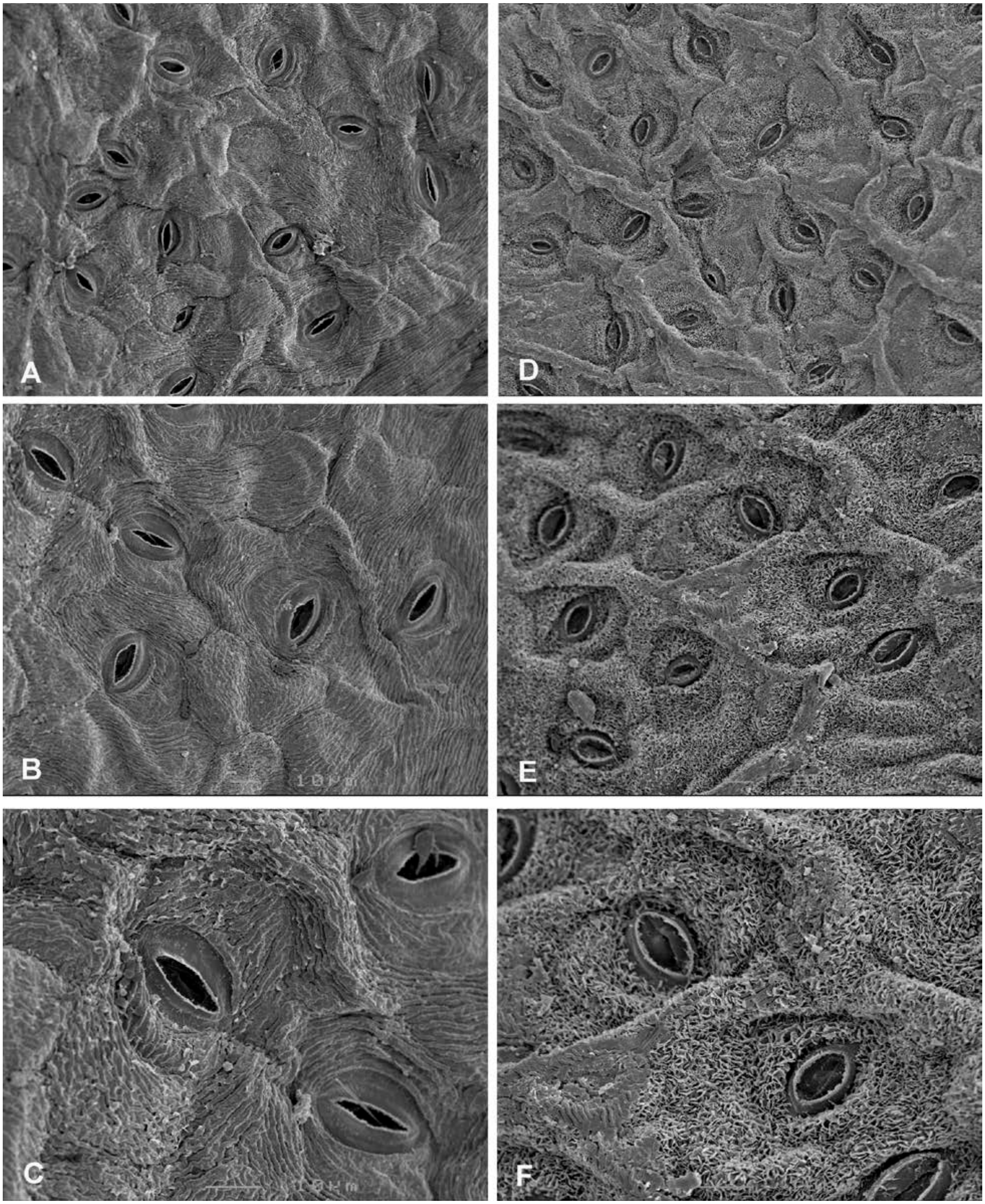


Fig. 4.3.16.3. *Cryptolepis macrophylla* leaf epidermal surfaces: (A–B) adaxial epidermal cells with tabular periclinal walls and stomata, (C) adaxial epidermal cells with tabular periclinal walls, slightly striated cuticle and stomata, (D–E) abaxial epidermis with cuticular folds, stomata and wax platelets, (F) abaxial epidermis with stomata and dense covering of wax platelets. Magnification: A, D = x400; B, E = x650; C, F = x1200. Specimen: (A–F) *Vurzo 27* (K).

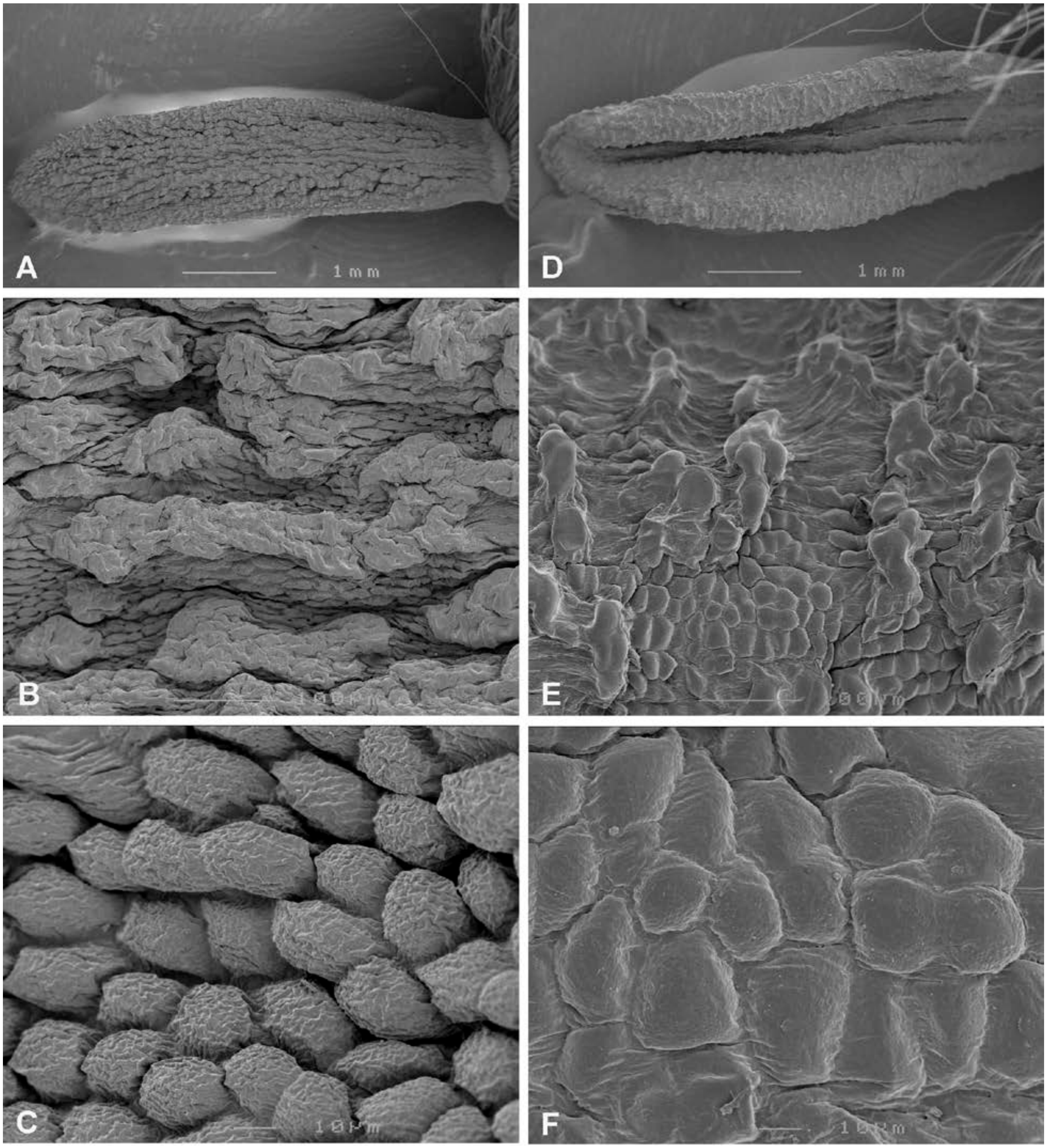


Fig. 4.3.16.4 *Cryptolepis macrophylla* seed surfaces: (A) adaxial view of seed, (B) adaxial seed surface with longitudinal ridges, (C) cells isodiametric with convex periclinal walls, deeply sunken anticlinal walls and striated cuticle, (D) abaxial view of seed, (E) abaxial seed surface with warts, (F) cells isodiametric with convex periclinal walls, deeply sunken anticlinal walls and smooth cuticle. Magnification: A, D = x20; B, E = x220; C, F = x900. Specimen: (A–F) *Smith & Lavranos 675* (K).

4.3.17 ***Cryptolepis microphylla*** Baill., Bulletin Mensuel de la Societé Linnnéenne de Paris 2: 804 (84 by error) (1889); Hiern: 676 (1898); N.E.Br.: 245 (1902).
Type: Angola, Golungo Alto, Queta Mountains, *Welwitsch 5940* (P, holo. missing; BM!, lecto. here designated; G!, K!, LISU-scan!, iso.).

= ***C. laurentii*** De Wild., Bulletin du Jardin Botanique de L'état Bruxelles 7: 26 (1920).
Type: Zaire [Democratic Republic of the Congo], Kwamouth, *Laurent, E. & Laurent, M. 1032* (BR!, holo.).[Note 1]

A slender climber with white latex. *Stems* woody, slender, twining, up to 3 mm diameter; young stems light reddish brown, smooth, glabrous to slightly puberulent; older stems brown, slightly verrucose, glabrous, bark peeling; interpetiolar ridges inconspicuous or absent, colleters inconspicuous. *Leaves* opposite, axils slightly villous, petiolate; petiole green, glabrous to slightly puberulous, slightly grooved, 2–3 mm long; blade oblong-lanceolate to lanceolate, 30–52 x 13–16(–22) mm, herbaceous, dark green, glabrous to sparsely puberulent adaxially, pale green, glaucous, papillate abaxially; margin plane to undulate; apex attenuate to acuminate, glabrous to slightly puberulent, not recurved; base rounded to truncate; venation brochidodromous, 6–7 secondary veins on either side of main vein, intersecondary venation absent, tertiary venation weakly percurrent, areole development lacking, veinlets absent. *Inflorescences* cymose, lax, few-flowered, slender, each cyme consists of 1–2 monochasia, or 1 dichasium ending in 1–2 monochasia, primary peduncle 10–15 mm long, secondary peduncles 5–18 mm long, pedicels 13–14 mm long; bracts opposite, sparsely arranged, glabrous, triangular, 0.5–0.8 mm long, margins fimbriate. *Buds* slender, 8–14 mm long, oblong, apices attenuate, full turn helically twisted. *Sepals* pale green, triangular to broadly ovate, 0.7–1 x 0.7–0.9 mm, acute, glabrous, margins slightly fimbriate, colleters conical. *Corolla* white to yellow, 13–18 mm long; tube campanulate, 3(–4) mm long, glabrous outside and inside; lobes spreading, linear, 10–14 x 1 mm, apices acute. *Corona* single; primary corona inserted ± 2 mm from corolla tube base, included, lobes inconspicuous, sub-clavate, fleshy, ± 0.2 mm long, glabrous, apices round to acute to obtuse, connivent over gynostegium, spongy coronal feet prominent, extending to staminal insertion point. *Stamens* inserted 0.8–1 mm from corolla tube base; anthers hastate, attenuate, villous, 0.7–1 mm long, filaments ± 0.2 mm long. *Nectaries* prominent, inserted 0.8–1 mm from corolla tube base. *Ovaries* ± 0.5 mm x 0.8 mm; style ± 0.2 mm long, style-head broadly pyramidal, acute, ± 0.4 x 0.4 mm. *Translators* narrowly elliptic, ± 0.3 mm long, apices obtuse. *Follicles* pendulous, narrowly divaricate at 20°–80°, narrowly cylindrical, 70–90 x 4 mm, dark brown, apices attenuate, recurved, bases cuneate. *Seeds* unknown. (Fig. 4.3.17.1.)

Diagnostic characteristics

Cryptolepis microphylla is a slender climber. Leaves are oblong-lanceolate to lanceolate, with attenuate to acuminate apices, medium sized to large, 30–52 x 13–22 mm and herbaceous. This species is vegetatively very similar to *C. eburnea* and *C. villosa,* with all three species possessing similar growth form, leaf shape and globular micromicropapillae on the abaxial leaf surface. *Cryptolepis microphylla* is distinguished from *C. eburnea* by its oblong buds with attenuate apices and glabrous corolla tubes, which are shorter than the corolla lobes, as opposed to dumb-bell shaped buds, salver-shaped corollas, with corolla tubes longer than the corolla lobes and puberulent outer corolla surfaces in *C. eburnea. Cryptolepis microphylla* is distinguished from *C. villosa* by its glabrous to sparsely puberulent adaxial leaf surfaces, triangular bracts, shorter than 1 mm and triangular to broadly ovate sepals, less than 1 mm long, as opposed to villose adaxial and abaxial leaf surfaces, acicular bracts, longer than 2.5 mm and narrowly lanceolate sepals, ± 4 mm long in *C. villosa*.

Distribution and habitat

Cryptolepis microphylla is found in Angola and the Democratic Republic of the Congo (Fig. 4.3.17.2.). It grows in riverine thicket at altitudes around 650 m. Associated species include a *Brachylaena* sp. and *Pteleopsis* sp. Flowering occurs from November to February.

Note

1. The *C. laurentii* type folder at BR contains three specimens. One is marked with the collector's number 1032, identifying it as the holotype. The other two specimens do not have any collector's data, but may be from the same collection as the first specimen. However, without a collector's name and number or date it is impossible to verify the isotype status of the latter two specimens.

Representative specimens

— **4º23' N, 18º37' E:** Central African Republic, Baangui, 08-12-1967, *Breyne 1327* (BR).

— **4º24'09'' S, 15º18'35'' E:** Democratic Republic of the Congo, Kinshasha, Lovanium, Lovanium University, 14-12-1967, *Pauwels, L. 5087* (WAG (x2)).

— **4º47' S, 13º07' E:** Democratic Republic of the Congo, Kiobo, 09-02-1940, *Donis, C. 178* (BR).

— **9º02' S, 15º03' E:** Angola, Golungo Alto, Queta Mountains, 1856, *Welwitsch 5939* (BM, K, LISU).

— **14º55' S, 14º39' E:** Angola, Huila District, Humpata, Das Neves., *Teixeira, B. 342* (BM).

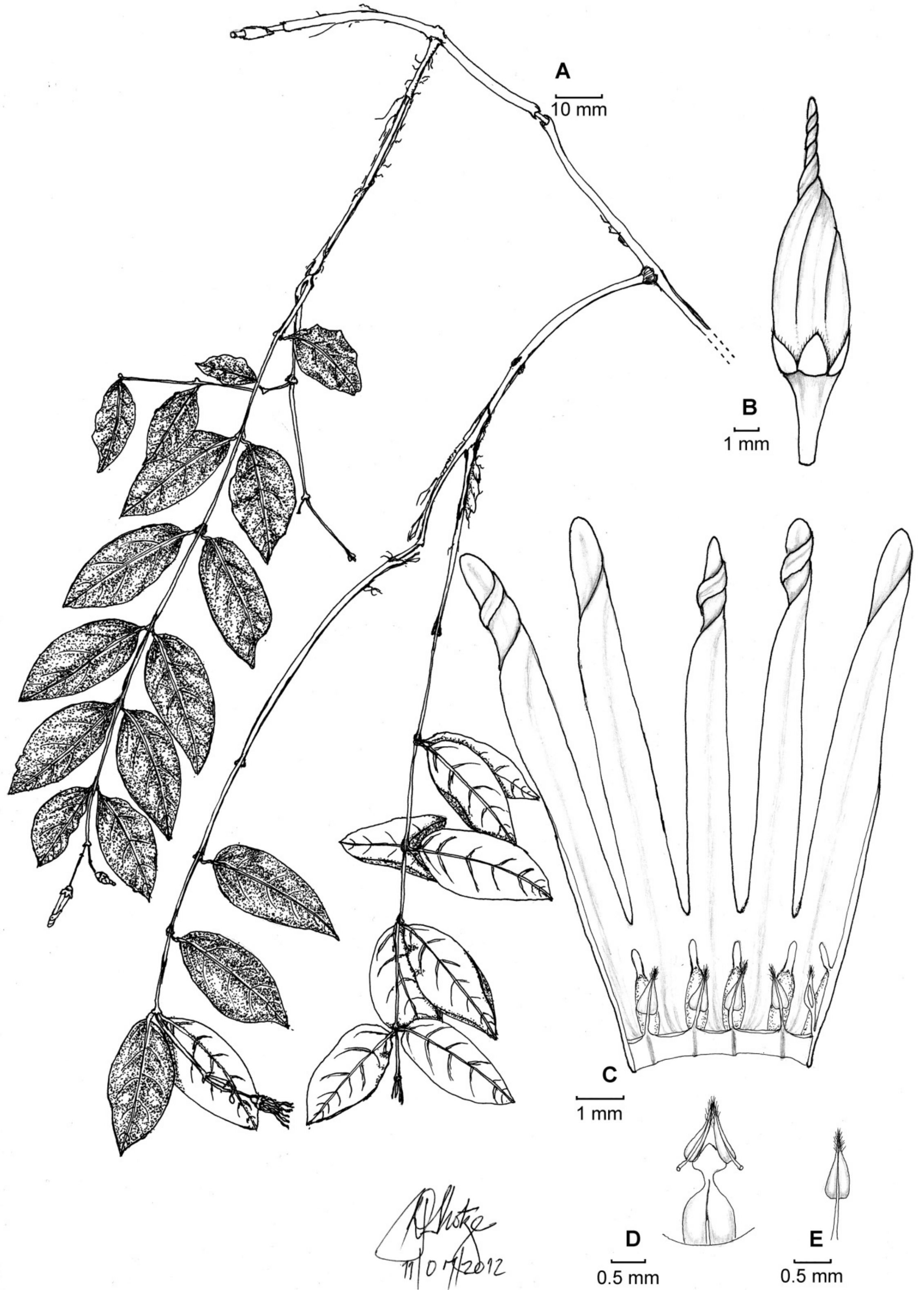


Fig. 4.3.17.1. Illustration of *Cryptolepis microphylla*: (A) stem with leaves and inflorescences, (B) external view of bud, (C) corolla opened showing helically twisted corolla lobes, sub-clavate primary corona lobes, stamens with narrowly hastate anthers and prominent nectaries, (D) pistil of semi-inferior apocarpous ovaries, style, with anthers connivent over style-head, (E) stamen with narrowly hastate anther and villous anther apex. Specimens: (A) *Welwitsch 5939* (BM); (B–E) *Popeguin 173* (P).

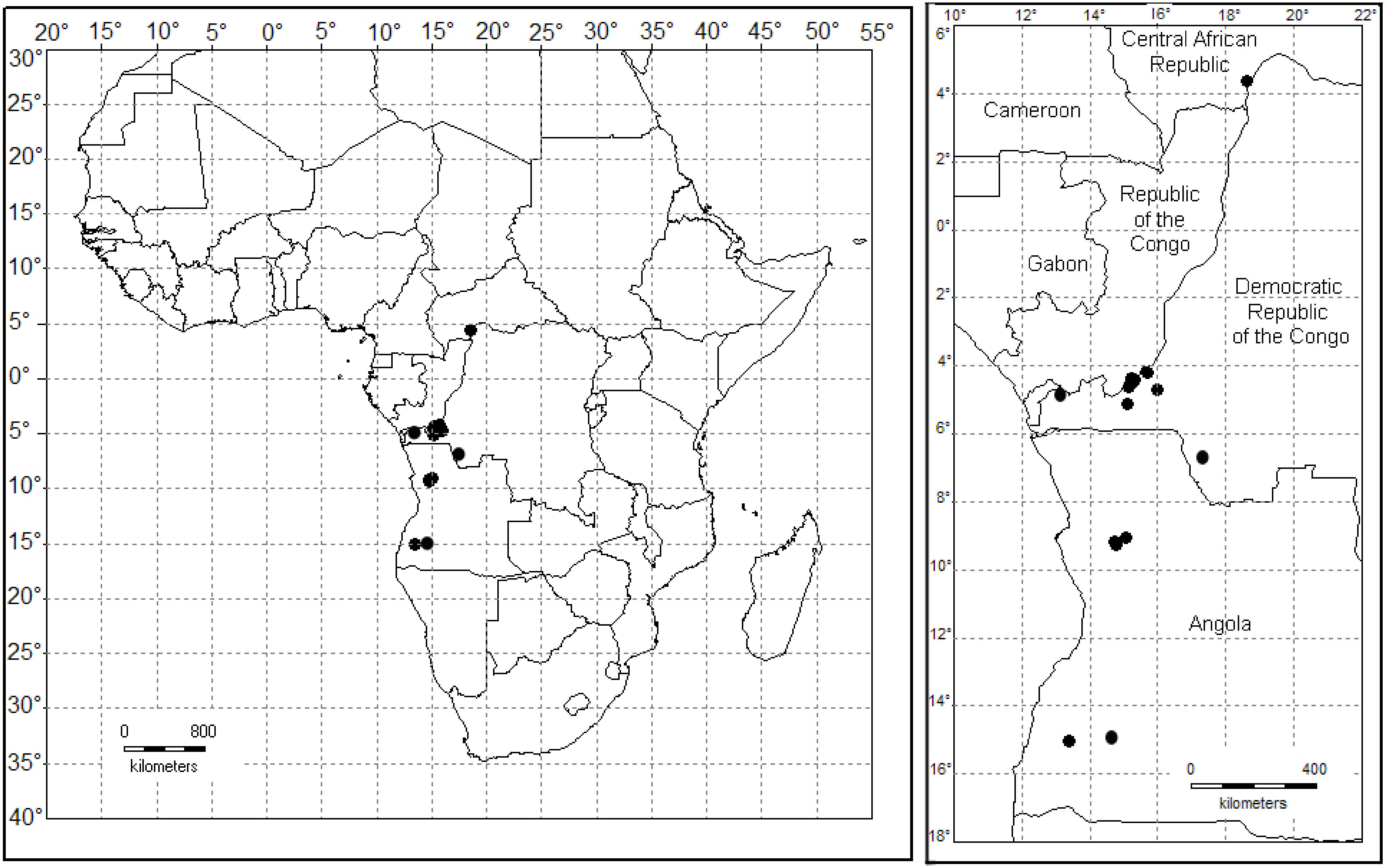


Fig. 4.3.17.2. Known distribution of *Cryptolepis microphylla*.

Leaf micromorphology

Cells on the adaxial surface are more or less isodiametric and tetra- to hexagonal. The periclinal walls are tabular while the anticlinal wall boundaries are straight to slightly curved and level with the epidermal surface (Fig. 4.3.17.3. A–C). The cuticle is slightly striated with straight, parallel striations which are continuous over intercellular boundaries (Fig. 4.3.17.3. A, C). Short, simple, unicellular, trichomes are occasionally present on the adaxial epidermis and then cuticular striations radiate from the trichome bases (Fig. 4.3.17.3. B).

The abaxial epidermal surface is densely covered by globular, striate micropapillae, connected by radiating ridges. The periclinal wall of each epidermal cell protrudes to form a single papilla while cell shape and anticlinal cell walls are not visible. The cuticle between micropapillae is slightly striated, with striations wavy, randomly orientated and continuous over intercellular boundaries (Fig. 4.3.17.3. D–F). Short, simple, unicellular, trichomes are occasionally present on the adaxial epidermis (Fig. 4.3.17.3. E)

The leaves are hypostomatic with numerous stomata level with other epidermal cells and randomly orientated. Subsidiary cells are often papillate or heavily striated with striations randomly orientated. The guard cells are elliptic with a broad stomatal ledge. (Fig. 4.3.17.3. D–F)

Seed micromorphology

Seeds unknown.

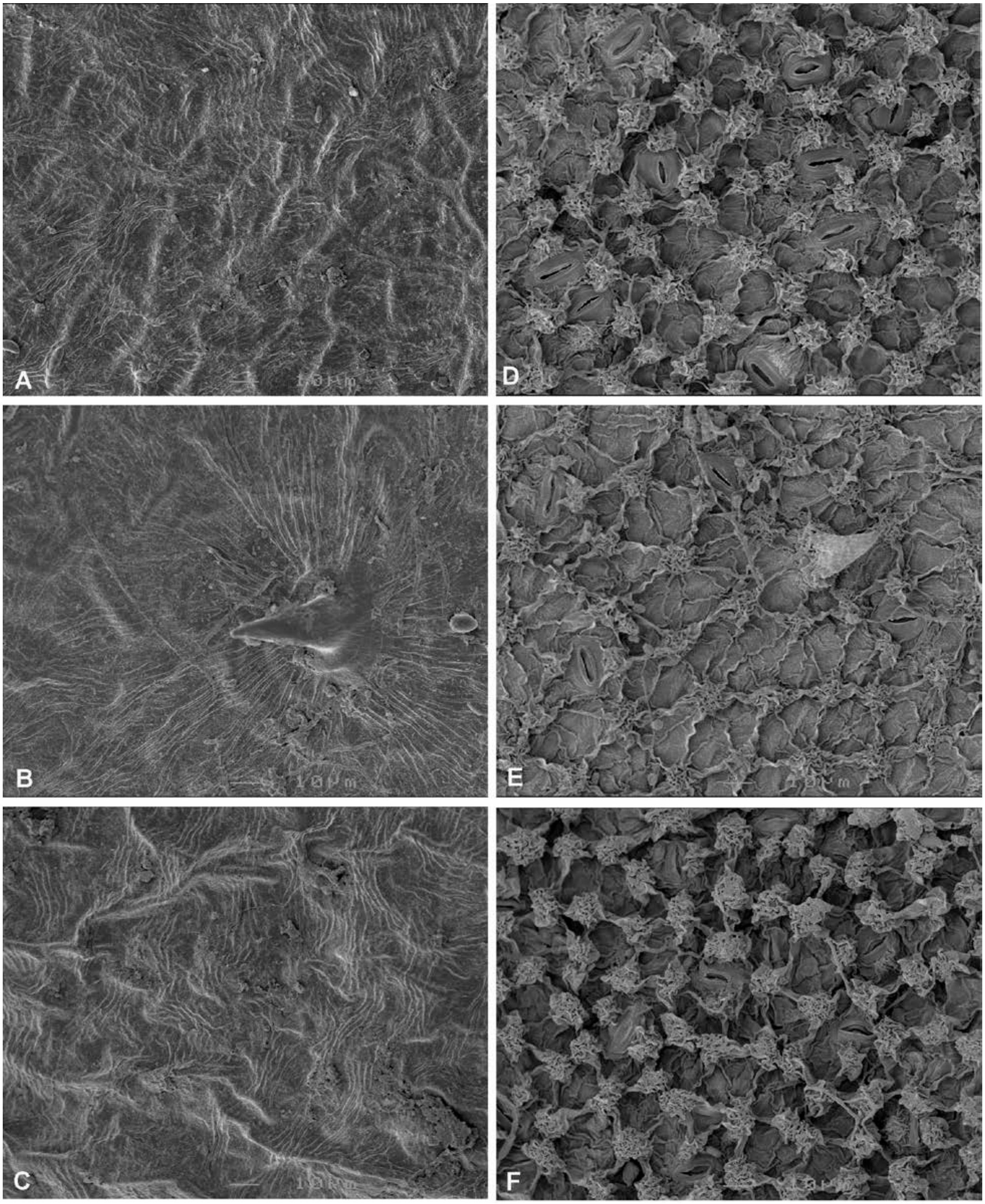


Fig. 4.3.17.3. *Cryptolepis microphylla* leaf epidermal surfaces: (A, C) adaxial epidermal cells with tabular periclinal walls and slightly striated cuticle, (B) adaxial epidermal cells with tabular periclinal walls, slightly striated cuticle and trichome, (D, F) abaxial epidermis globular striate micropapillae and stomata, (E) abaxial epidermis globular, striate micropapillae, stomata and trichome. Magnification: A–F = x650. Specimens: (A, D) *Donis 178* (BR); (B, E) *Welwitsch 5940* (BM); (C, F) *Pauwels 5087* (WAG).

4.3.18 *Cryptolepis migiurtina* Chiov., Flora Somala 2: 217, t. 23, f. 4 (1929); Venter: 136 (2006).
Type: Somalia, Costa du Migiurtini, Tabantòh, *Puccioni, N. & Stefanini, G. 1043* (FT-scan!, holo.).

= *Curroria migiurtina* (Chiov.) Bullock, Kew Bulletin 9: 361 (1954).
Type: Homotypic synonym.

A multi-stemmed shrub, with white latex, up to 3 m high; on one specimen noted as a scrambler. *Stems* woody, slender, stem diameter unknown, nodes tumid, creating a knobbly appearance where internodes are short; young stems reddish-brown, smooth to slightly verrucose, glabrous; older stems grey, smooth to slightly verrucose, brachyblasts often present; interpetiolar ridges puberulous, inconspicuous on older branches, conspicuous on brachyblasts; colleters inconspicuous. *Leaves* opposite, axils villous, petiolate; petiole green, glabrous, slightly grooved, 1–3 mm long; blade obovate to narrowly obovate, 10–30 x 4–18 mm, coriaceous, pale green, glabrous on both surfaces; margin plane; apex obtuse, rarely retuse, mucronate, glabrous to slightly puberulous, not recurved; base cuneate; venation brochidodromous to eucamptodromous, 4–5 secondary veins on either side of main vein, indistinct, higher order venation indistinct, tertiary veins random reticulate, areole development incomplete, veinlets branched. *Inflorescences* cymose, semi-compact, few-flowered, each cyme consists of 1 dichasium, occasionally ending in 1–3 monochasia, primary peduncle 5–10 mm long, secondary peduncles, when present, 1–2 mm long, pedicels 6–7 mm long; bracts opposite, sparsely arranged, glabrous, acicular, 1.5–2 x 0.2 mm long, apices mucronate, slightly villous. *Buds* slender, 7–8 mm long, narrowly ovoid, apices cuspidate, full turn helically twisted. *Sepals* dark green, narrowly lanceolate, 2–3 x 0.8 mm, acute, glabrous, colleters conical to ovate with dentate apices. *Corolla* white to cream, 8.2–12 mm long; tube campanulate, 1.2–2 mm long, glabrous outside and inside; lobes spreading, linear, 7–10 x 0.8–1 mm, apices acute. *Corona* single; primary corona inserted 0.8–1.5 mm from corolla tube base, included, lobes clavate to subulate with broad base, fleshy, 0.5–1 mm long, glabrous, apices acute, connivent over gynostegium. *Stamens* inserted ± 0.7–0.8 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 0.6–0.7 mm long, semi-sessile to filaments ± 0.2 mm long. *Nectaries* inconspicuous, inserted ± 0.5 mm from corolla tube base. *Ovaries* ± 0.3–0.4 x 0.7–0.8 mm; style ± 0.2 mm long, style-head broadly pyramidal, acute, ± 0.4–0.5 x 0.5–

0.7 mm. *Translators* narrowly elliptic, ± 0.3 mm long, apices acute. *Follicles* erect, widely divaricate at 170°–180°, narrowly ovoid, 36–90 x 4–9 mm, brown, apices attenuate, bases cuneate. *Seeds* narrowly oblong, 5–7 x 1.5–2 mm, dark brown, slightly warty; coma yellowish-white, 20–30 mm long. (Fig. 4.3.18.1.)

Diagnostic characteristics

Cryptolepis migiurtina is a multi-stemmed shrub, with erect stems and tumid nodes. The leaves are obovate to narrowly obovate, small to medium-sized, 10–30 x 4–18 mm, coriaceous and glabrous with obtuse to retuse, mucronate apices. *Cryptolepis migiurtina* is distinguished from *C. arbuscula*, by having light green leaves, flowers arranged in semi-compact, few-flowered inflorescences and clavate to subulate corona lobes. By contrast, *C. arbuscula* has leaves with dark green puberulent adaxial surfaces and pale green abaxial surfaces, solitary flowers and filiform primary corona lobes. *Cryptolepis migiurtina* is distinguished from other species with similar growth form, such as *C. macrophylla* and *C. socotrana*, based on leaf shape and size, these species having broadly elliptic to orbicular leaves, larger than 35 x 21 mm.

Distribution and habitat

Cryptolepis migiurtina is endemic to Somalia (Fig. 4.3.18.2.). It grows on rocky slopes in valleys and in shallow soil on plains, always associated with limestone at altitudes from 60–900 m. *Cryptolepis migiurtina* is a component of mixed scrub or open bushland and is associated with a large variety of species, including: *Acacia ankokib* Chiov., *A. sarcophylla* Chiov., *Acacia* sp. aff. *reficiens* Wawra & Peyr., *Aloe* sp., *Andropogon kelleri* Hack. ex Schinz, *Balanites* sp., *Boscia minimifolia* Chiov., *Blepharispermum fruticosum* Klatt, *Bossellia* sp., *Caesalpinia erianthera* Chiov., *Commiphora* sp., *Cenchrus* sp., *Cymbopogon schoenanthus* Spreng., *Dactyloctenium scindicum* Boiss., *Dracaena schizantha* Baker, *Erythrina* sp., *Grewia villosa* Willd., *Heliotropium* sp., *Inigofera* sp., *Jatropha* sp., *Kelleronia sp., Ruellia* sp., *Sterculia* sp. and *Tephrosia* sp. Flowering occurs from May to early November, with a peak in May.

Vernacular name

Warsengeleh: Geysa raid (Bullock, 1954).

Representative specimens

— 7º54' N, 49º37' E: Nugaal Region, Dhanaane District, 33 km on track from Dhanaane to Eyl, 11-05-2001, *Thulin, M., Dahir, A., Khalid, A. & Osman, A. 10534* (K, UPS).

— 8º01' N, 49º48' E: Nugaal Region, Eyl District, 5 km N of Eil [Eyl], 25-11-1986, *Lavranos* & *Carter 24945* (K).

— 8º56' N, 50º09' E: Bari Region, upper part of Togga Qundheed [River], 19-05-2001, *Thulin, M., Dahir, A., Khalid, A. & Osman, A. 10658* (K, UPS).

— 10º50' N, 49º27' E: Bari Region, Tisjiic, near the upper village, 02-01-2000, *Thulin, M., Dahir, A. & Osman, A. 10099* (K, UPS).

— 11º02' N, 48º55' E: Sanaag Region, Einad District, 18-11-1929, *Collenette, C.N. 316* (K).

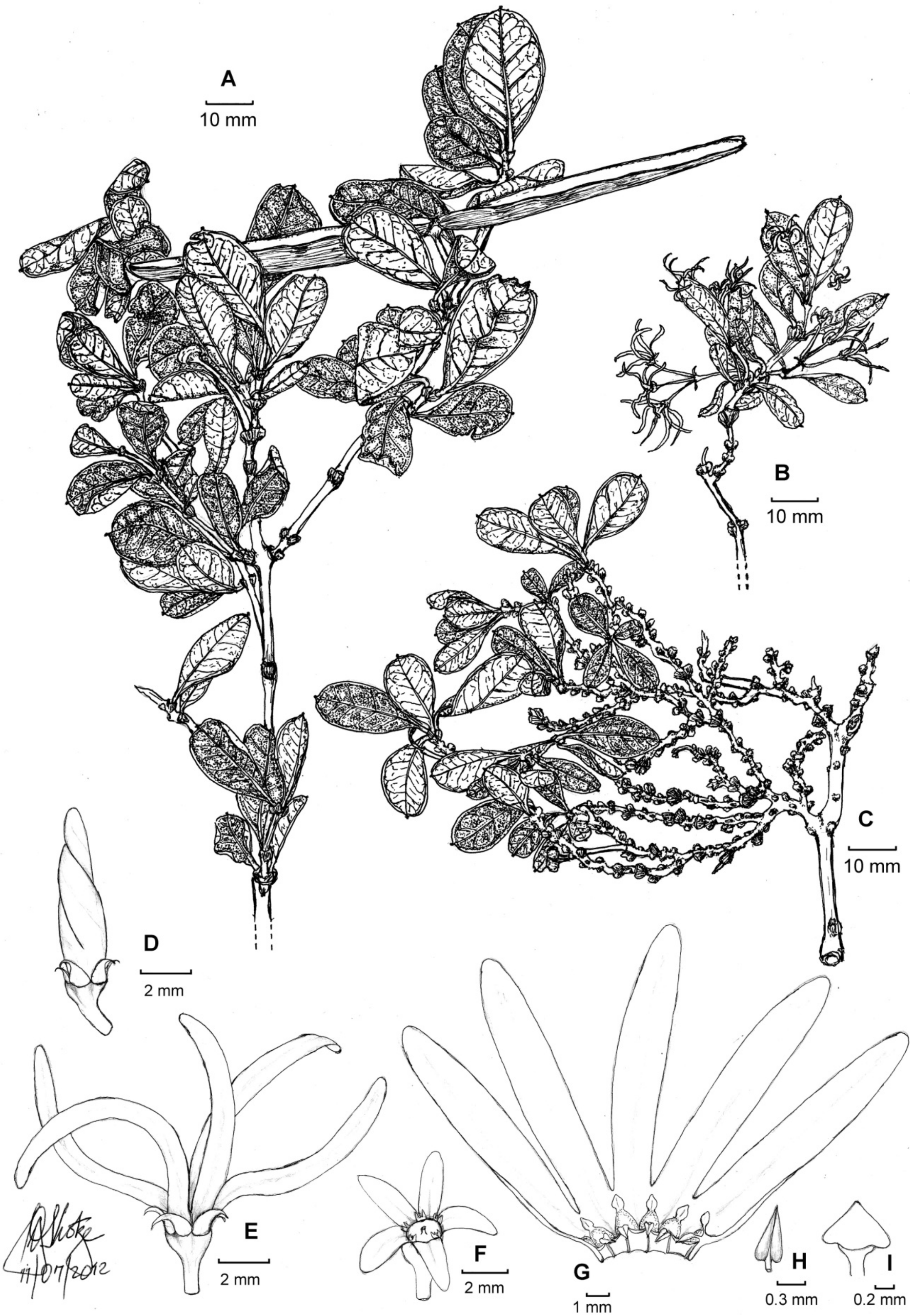


Fig. 4.3.18.1. Illustration of *Cryptolepis migiurtina*: (A) stem with leaves and paired follicles, (B) stem with inflorescences, (C) stem with leaves and tumid nodes, (D) external view of bud, (E) external view of mature flower, (F) calyx opened, showing ovate colleters with dentate apices, (G) corolla opened showing clavate corona lobes, stamens with narrowly hastate anthers and nectaries, (H) stamen with glabrous, narrowly hastate anther, (I) style and style-head. Specimens: (A, C) *Thulin et al. 10099* (UPS); (B, H–I) *Thulin et al. 10658* (UPS); (D–E) *Lavranos & Carter 24945* (K); (F–G) *Thulin et al. 10534* (UPS).

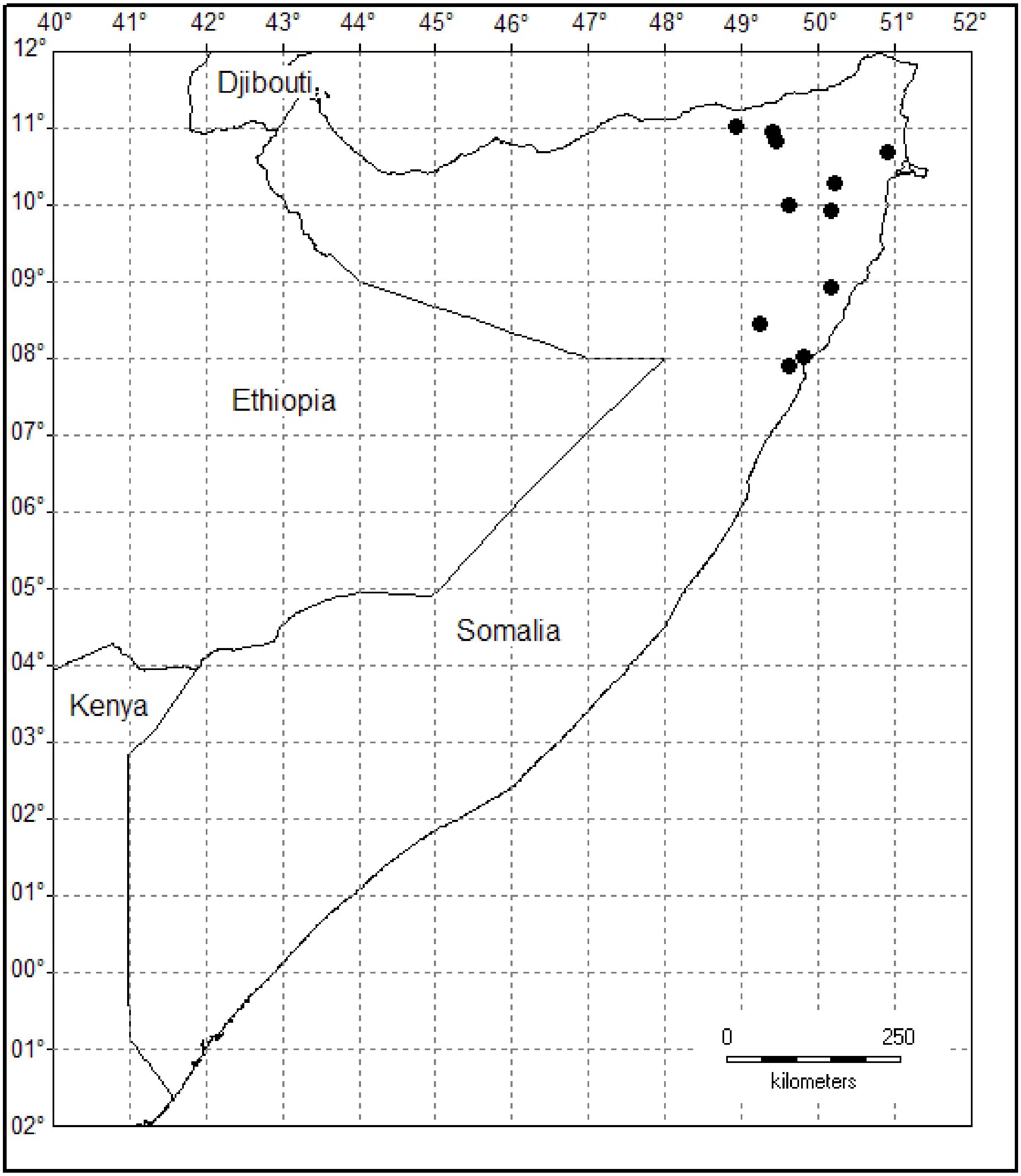


Fig. 4.3.18.2. Known distribution of *Cryptolepis migiurtina*.

Leaf micromorphology

Cells on the adaxial epidermal surface are isodiametric and penta- to hexagonal. Periclinal walls are tabular (Fig. 4.3.18.3. A, C) to slightly convex (Fig. 4.3.18.3. B) while anticlinal walls are straight and level with the epidermal surface (Fig. 4.3.18.3. A, C) or slightly sunken (Fig. 4.3.18.3. B). Cuticular patterning is variable, ranging from slightly (Fig. 4.3.18.3. B–C) to densely striated (Fig. 4.3.18.3. A). Striations may be parallel and straight (Fig. 4.3.18.3. B–C) or randomly orientated and wavy, crossing intercellular boundaries (Fig. 4.3.18.3. A). Cuticular folding may also occur (Fig. 4.3.18.3. A, C).

Cell shape on the abaxial epidermal surface is indistinguishable. The cuticle is sparsely (Fig. 4.3.18.3. E–F) to densely striated (Fig. 4.3.18.3. D), with striations randomly orientated and wavy or straight and parallel, crossing intercellular boundaries. Cuticular folding is often present (Fig. 4.3.18.3. D, F).

Leaves are amphistomatic. Stomata are more numerous on the abaxial surface than on the adaxial surface. Stomata are randomly orientated and slightly sunken. The cuticle covering the guard cells is usually striated, with striations perpendicular to the stomatal pore. Guard cells are narrowly elliptic and are covered by a broad stomatal ledge. (Fig. 4.3.18.3. A–F)

Seed micromorphology

The upper seed surface is covered by sparsely arranged protuberances that are formed by raised epidermal cells. Epidermal cells forming these protuberances show no clearly distinguishable shape (Fig. 4.3.18.4. A–B). Epidermal cells between the protuberances are more or less isodiametric and tetra- to hexagonal. Near the middle of the seed periclinal walls are concave (Fig. 4.3.18.4. C), while near the margin periclinal walls are convex to partially concave. Anticlinal walls are curved and slightly sunken. The cells are covered by a finely granular cuticle (Fig. 4.3.18.4. C).

The lower seed surface has a slightly thickened margin and a narrow, inconspicuous central ridge (Fig. 4.3.18.4. D). Between the ridge and seed margin the surface is smooth (Fig. 4.3.18.4. E). Cells are isodiametric and tetra- to hexagonal. Periclinal walls are concave while anticlinal walls are curved and slightly sunken. The cuticle has a fine, granular appearance (Fig. 4.3.18.4. F).

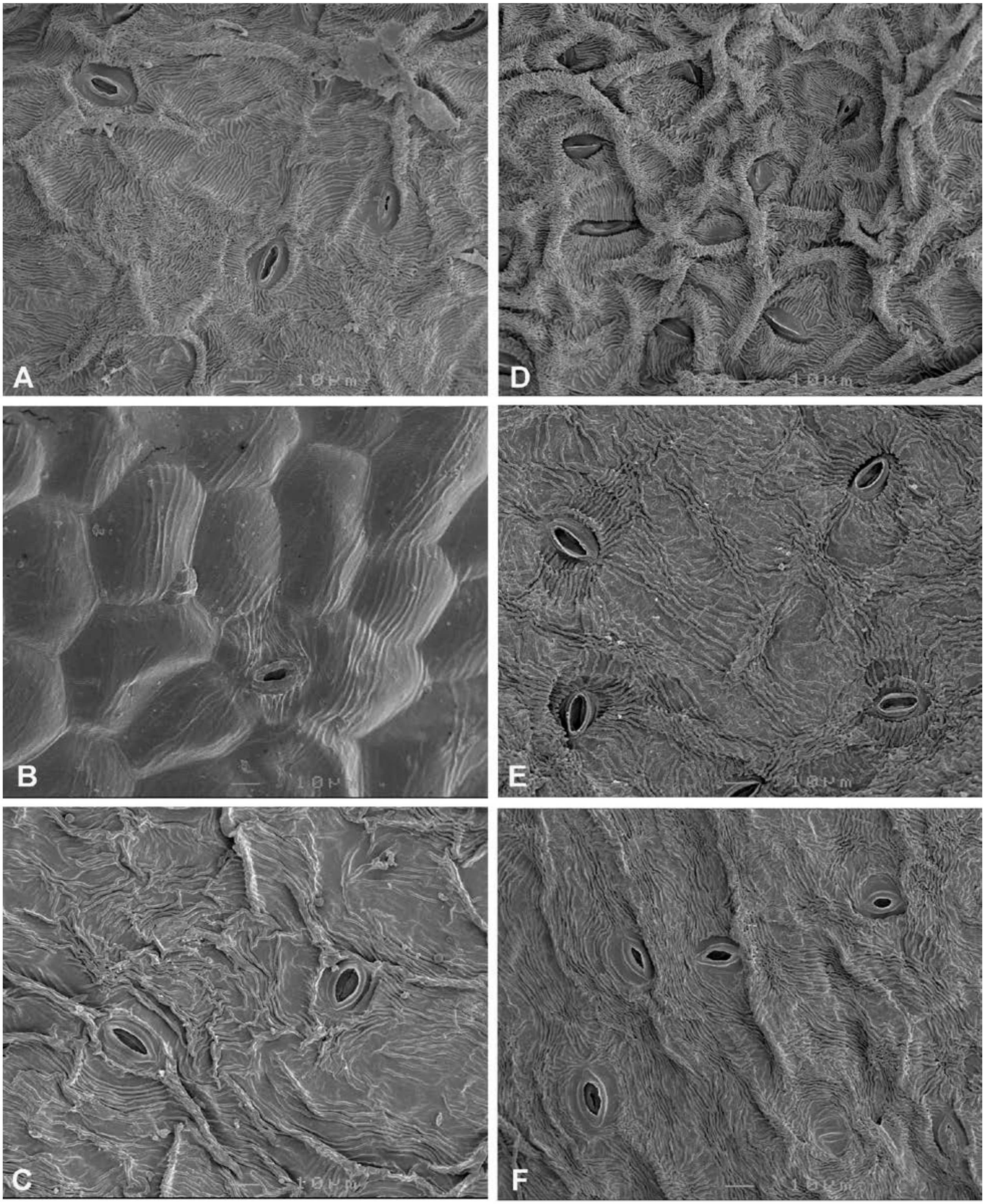


Fig. 4.3.18.3. *Cryptolepis migiurtina* leaf epidermal surfaces: (A) adaxial epidermal cells with tabular periclinal walls, striated cuticle, cuticular folds and stomata, (B) adaxial epidermal cells with slightly convex periclinal walls, slightly striated cuticle and stomata, (C) adaxial epidermal cells with tabular periclinal walls, slightly striated cuticle, cuticular folds and stomata, (D) abaxial epidermis with heavily striated cuticle, cuticular folds and stomata, (E) abaxial epidermis with slightly striated cuticle and stomata, (F) abaxial epidermis with striated cuticle, cuticular folds and stomata. Magnification: A–F = x650. Specimens: (A, D) *Collenette 198* (K); (B, E) *Collenette 316* (K); (C, F) *Lavranos & Carter 24945* (K).

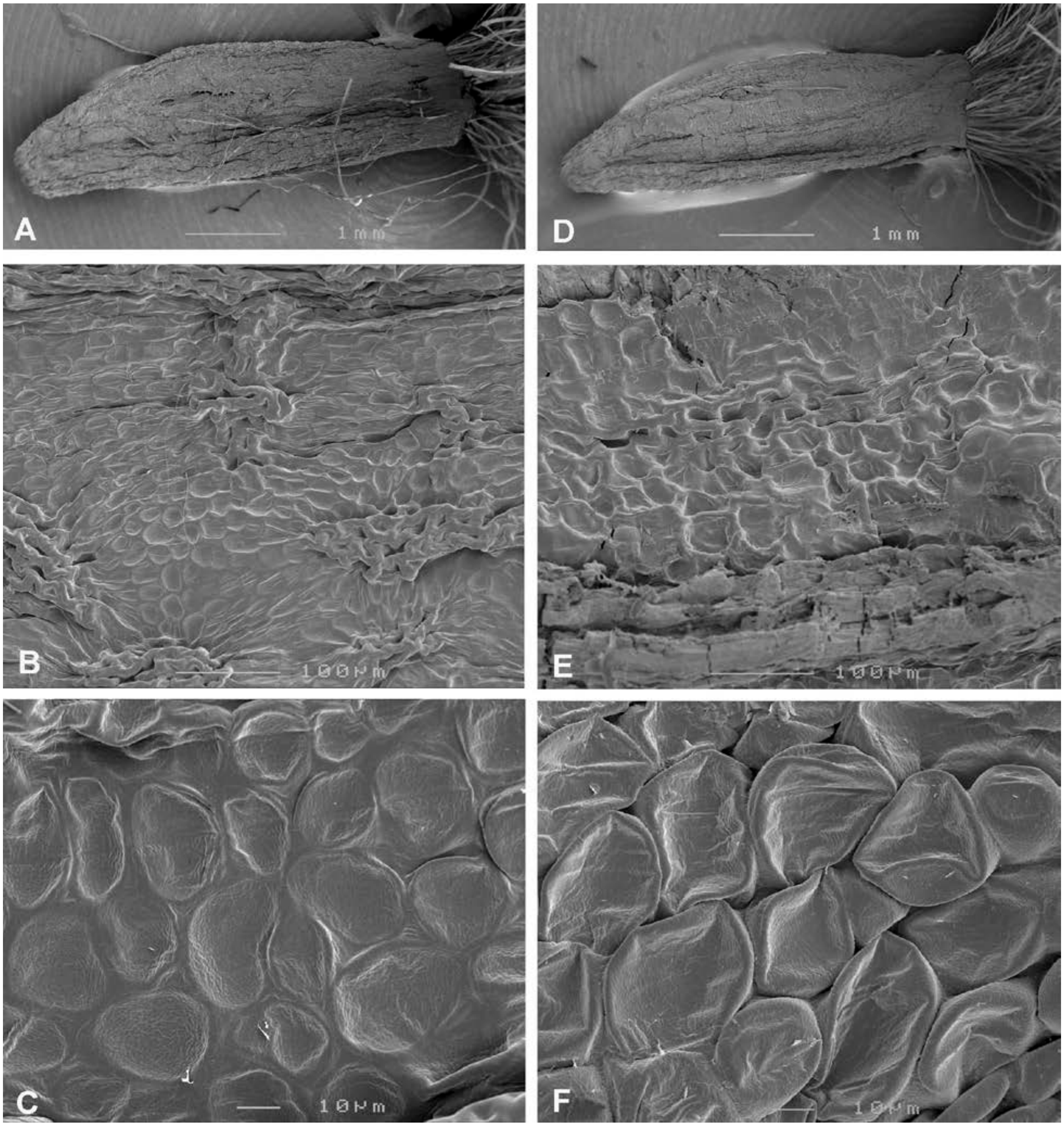


Fig. 4.3.18.4. *Cryptolepis migiurtina* seed surfaces: (A) adaxial view of seed, (B) adaxial seed surface with inconspicuous, sparsely arranged protuberances, (C) cells near middle of seed, tetra- to hexagonal with concave periclinal walls and granular cuticle, (D) abaxial view of seed, (E) seed surface between central ridge and seed margin smooth, (F) cells tetra- to hexagonal with concave periclinal walls and granular cuticle. Magnification: A, D = x20; B, E = x220; C, F = x900; E = x1800. Specimen: (A–F) *Collenette 316* (K).

4.3.19 *Cryptolepis nugaalensis* Venter & Thulin in Venter et al., South African Journal of Botany 72: 139 (2006a); Venter: 137 (2006).

Type: Somalia, Nugaal, 5 km along track from Gaalogod to Garadeen, *Thulin, Dahir, Khalid & Osman 10504* (UPS-scan!, holo.; K, iso).

An erect dwarf shrub, with white latex, up to 0.5 m high. *Stems* woody, branching, slender, stem diameter unknown, nodes tumid, lateral shoots opposite; young stems brown, smooth, glabrous; older stems dark grey, smooth to slightly verrucose, glabrous; interpetiolar ridges conspicuous, colleters present. *Leaves* opposite, axils slightly villous, sessile; blade oblong-obovate, 8–10 x 2 mm, semi-succulent, glabrous, green; margin plane; apex obtuse to retuse, mucronate, fimbriate, recurved; base cuneate; venation indistinct, main vein prominent below, higher order venation invisible. *Inflorescences* cymose, compact, few-flowered, each cyme consists of 1–2 dichasia, primary peduncle 1–2 mm long, pedicels 1–2 mm long; bracts subulate, 0.7–1 mm long, margins fimbriate. *Buds* slender, ± 9 mm, ovoid, apices apiculate, full turn helically twisted. *Sepals* narrowly triangular to narrowly ovate, 2–3 x 0.5 mm, attenuate with reddish mucros, margins glabrous, colleters ovate with dentate apices. *Corolla* pale yellow, 9–11 mm long; tube campanulate, ± 2 mm long, glabrous outside and inside; lobes spreading, linear, 7–9 x 1 mm, apices obtuse. *Corona* inserted ± 1 mm from corolla tube base, clavate, ± 1 mm long, spongy coronal feet inconspicuous. *Stamens* inserted ± 0.5 mm from corolla tube base, sub-sessile; anthers hastate, ± 1 mm long, apices apiculate, glabrous. Nectaries prominent, inserted ± 0.5 mm from corolla tube base. *Ovaries* ± 0.5 x 0.5 mm; style ± 0.5 mm long, dilating terminally; style-head broadly pyramidal, apex attenuate, ± 0.5 x 0.5 mm. *Translators* spatulate, ± 0.3 mm long, apices acute*. Follicles* unknown. *Seeds* unknown. (Fig. 4.3.19.1.)

Diagnostic characters

Cryptolepis nugaalensis is an erect dwarf-shrub. The leaves are oblong-obovate, small, 8–10 x 2 mm and semi-succulent. This species is distinguished from other species with similar growth form and semi-succulent leaves by a combination of flowers in compact, few-flowered inflorescences and clavate, not filiform, primary corona lobes. *Cryptolepis nugaalensis* is most similar to *C. somaliensis, C. stefaninii* and *C. yemenensis*, which all have flowers in inflorescences and clavate corona lobes. *Cryptolepis stefaninii* is most easily distinguished in this group, having larger leaves than the other three species, with leaf sizes 25–47 x 3–7 mm and corona lobes reddish with bilobed apices. *Cryptolepis* *nugaalensis* is distinguished from *C. somaliensis* and *C. yemenensis* by having larger flowers, corolla longer than 9 mm and corolla lobes linear, longer than 7 mm and glabrous anthers. By contrast *C. somaliensis* and *C. yemenensis* both have corollas shorter than 6 mm, corolla lobes narrowly triangular, narrowly ovate or oblong, shorter than 4 mm and *C. somaliensis* has villous anthers, while *C. yemenensis* has glabrous anthers.

Distribution and habitat

Cryptolepis nugaalensis is endemic to Somalia (Fig. 4.3.19.2.). It grows in shallow soil on arid plains, always associated with limestone at altitudes around 100 m. This species is a component of mixed scrub. The single flowering specimen was collected in May.

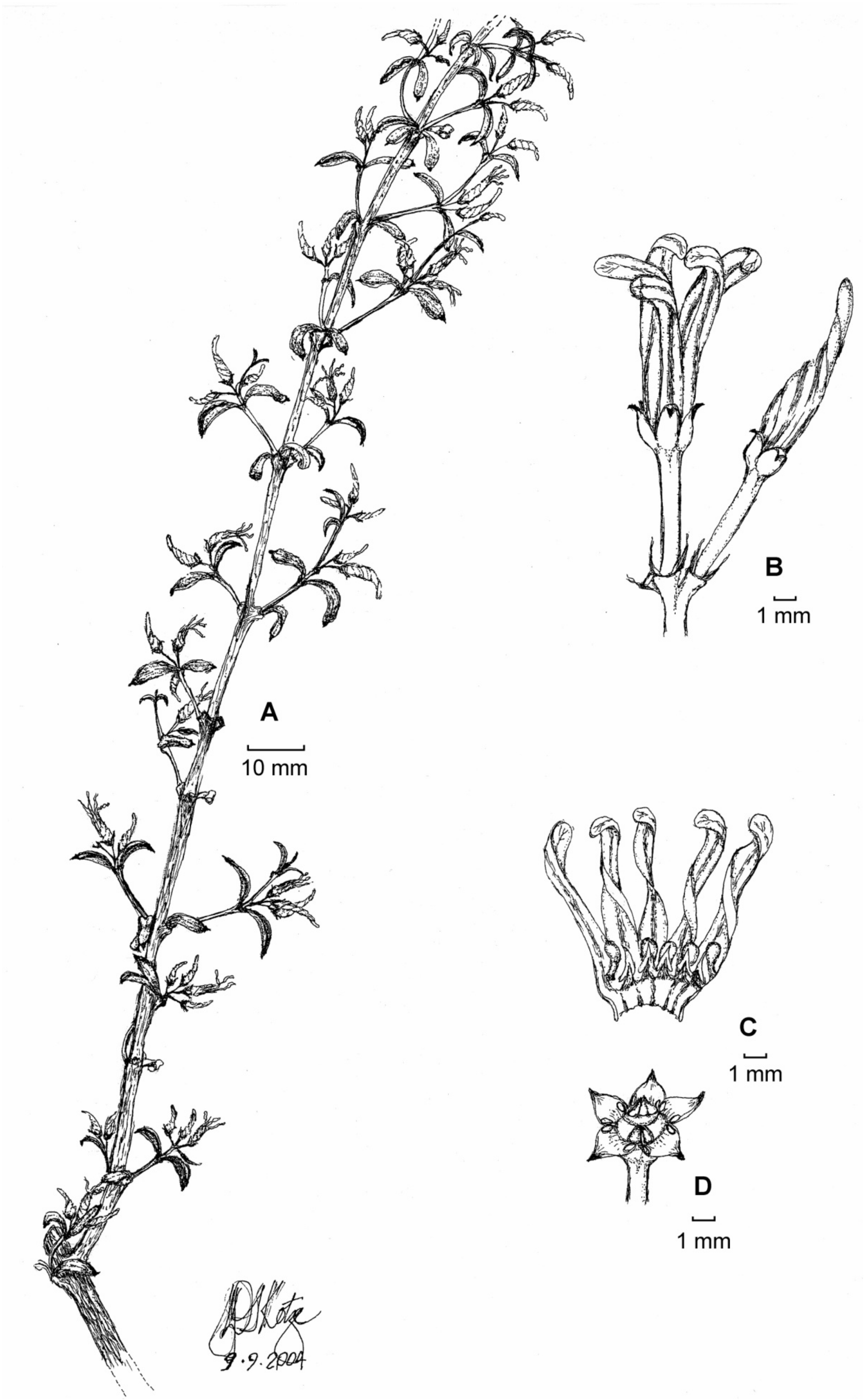


Fig. 4.3.19.1. Illustration of *Cryptolepis nugaalensis*: (A) stem with leaves and inflorescences, (B) inflorescence with mature flower and bud, (C) corolla opened showing clavate primary corona lobes and glabrous anthers, (D) calyx and pistil. Specimen: (A–D) *Thulin et al. 10504* (UPS). Reproduced with permission of South African Journal of Botany.

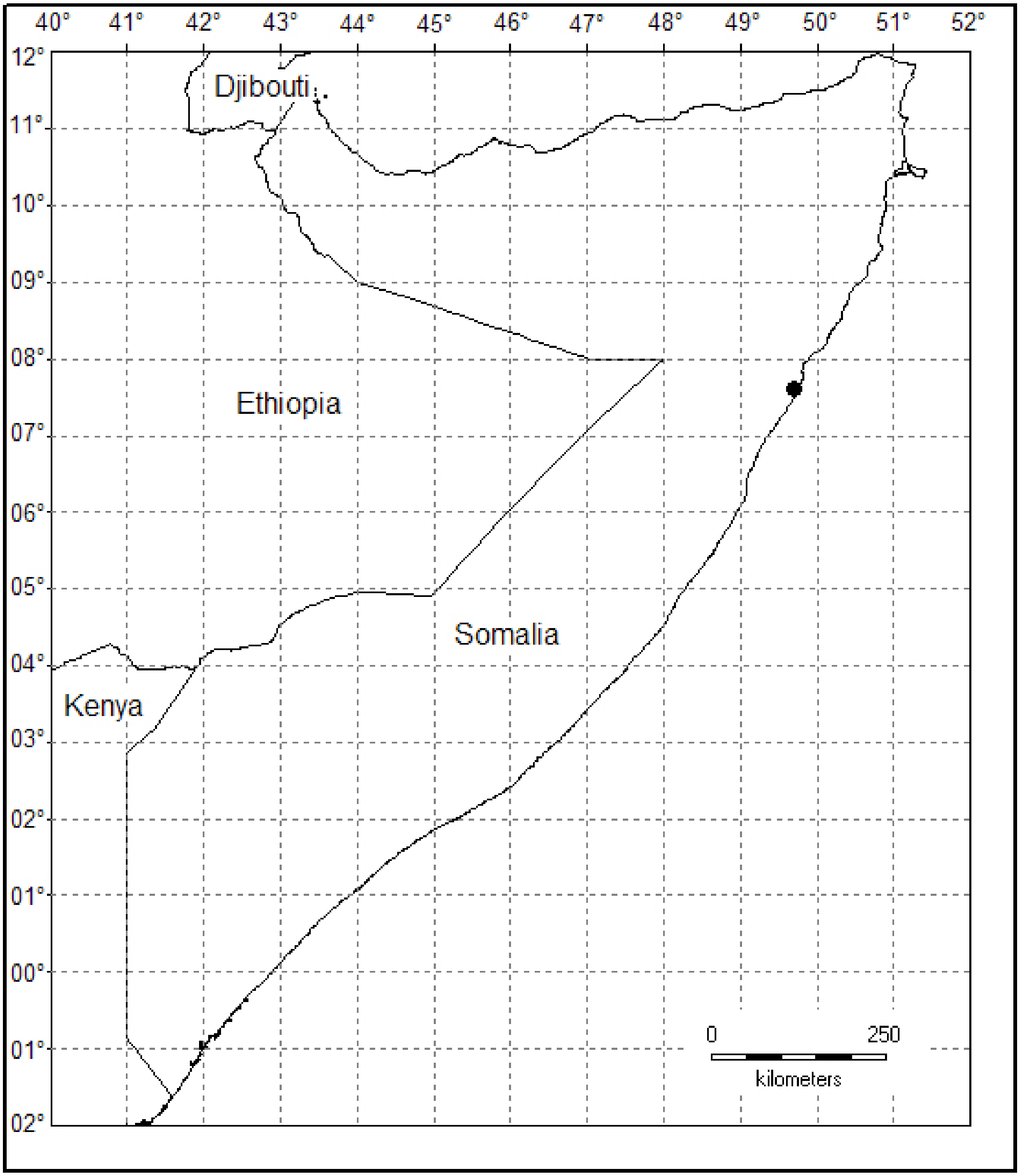


Fig. 4.3.19.2. Known distribution of *Cryptolepis nugaalensis*.

Leaf micromorphology

Cells on the adaxial surface are more or less isodiametric and tetra- to hexagonal. The periclinal walls are tabular while the anticlinal walls are wavy and slightly sunken. The cuticle is slightly striated with straight, parallel striations. Striations are usually restricted to individual cells, but occasionally cross intercellular boundaries. (Fig. 4.3.18.3. A–C)

Abaxial epidermal cells are obscured by a heavily striated cuticle. Striations are broad, wavy, randomly orientated or parallel and continuous over intercellular boundaries. (Fig. 4.3.19.3. D–F)

Leaves are amphistomatic, with stomata on the abaxial surface more numerous than on the adaxial surface (Fig. 4.3.19.3. A, D). Stomata on the adaxial surface are level with the epidermal surface (Fig. 4.3.19.3. B–C), while on the abaxial surface stomata are slightly sunken (Fig. 4.3.19.3. E–F) Stomata are paracytic with striations on the subsidiary cells parallel to the stomatal pore. Guard cells are narrowly to broadly elliptic and covered by a broad stomatal ledge (Fig. 4.3.19.3. C, F).

Seed micromorphology

Seeds unknown.

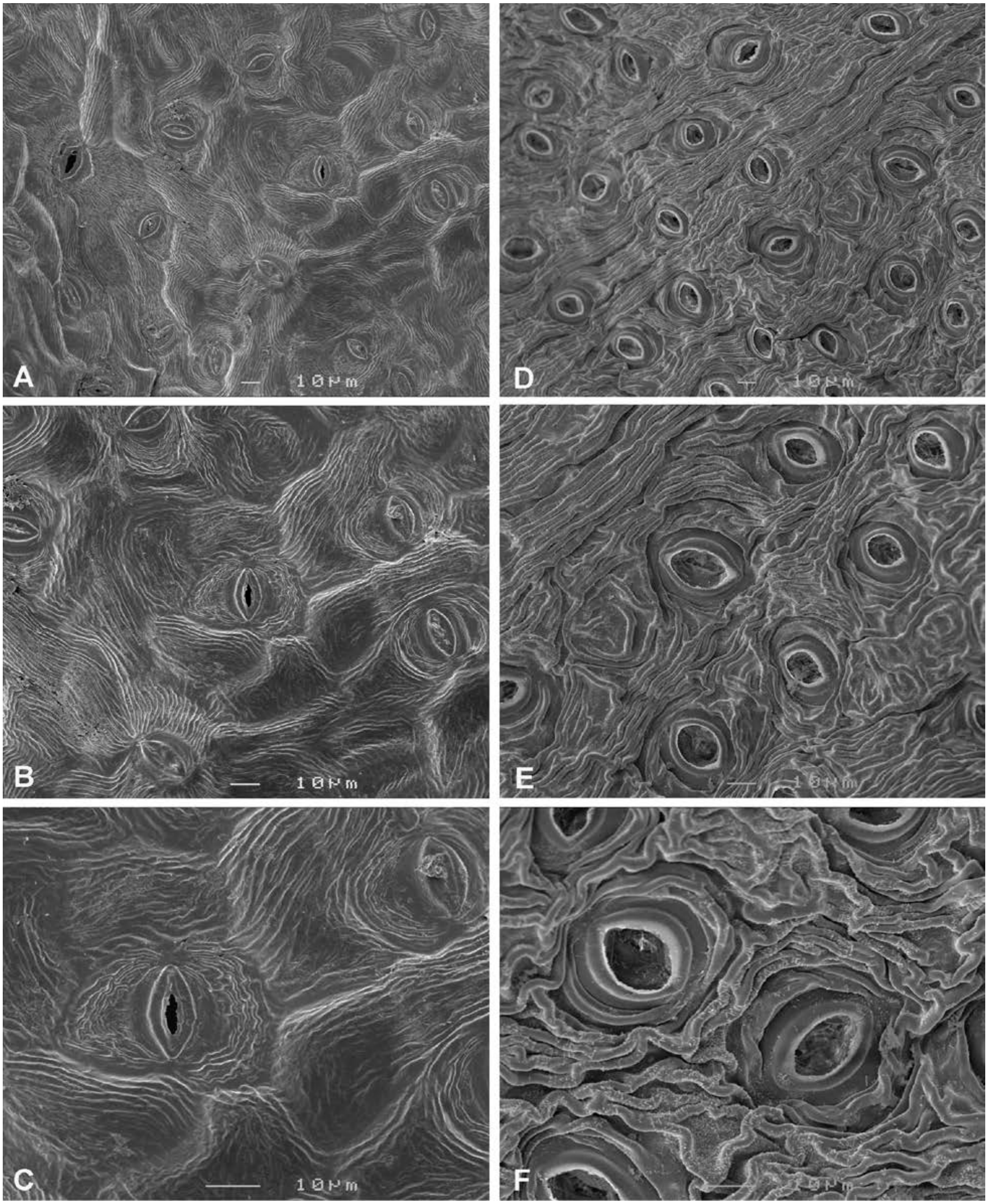


Fig. 4.3.19.3. *Cryptolepis nugaalensis* leaf epidermal surfaces: (A–C) adaxial epidermal cells with tabular periclinal walls, wavy anticlinal walls, slightly striated cuticle and stomata, (D–F) abaxial epidermis with heavily striated cuticle and numerous stomata. Magnification: A, D = x400; B, E = x650; C, F = x1200. Specimen: (A–F) *Thulin et al. 10504* (UPS).

4.3.20 ***Cryptolepis oblongifolia*** (Meisn.) Schltr., Journal of Botany 34: 315 (1896); N.E.Br.: 249–250 (1902), 529 (1907); Eyles: 446 (1916); Bruce: 46 (1947); Robyns: 86 (1947); Lebrun, Taton & L.Touss.: 107 (1948); Brenan: 64 (1949); F.W.Andrews: 406 (1952); Monod & Schnell: 14 (1952); Bullock: 269 (1955); H.Huber: 2 (1967); Compton: 444 (1976); Venter: 130 (2012). Basionym: *Ectadium oblongifolium* Meisn. in Hook., London Journal of Botany: 542 (by error 442) (1843); Hochst.: 827 (1844); Walp.: 481 (1847), 48 (1852); Bullock: 268 (1955).
Type: [South Africa, KwaZulu-Natal], Port Natal [Durban], Umgani [Umgeni], *Krauss 132* (K-herb. Bentham!, lecto. here designated; K-herb. Hooker!, BM!, MO-scan!, isolecto.).

= ***Ectadiopsis oblongifolia*** (Meisn.) B.D.Jacks., Index Kewensis 1(2): 822 (1893); K.Schum.: 219 (1895b); Schltr.: 14 (1894), 10 (1895a); J.M.Wood: 84 (1907); Bullock: 268 (1955); I.B.Friis & Vollesen: 322 (1998). Note 1
Type: Homotypic synonym.

= ***C. angolensis*** Welw. in Hiern, Catalogue of the African Plants collected by Dr. Friedrich Welwitsch in 1853–61 1(3): 677 (1898); N.E.Br.: 249 (1902); C.Norman: 91 (1929); Bullock: 269 (1955).
Type: Angola, Huila District, near Lopollo, *Welwitsch 4204* (BM!, lecto. here designated; K!, LISU-scan!, isolecto.).

= ***C. arenicola*** Schltr. ex Dinter, Repertorium specierum novarum regni vegetabilis 16: 364 (1920).
Type: Namibia, Gaub, *Dinter 2430* (SAM!, holo.; SAM!, WIND, iso.).

= ***C. baumii*** N.E.Br. in Dyer, Flora of Tropical Africa 4(1): 247 (1902), 614 (1904); Bullock: 269 (1955). Note 2
Type: Angola, Amboella District, River Longa, below Napalanka, *Baum* 577 (K!, holo.; BM!, BR!, COI, G!, HBG-scan!, M-scan!, iso.).

= ***C. baumii*** Schltr. in Baum, Warburg Kunene-Sambesi Expedition: 340 (1903), *nom. illegit*.
Type: Angola, Kubango River, above Kuimarva, *Baum 457* (B†, holo.; Z!, lecto. here designated; BM!, E, HBG-scan!, K!, M-scan!, W-scan!, isolecto.).

= *C. brazzaei* Baill., Bulletin Mensuel de la Societé Linnéenne de Paris 2: 803 (1889); Hiern.: 678 (1898); Henriq.: 67 (1899); N.E.Br.: 248 (1902); Bullock.: 268 (1955).

Type: Angola, Pungo Andongo District, *Welwitsch 4197* (P!, holo.; BM!, COI, K!, LISU-scan!, iso.).

= *C. buxifolia* Chiov., Raccolte Botaniche fatte Dai Missionari Della Consolata Nel Kenya: 80 (1935); Bullock: 269 (1955).

Type: Kenya, Mt. Kenya NE, Meru, 17-11-1910, *Balbo 16* (FT-scan!, holo.; FT-scan!, iso.)

= *C. debeerstii* De Wild., Annales du Musée du Congo, Série 5(1): 180 (1904); T.Durand & H.Durand: 355 (1909); Bullock: 269 (1955).

Type: Zaire [The Democratic Republic of the Congo], Pala, *Debeerst, G. anno 0-0-1895* (BR!, holo.).

= *C. elliotii* Schltr., Journal of Botany, London 33: 300 (1895b); N.E.Br.: 250 (1902); Bullock: 268 (1955).

Types: Burundi, Urundi Hills, *Scott-Elliott, G.F. 8372* (BM!, lecto. here designated; K! isolecto.); East side of Albert Edward Lake, *Scott-Elliott, G.F. 8066* (BM!, syn.).

= *C. hensii* N.E.Br. in Dyer, Flora of Tropical Africa 4(1): 246 (1902); De Wild: 180 (1904), 26 (1920); T.Durand & H.Durand: 355 (1909); Bullock: 269 (1955).

Type: Zaire [The Democratic Republic of the Congo], Ntombi River, near Lutete, *Hens 227* (K!, holo.; BR!, L!, Z!, iso.).

= *C. linearis* N.E.Br. in N.E.Br. & Staf., Kew Bulletin 1908: 408 (1908); Bullock: 269 (1955).

Type: Angola, Ulondo Mountains, *Wellman 1785* (K!, holo.).

= *C. myrtifolia* (Baill.) Schltr., Journal of Botany, London 33: 301 (1895b)[Note 3]; Hiern: 677 (1898); Bullock: 268 (1955). Basionym: *Ectadiopsis myrtifolia* Baill., Bulletin Mensuel de la Societé Linnéenne de Paris 2: 803 (1889).

Type: Angola, Huila District near Lopollo, *Welwitsch 4206* (P!, holo.; BM!, G!, K!, LISU-scan!, iso.).

= *C. nigritana* (Benth.) N.E.Br. in Dyer, Flora of Tropical Africa 4(1): 251 (1902); A.Chev.: 196 (1913); Schltr.: 542 (1914); Hutch. and J.M.Dalz.: 53 (1931); Bruce: 46 (1947); Robyns: 86 (1947); Bullock: 269 (1955). Basionym: *Ectadiopsis nigritana* Benth., Hooker's Icones Plantarum 12: 75, f. 1187 (1876b); Baill.: 802 (1889); K.Schum.: 219 (1895b); Bullock: 268 (1955).
Type: Nigeria, Nupe, *Barter 1324* (K!, holo.; P [2 sheets]!, iso.).

= *C. producta* N.E.Br. in Dyer, Flora of Tropical Africa 4(1): 247 (1902), 614 (1904); Eyles: 446 (1916), Bullock: 278 (1955).
Type: Angola, Kubango River, above Kuimarva, *Baum 457* (K!, holo; B†, BM!, E, HBG-scan!, M-scan!, W-scan!, Z!, iso.).

= *Ectadiopsis producta* (N.E.Br.) Bullock, Kew Bulletin 10: 278 (1955).
Type: Homotypic with *C. producta*.

= *C. scandens* (K.Schum) Schltr., Westafrikanische Kautschuk-Expedition. 308 (1900), 340 (1903); N.E.Br.: 249 (1902), 614 (1904); Bullock: 268 (1955). Basionym: *Ectadiopsis scandens* K.Schum. in Engl. & Prantl, Die Natürlichen Pflanzenfamilien, 4(2): 219 (1895b); De Wild: 180 (1904); T.Durand & H.Durand: 356 (1909); Bullock: 268 (1955).
Types: Angola, Amboella District, River Longa below Napalanka, *Baum 577* (K!, neo. here designated; BM!, BR!, COI, G!, M, Z!, isoneo.).[Note 4]

= *C. sizenandii* Rolfe, Boletim da Sociedade Broteriana 11: 86 (1893); Bullock: 268 (1955); Hiern: 678 (1898).
Type: Angola, Malange, *Marques, S. 185* (COI, holo.; K!, iso.).

= *C. suffruticosa* (K.Schum.) N.E.Br. in Dyer, Flora of Tropical Africa 4(1): 251 (1902); Brenan: 64 (1949); Bullock: 269 (1955). Basionym: *Ectadiopsis suffruticosa* K.Schum. in Engl., Botanische Jarbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 28: 453 (1901); Brenan: 65 (1949); Bullock: 269 (1955).
Type: Tanzania, Uhehe, Iringa, Weru Area, *Goetze 665* (B†, holo.). [Note 5]

= *C. welwitschii* (Baill.) Schltr., Journal of Botany, London 33: 301 (1895b); Hiern.: 677 (1898); N.E.Br.: 248 (1902), 614 (1904); C.Norman: 91 (1929) Note 6; Bullock: 268 (1955). Basionym: *Ectadiopsis welwitschii* Baill., Bulletin Mensuel de la Societé Linnéenne de Paris 2: 802 (1889); Britten: 26 (1894); K.Schum: 320 (1895a), 219 (1895b); Bullock: 268 (1955).

Type: Angola, Huila Province, *Welwitsch 4203* (P!, holo.; BM!, COI, G!, K!, LISU-scan!, iso.).

= *C. welwitschii* var. *luteola* Hiern, Catalogue of the African Plants collected by Dr. Friedrich Welwitsch in 1853–61 1(3): 677 (1898); N.E.Br.: 249 (1902); Bullock: 269 (1955).

Type: Angola, Huila Province, near Huila, *Welwitsch 4205* (BM!, lecto.; K!, LISU-scan!, isolecto.).

= *Ectadiopsis acutifolia* (Sond.) Benth. in Benth. & Hook.f., Genera Plantarum 2(2): 741 (1876a).; K.Schum.: 219 (1895b); Bullock: 269 (1955). Basionym: *Secamone acutifolia* Sond., Linnaea 23(1): 76 (1850).; Walp.: 48 (1852); Schltr.: 10 (1895a); J.M.Wood: 84 (1907); Bullock: 268 (1955).

Types: South Africa, Magaliesberg, *Zeyher, C.L.P. 1182* (S-scan!, lecto. here designated; G!, K!, P!, isolecto.); Port Natal [Durban], *Guienzius,* W. *431* (G!, S-scan!, syn.).

= *Ectadiopsis lanceolata* Baill., Bulletin Mensuel de la Societé Linnéenne de Paris 2: 803 (1889); K.Schum.: 219 (1895b); Bullock: 268 (1955); Hiern: 678 (1898).

Type: Angola, Huila, *Welwitsch 4207* (P!, holo.; BM!, COI, iso.).

= *Ectadiopsis nigritana* var. *congesta* K.Schum. in Engl., Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie 23: 232 (1896); Bullock: 269 (1955).

Types: Togo, Ayanga, *Buttner 404* (B†, holo.; K!, lecto. here designated).

A suffrutescent dwarf-shrub with a woody rootstock, up to 1.2 m high or occasionally a climber, with white latex. *Stems* woody, slender, prostrate to erect, occasionally twining, up to 10 mm diameter; younger stems bright orange-red, smooth, glabrous to muricate; older stems dark reddish-brown, smooth to slightly verrucose, glabrous; interpetiolar ridges villous; colleters present. *Leaves* decussate, axils villous, sub-sessile to petiolate; petiole green, glabrous or puberulous, grooved, 1–6(–8) mm long; blade elliptic to narrowly elliptic, lanceolate to narrowly lanceolate, occasionally linear, (3–)15–60(–131) x 1–27(–41) mm, coriaceous, smooth, glabrous or slightly puberulous along main vein, bright to dark green adaxially, pale green abaxially; margin revolute; apex acute, attenuate, acuminate, apiculate or occasionally mucronate, not recurved; base obtuse to narrowly cuneate; venation brochidodromous, conspicuous, yellow to light green adaxially, 6–12 secondary veins on either side of main vein, poorly distinguished from prominent, random reticulate tertiary venation, intersecondary veins absent, areole development imperfect, veinlets branched. *Inflorescences* cymose, compact to lax, many-flowered, rarely few-flowered, each cyme consists of 3–8 dichasia, each terminating in 1–3 monochasia, muricate, primary peduncle 2–12(–30) mm long, secondary peduncles 1–12(–20) mm long, pedicels 1–6 mm long; bracts opposite, sparsely to densely arranged, glabrous, acicular, 0.7–2 mm long, margins fimbriate. *Buds* slender, 3–7(–10) mm long, ovoid, apices apiculate to attenuate, rarely obtuse, half to full-turn helically twisted. *Sepals* ovate to broadly ovate, 1–2 x 0.8–1.5 mm, rotund to acute, glabrous to puberulent, margins glabrous to fimbriate, colleters conical. *Corolla* white to yellow, occasionally tinged carmine red to lilac on the outer corolla surface and along the main vein of each petal, 4–12 mm long; tube campanulate, 1.5–3.0(–4.5) mm long, outside glabrous, inside glabrous to rarely slightly puberulent; lobes spreading, ovate to elongate-ovate, 2.5–6.0 x 1–2 mm, apices acute to obtuse. *Corona* double; primary corona inserted (0.8–)1–1.8(–2.3) mm from corolla tube base, included, lobes clavate, apices obtuse to acute, fleshy, 0.3–0.6(–1.0) mm long, glabrous, apices connivent over gynostegium; secondary corona in corolla lobe sinuses, pocket-like, prominent, often with filiform lobes of 0.1–0.5 mm long from pocket rims, apices acute to slightly bifid, glabrous to occasionally puberulous. *Stamens* inserted 0.3–0.8(–1.0) mm from corolla tube base; anthers hastate, attenuate, glabrous, 0.5–0.8 mm long, filaments ± 0.2 mm long. *Nectaries* prominent, inserted 0.3–0.8(–1.0) mm from corolla tube base. *Ovaries* 0.5–0.8 x 0.5–0.8 mm; style 0.2–0.5 mm long, style-head broadly pyramidal, acute, 0.3–0.5 x 0.5–0.8 mm. *Translators* narrowly elliptic, 0.2–0.4 mm long, apices acute. *Follicles* erect, divaricate at 30°–90°, narrowly ovoid, (37–)50–125(–173) x

3–15 mm, brown, apices blunt, bases cuneate. *Seeds* oblong-obovate, (4–)6–10 x 1–3(–4) mm, slightly warty; coma white, 16–46 mm long. (Figs. 4.3.20.1. and 4.3.20.2.)

Diagnostic characteristics

A suffrutescent dwarf-shrub with a woody rootstock, up to 1.2 m high or occasionally a climber. Leaves elliptic, lanceolate to narrowly lanceolate, occasionally linear. Venation brochidodromous, conspicuous, yellow to light green adaxially; secondary veins, poorly distinguished from prominent, random reticulate tertiary venation. Inflorescences compact to lax. Buds 3–7(–10) mm long, ovoid, apices apiculate to attenuate, rarely obtuse. *Corolla* white to yellow, often tinged carmine red to lilac on the outer corolla surface and along the main vein of each petal, 4–7(–12) mm long. *Corona* double; primary corona lobes clavate, apices obtuse to acute, 0.3–0.6(–1.0) mm long; secondary corona prominent, often with filiform lobes of 0.1–0.5 mm long from pocket rims, apices acute to slightly bifid, glabrous to occasionally puberulous. Follicles are erect, divaricate at 30–90°, narrowly ovoid, 50–125 x 3–15 mm, apices blunt.

This species is highly variable in both vegetative and floral morphology. Variable characters such as petiole length, leaf size and shape, inflorescence size, number of flowers, corolla length and secondary corona structure all vary randomly and cannot be used to delimit well-circumscribed groups. However, some combinations of these characters occur more often than others and, in some cases, are restricted to specific geographic areas. Four such groups are described below. It should be noted, however, that exceptions and intermediate forms are common and these groups represent no formal classification but are presented here only to ease identification.

Brazzaei Group

This group represents various transitional forms between the Linearis Group and Oblongifolia Group*.* A suffrutescent shrub, often with prostrate to twining branches. Leaves narrowly to broadly lanceolate, 35–70 x 5–10 mm; apices attenuate; petiolate or rarely sub-sessile, petiole 1–3 mm long. Inflorescences compact to semi-compact, many- to few-flowered. Buds ovoid, apiculate, 3–4 mm long. Corolla white to yellowish-white, 4–5 mm long, often with a slightly villous inner corolla tube. Corona double, primary corona clavate, secondary corona pocket-like often with filiform or bifid lobes from pocket rims. (Fig. 4.3.20.2. B). Common in Central Africa, from Angola to Zambia and the Democratic Republic of the Congo.

Linearis Group

A suffrutescent dwarf-shrub up to 0.8 m high. Stems erect. Leaves linear, 45–100 x 2.5–3(–4) mm; apices acute; sessile to sub-sessile. Inflorescences compact, often globose, many flowered. Buds ovoid, apiculate, 4–5 mm long. Corolla yellow to white, often tinged carmine red to lilac on the outer corolla surface and along the main vein of each petal, 4–7 mm long. Corona double, primary corona clavate, secondary corona pocket-like often with filiform lobes from pocket rims. (Fig. 4.3.20.2. A). This group is rare, with most collections being from Angola and few collections from Ivory Coast, Zambia, Gabon and Tanzania.

Oblongifolia Group

A suffrutescent dwarf-shrub up to 1 m high. Stems erect. Leaves elliptic to narrowly elliptic, occasionally ovate, 17–50(–70) x 8–18(–24) mm, sub-sessile to petiolate; petiole 1–4 mm; apices acute or apiculate. Inflorescences semi-compact to lax, many-flowered. Buds ovoid, apiculate, ± 4 mm long. Corolla yellow, 4–6 mm long, usually glabrous inner corolla tube in the eastern parts of its distribution, but often with a slightly villous inner corolla tube in the western parts of its distribution. Corona double; primary corona clavate; secondary corona pocket-like, without filiform lobes from the pocket rims (Fig. 4.3.20.1.). This group is widely distributed throughout the distribution range of *C. oblongifolia*, and is the dominant group in southern and East Africa.

Producta Group

This group is vegetatively most similar to form *oblongifolia*. A suffrutescent dwarf-shrub up to 1 m high. Stems erect or rarely twining. Leaves elliptic, 20–55 x (8–)12–22; apices attenuate to apiculate; sub-sessile to petiolate, petiole 1–2 mm. Leaves are very rarely lanceolate to broadly lanceolate and large (80–90 x 18–41 mm); petiolate, petiole 5–8 mm long. This group is only distinguished from the other groups based on its much larger flowers. Buds ovoid, attenuate, 7–10 mm long. Corolla white to yellow, 7–12 mm long. Corona double; primary corona clavate; secondary corona pockets always have filiform lobes of 0.1–0.5 mm long from pocket rims. The Producta Group of *Cryptolepis oblongifolia* is mainly restricted to Zimbabwe and Zambia and is occasionally found in the southern parts of Tanzania and the Democratic Republic of the Congo.

Distribution and Ecology

This species is common, with the widest distribution of all African *Cryptolepis* species, occurring throughout the tropical and subtropical regions of sub-Saharan Africa (Fig. 4.3.20.4). It grows on plains, ridges, hill slopes, hill tops and rocky escarpments at altitudes ranging from 90 to 2000 m. *Cryptolepis oblongifolia* is associated with a variety of geological formations ranging from sandstone, quartzite and shale to dolomite, basalt and granite. This species is most often associated with well-drained rocky sand or loam but may occasionally be found growing in silty clay. *Cryptolepis oblongifolia* is usually a component of Miombo woodland (*Brachystegia* species dominant) or grassland in association with *Brachystegia allenii* Hutch. & Burtt Davy, *B. boehnii* Taub. and *Julbernardia globiflora* (Benth.) Troupin. *Cryptolepis oblongifolia* may occasionally be found in streamside forest or in degraded forest, associated with *Ensete* sp., *Ficus* sp., *Khaya* sp., *Trilepisium* sp., *Ocotea* sp. and *Podocarpus* sp. This species is often found in regularly disturbed areas such as roadsides, pasture, grazed vegetation or areas which are regularly burnt. In the northern hemisphere, within 10° of the equator, flowering occurs from February to October, with a peak from April to July. In the southern hemisphere, within 15° of the equator, flowering occurs from May to January, with a peak from October to January, while further south, flowering occurs from October to March, with a peak from November to January.

Vernacular names

Kuangali: Kahuisamasini (Angola)
Zulu: emoHalahaleni (South Africa)

Notes

1. Bullock (1955) cited the author incorrectly when referring to *Ectadiopsis oblongifolia* (Meisn.) Schltr. and this mistake was subsequently repeated by Gilli (1973). Authors cited by Bullock (1955), namely Schlechter (1894, 1895a) and Schumann (1895b), both referred to *Ectadiopsis oblongifolia* (Meisn.) Benth. However, Bentham (1876a) did not formally transfer *Ectadium oblongifolium* to *Ectadiopsis*. The new combination, *Ectadiopsis oblongifolia,* was made by Jackson (1893) under the entry for *Ectadium oblongifolium.*

2. Bullock (1955) indicated the specimen *Baum 577* as the type of *Cryptolepis baumii* N.E.Br. and the isotype of *Cryptolepis scandens* Schltr. This differs from the original type of *C. scandens* as designated by Schlechter (1900), which is *Schlechter 12451.*

3. The Index Kewensis credits Hiern (1898) with the transfer of *Ectadiopsis myrtifolia* Benth. to *Cryptolepis*, but Schlechter (1895b) had already made this transfer and should therefore be the accepted author of *Cryptolepis myrtifolia.*

4. Schumann (1895b) published a short description of *Ectadiopsis scandens* K.Schum., but never referred to any specimen of the species. Schlechter (1900) published a short description, referring to a voucher specimen for *Cryptolepis scandens* K.Schum., and also stated that *Ectadiopsis scandens* was identical to *Cryptolepis scandens*. *Ectadiopsis scandens* K.Schum. was therefore synonymised with *Cryptolepis scandens* by Schlechter (1900). However, Schlechter (1900) did not indicate any specimens on which he founded the synonymy of *E. scandens* with *C. scandens* and Brown (1902) questioned the determination by Schlechter (1900) since no descriptive evidence was supplied. Eventually Bullock (1955) synonymized both these taxa with *Ectadiopsis oblongifolia* (Meisn.) Schltr. It is consequently neccesary to designate a neotype for the basionym, *E. scandens.* Schlechter (1900) refers to a specimen collected by himself (*Schlechter 12451*) in The Democratic Republic of the Congo. However, this specimen could not be located. The neotype is selected from the specimens collected during Baum's Kunene-Sambesi Expedition to Angola and which were identified by Schlechter (1903) as *Cryptolepis scandens.*

5. When Brown (1902) transferred *Ectadiopsis suffruticosa* K.Schum. to *Cryptolepis* he stated that he had not seen the type specimen designated by Schumann. The synonymy is therefore based on Schumann's (1901) description alone.

6. Norman (1929) erroneously gives Hiern (1898) as the author of *Cryptolepis welwitschii* in stead of Schlechter (1895b). Hiern (1898) is the author of *C. welwitschii* var. *luteola.*

Representative specimens

— **7º13'02'' N, 13º36'01'' E:** Cameroon, Ngaoundéré District, 10 km S of Ngaoundéré, along road to Meiganga, 01-02-1966, *Leeuwenberg, A.J.M. 7669* (K).

— **10º20' N, 1º41' E:** Benin, Atakora Province, Kouandé, 22-09-2001, *Essou, J.-P. 2777* (WAG).

— **4º31' S, 38º17'02'' E:** Tanzania, Taga Province, Shagayu Forest, near Sunga, in the Western Usambara Mountains, 17-05-1953, *Drummond, R.B. & Hemsley, J.H. 2603* (EA).

— **8º49'60'' S, 31º22'60'' E:** Zambia, Kalandbo Falls, 14-10-1952, *White, F. 3644* (K).

— **14º45'30'' S, 13º28'53'' E:** Angola, Huila Province, Bibala Pass, 16.8 km E of Bibala, 18.4 km NNW of Lubango, 26-01-2009, *Bester, S.P. 9294* (PRE).

— **24º36'34'' S, 30º48'86'' E:** South Africa, Mpumalanga Province, Blyde River Canyon, at first viewpoint over Mariepskop, along road from Bourke's Luck to Forever Resort, left of parking area, 15-11-2006, *Joubert, L. 26* (BLFU).

— **25º11' S, 27º15' E:** South Africa, [North West Province], Potchefstroom, Sandfontein, 19-03-1983, *Venter, H.J.T. 8805* (BLFU).

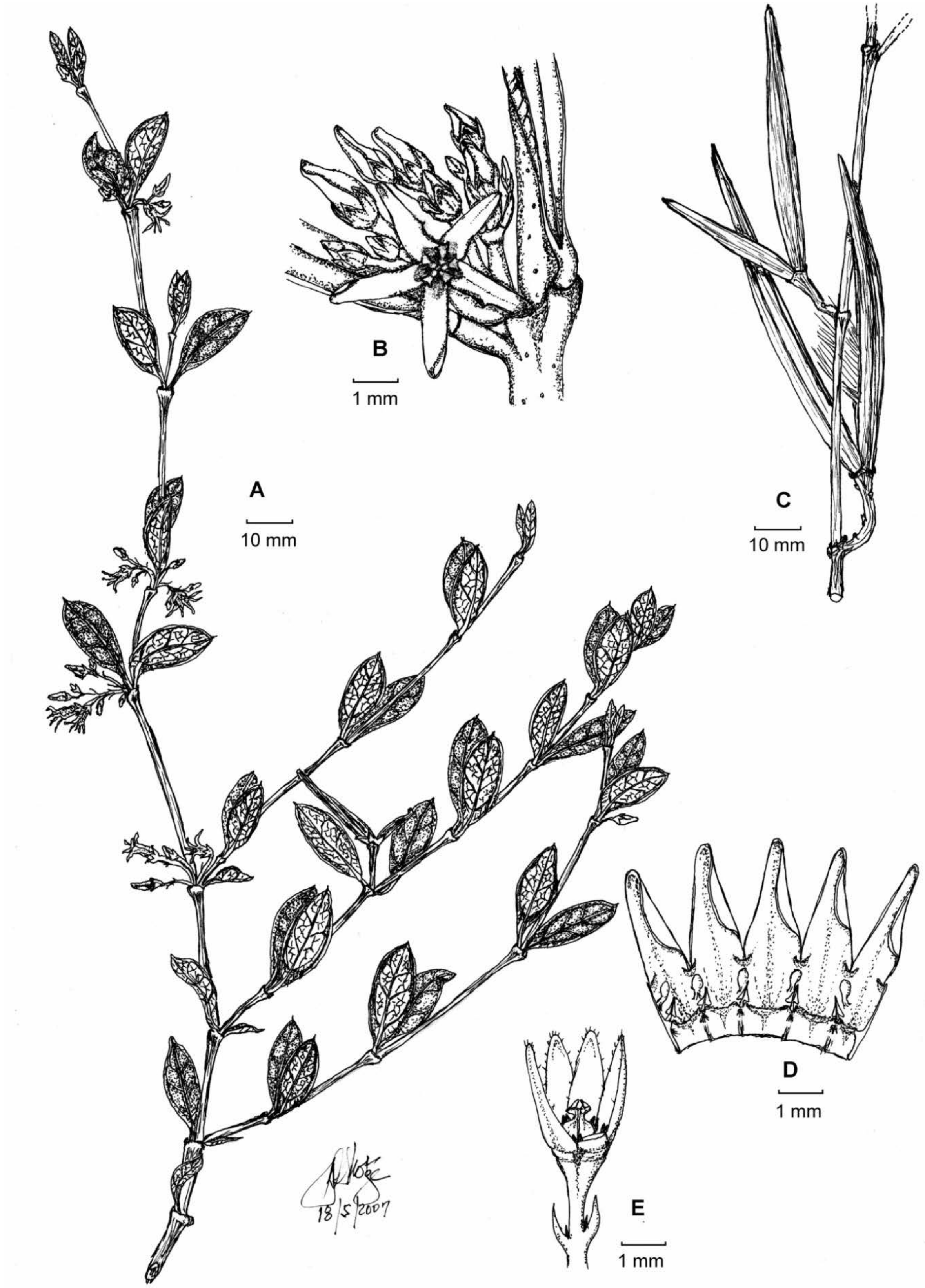


Fig. 4.3.20.1. Illustration of *Cryptolepis oblongifolia, "* Oblongifolia Group"*:* (A) stem with leaves and inflorescences, (B) inflorescence of mature flower and buds, (C) stem with paired follicles, (D) corolla opened showing corolla, secondary corona of corolla sinus pockets, primary corona of clavate lobes and stamens with hastate anthers, (E) calyx of hairy sepals and pistil of semi-inferior apocarpous ovaries, style and style-head. Specimens: (A) *Botha 2348* (BLFU); (B, D–E) *Joubert 26* (BLFU)*;* (C) *Venter 8805* (BLFU).

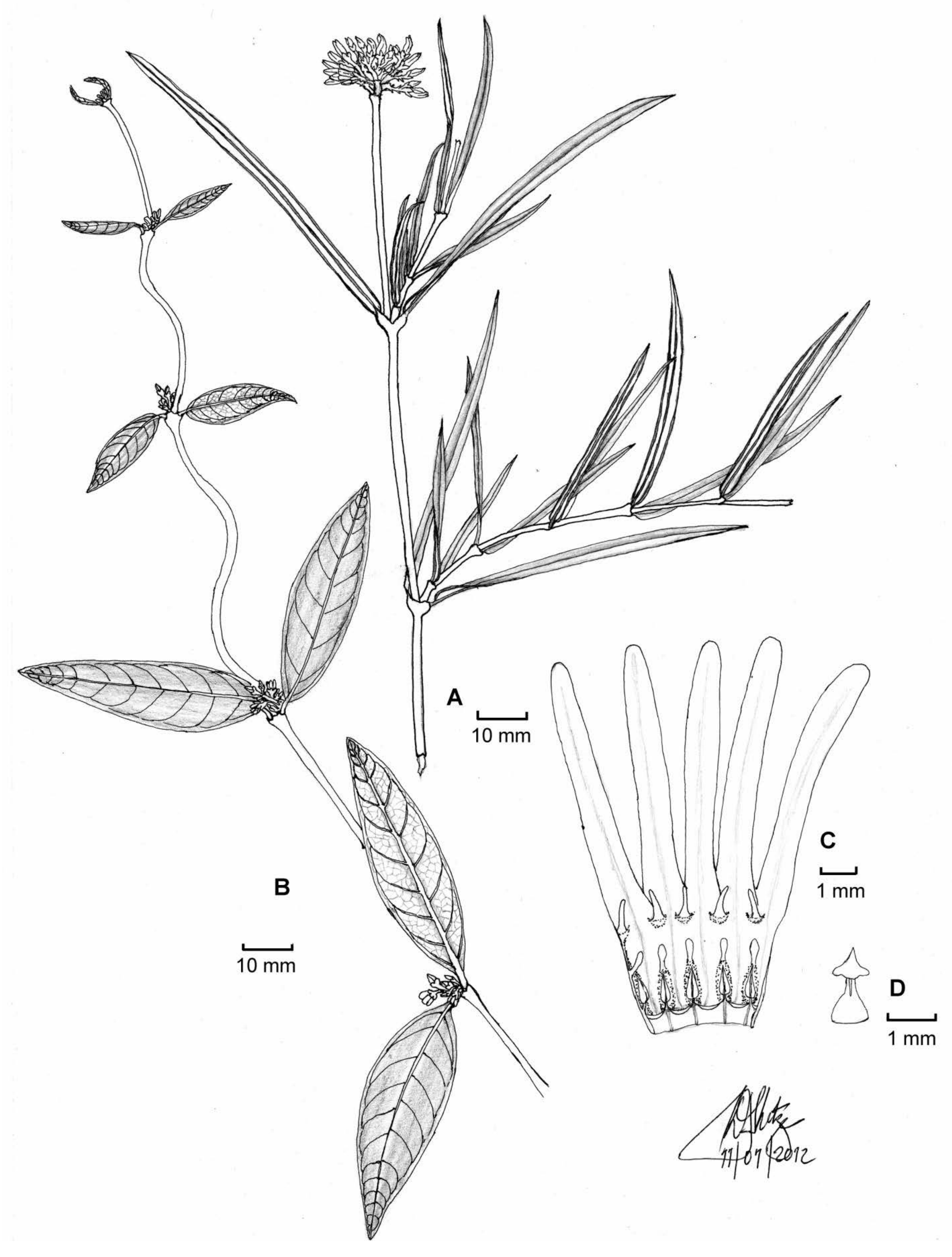


Fig. 4.3.20.2. Illustration of *Cryptolepis oblongifolia*: (A) "Linearis Group", stem with linear leaves and compact, many-flowered inflorescence, (B) "Brazzaei Group", twining stem with leaves and compact, few-flowered inflorescences, (C) corolla opened showing corolla, primary corona of clavate lobes, seconday corona of sinus pockets with filiform lobes and stamens with hastate anthers, (D) pistil of semi-inferior apocarpous ovaries, style and style-head. Specimens: (A) *Wellman 1785* (K), (B–D) *Herb. Horti. Bot. Nat. Belg. B194* (BR).

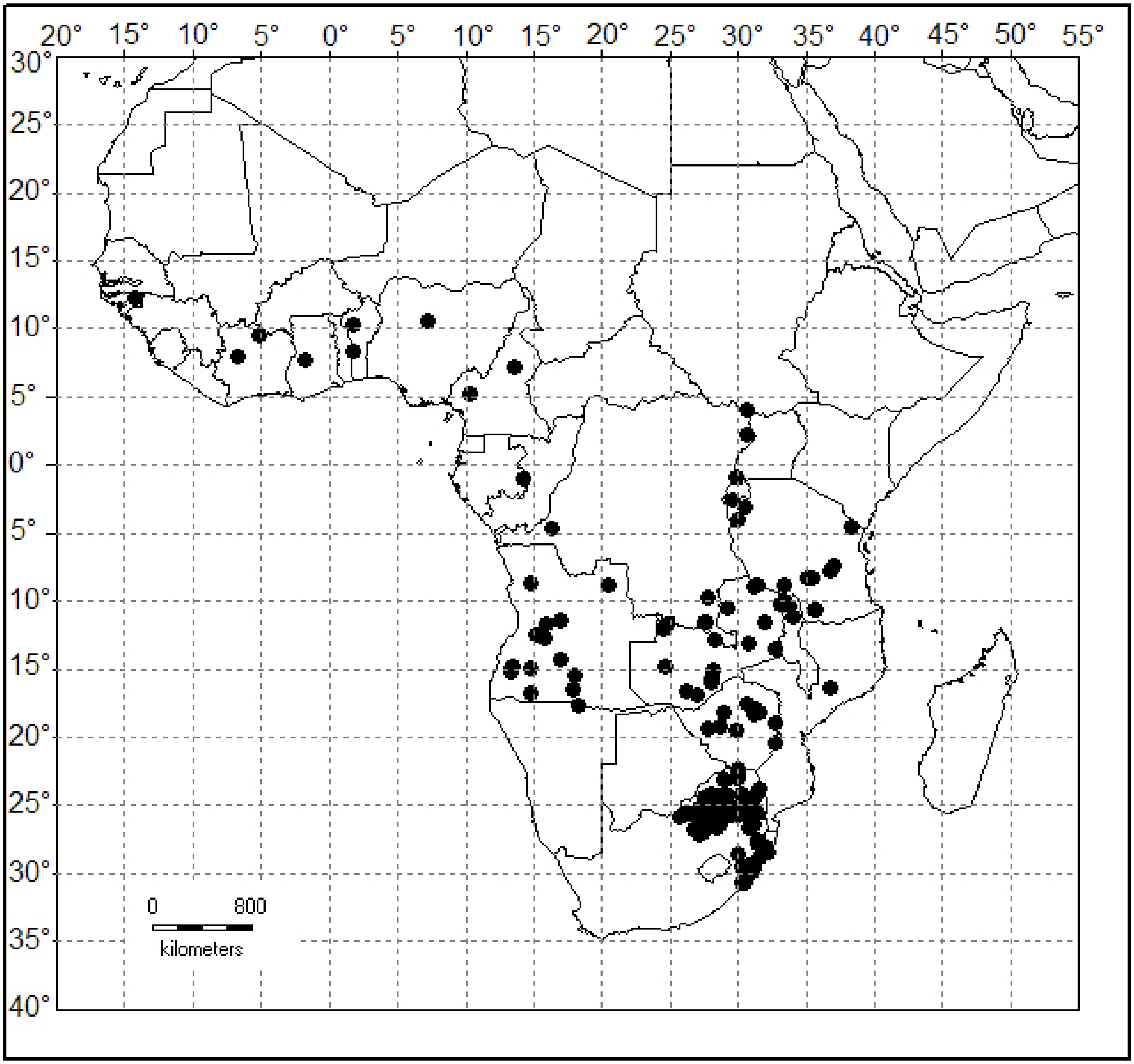


Fig. 4.3.20.3. Known distribution of *Cryptolepis oblongifolia*.

Leaf micromorphology

Cryptolepis oblongifolia exhibits a significant amount of variation in leaf epidermal surfaces among different specimens. To facilitate comparison among specimens the adaxial and abaxial leaf epidermal surfaces of each specimen are presented as pairs in Figs. 4.3.20.4 and 4.3.20.5.

In surface view the adaxial epidermis consists of more or less isodiametric, tetra- to hexagonal cells with tabular to slightly convex periclinal walls. Anticlinal walls are straight or slightly curved and slightly sunken (Fig. 4.3.20.4. A–C; Fig. 4.3.20.5. A–C). The cuticle may be heavily striated with the striations wavy, randomly orientated and restricted to individual cells or continuous over intercellular boundaries (Fig. 4.3.20.4. A–C; Fig. 4.3.20.5. C). Occasionally the cuticle is only slightly striated, with striations straight to slightly wavy, parallel and restricted to individual cells (Fig. 4.3.20.5. A–B). Short, unicellular trichomes may be present (Fig. 4.3.20.5. A, C).

Epidermal cells of the abaxial surface are isodiametric, tetra- to hexagonal, with tabular (Fig. 4.3.20.5. A–C) to convex periclinal walls and straight, sunken anticlinal walls (Fig. 4.3.20.4. A–C). The cuticle on the abaxial leaf surface is heavily striated, with striations wavy, randomly orientated and continuous over intercellular boundaries (Fig. 4.3.20.4. A–C), occasionally parallel (Fig. 4.3.20.5. A) or radiating from the centres of cell surfaces (Fig. 4.3.20.5. C). Short, unicellular trichomes may be present (Fig. 4.3.20.5. D–E).

The leaves are hypostomatic (Fig. 4.3.20.4. A–F) or amphistomatic (Fig. 4.3.20.5. A–F). Stomata are numerous, randomly orientated and level with the surrounding epidermal cells. Dense to sparse striations on the subsidiary cells are randomly orientated but cannot be distinguished from the striations over the rest of the leaf surface. The guard cells are elongate-elliptic with a narrow stomatal ledge (Fig. 4.3.20.4. D–F; Fig. 4.3.20.5. A–F).

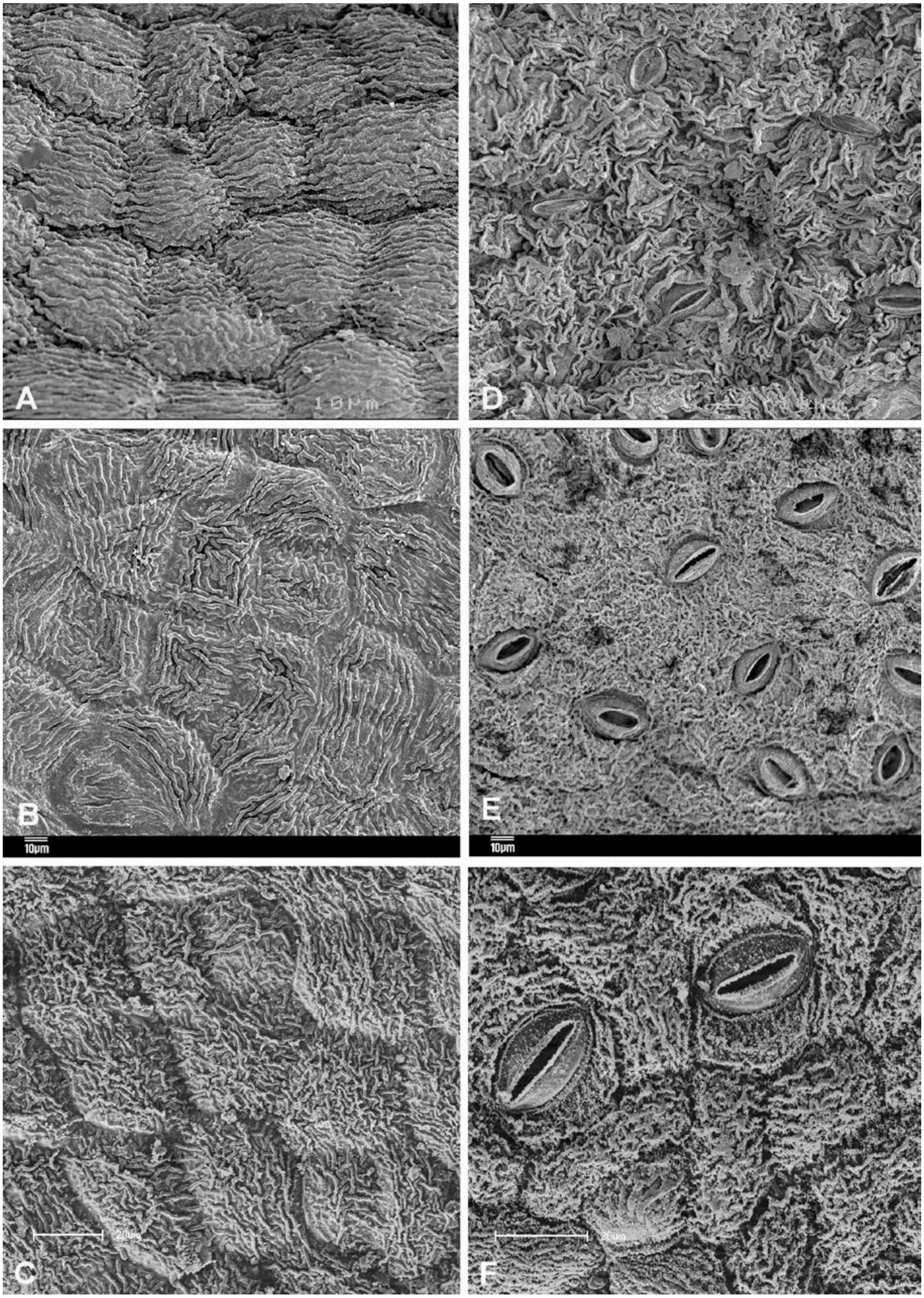


Fig. 4.3.20.4. *Cryptolepis oblongifolia* leaf epidermal surfaces: (A) adaxial epidermal cells with convex periclinal walls and densely striated cuticle, (B) adaxial epidermal cells with tabular periclinal walls and densely striated cuticle, (C) adaxial epidermal cells with convex periclinal walls and densely striated cuticle, (D–F) abaxial epidermis with convex periclinal walls, densely striated cuticle and stomata. Magnification: A, D = x650; B, E = x600; C = x1200; F = x1600. Specimens: (A, D) *Gossweiler 9745* (K); (B, E) *Botha 2848* (BLFU); (C, F) *Joubert 26* (BLFU).

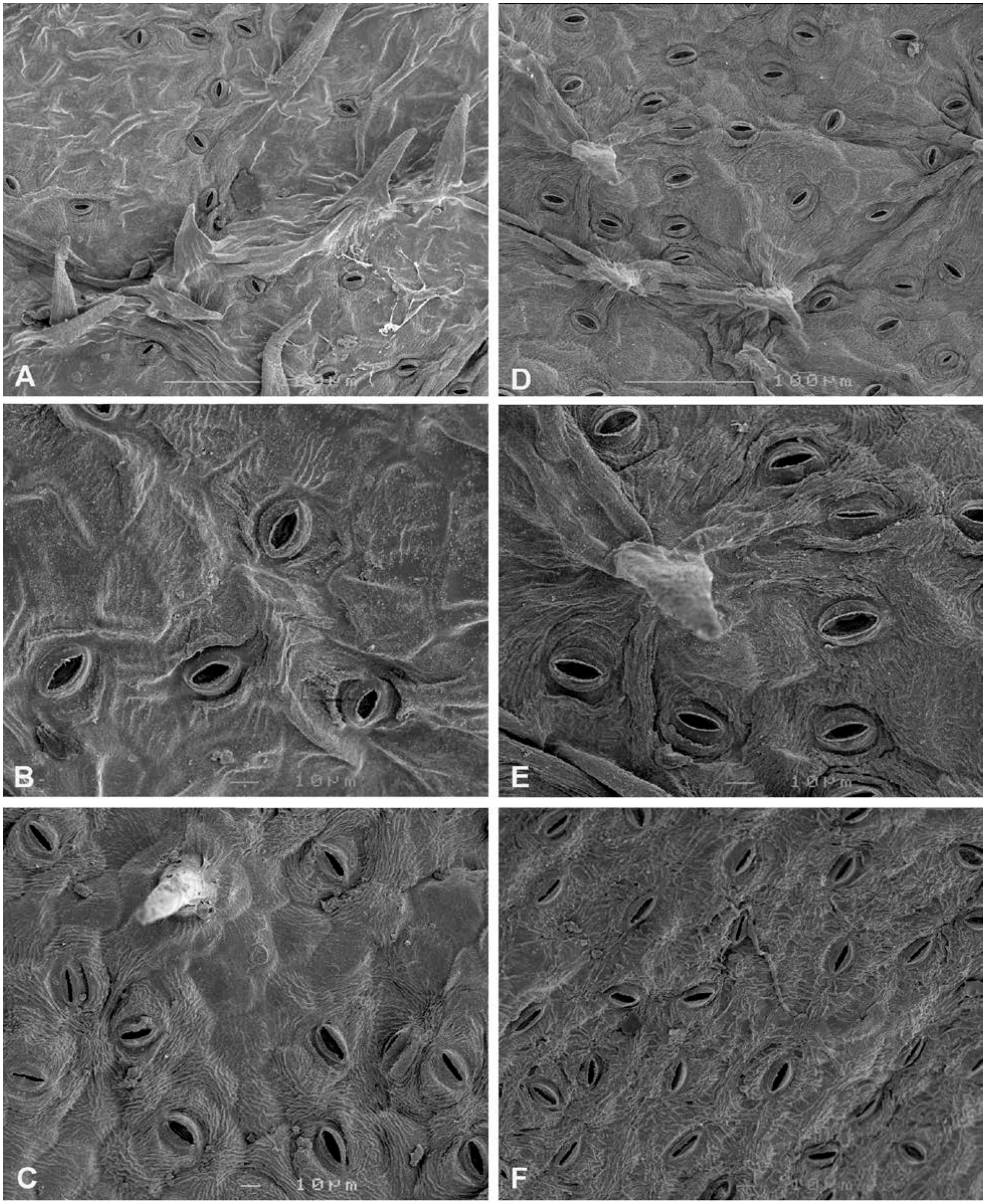


Fig. 4.3.20.5. *Cryptolepis oblongifolia* leaf epidermal surfaces: (A–B) adaxial epidermal cells with tabular periclinal walls, slightly striated smooth cuticle, stomata and trichomes, (C) adaxial epidermal cells with convex periclinal walls, striated cuticle, stomata and trichomes, (D–F) abaxial epidermis with tabular periclinal walls, densely striated cuticle, stomata and trichomes, Magnification: A = x220; B, E = x650; C, F = x400; D = x300. Specimens: (A–B, D–E) *Wild 44467* (SRGH); (C, F) *Milne-Redhead & Taylor 8125* (SRGH).

Seed micromorphology

The adaxial seed surface shows ridges radiating from the middle of the seed, consisting of raised, contorted epidermal cells (Fig. 4.3.20.6. A–B). Cells between the ridges are isodiametric and tetra- to hexagonal. Periclinal walls are convex while anticlinal walls are straight and deeply sunken. The cuticle is densely striated with striations parallel to randomly orientated, straight or slightly undulate and continuous over cell boundaries (Fig. 4.3.20.6. C).

The abaxial seed surface is smooth, with a narrow central ridge and thickened outer margin (Fig. 4.3.20.6. D). Marginal cells are morphologically similar to those near the central ridge and are isodiametric to elongate, tetra- to hexagonal. Periclinal walls are concave (Fig. 4.3.20.6. E) to tabular (Fig. 4.3.20.6. F). Anticlinal walls are straight to curved and slightly to deeply sunken. Cell surfaces are covered by a densely striated cuticle with striations randomly orientated, straight to slightly undulate and continuous over intercellular boundaries (Fig. 4.3.20.6. E–F).

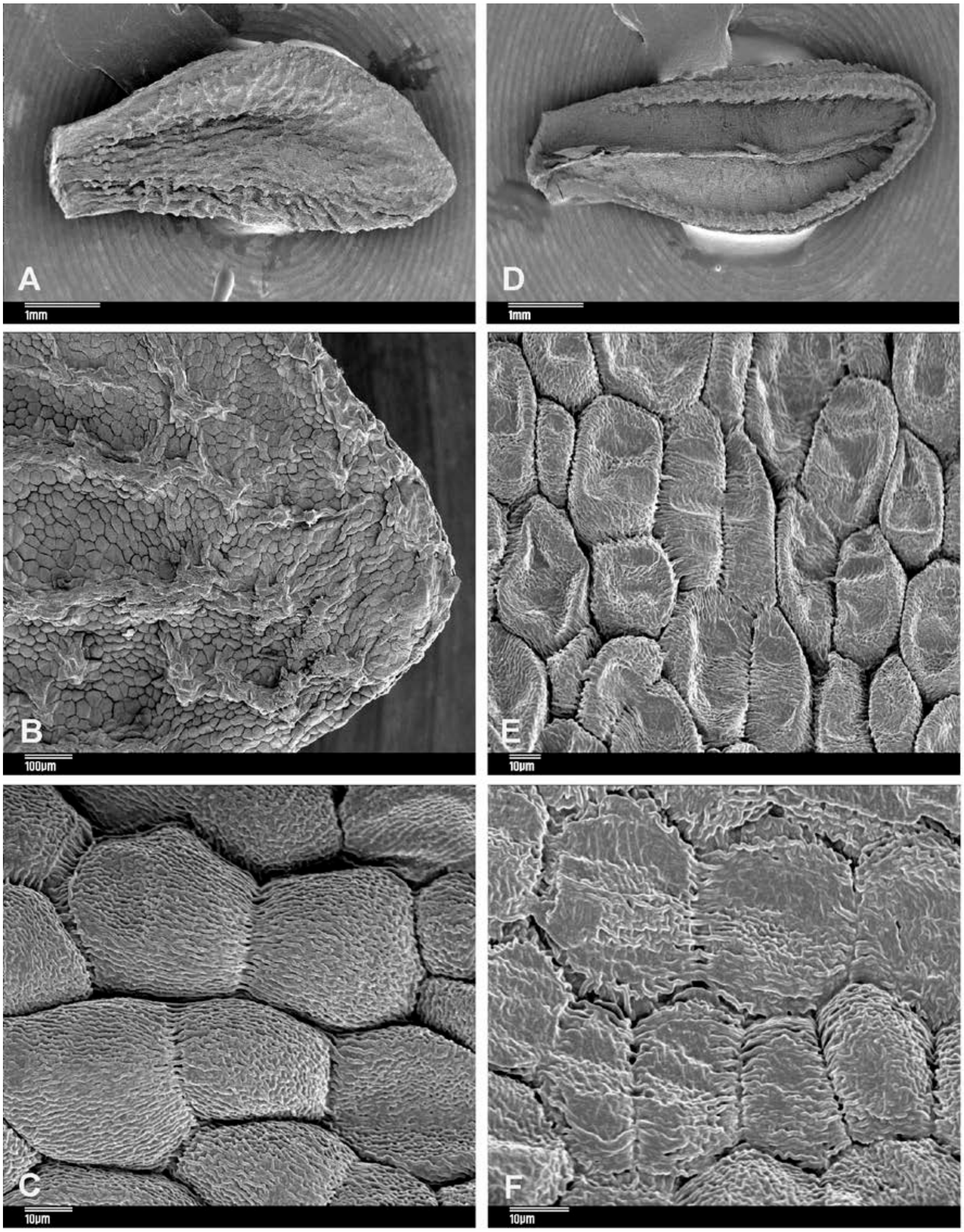


Fig. 4.3.20.6. *Cryptolepis oblongifolia* seed surfaces: (A) adaxial view of seed, (B) adaxial seed surface with protuberances consisting of deformed cells, (C) adaxial cells tetra- to hexagonal with convex periclinal walls and deeply sunken anticlinal walls, (D) abaxial view of seed, (E) abaxial cells with concave periclinal walls and striated cuticle, (F) abaxial cells with tabular periclinal walls and striated cuticle. Magnification: A, D = x19; B = x120; C = x1200; E = x800; F = 1500. Specimen: (A–F) *Venter 8805* (BLFU).

4.3.21 *Cryptolepis obtusa* N.E.Br., Kew Bulletin 1895: 110 (Apr./May 1895a)[Note 1], 246 (1902), 528 (1907); K.Schum.: 219 (1895b); Schltr.: 315 (1896); Brenan: 64 (1949); Bullock: 281 (1955), Venter: 132 (2012).

Types: Mozambique, between Tete and sea coast, 12-04-1860, *Kirk s.n.* (K!, lecto. designated by Bullock (1955)); [Malawi], valley of Shire River, *Meller s.n.* (K!, syn.); [Mozambique], Luabo River, *Kirk 38* (K!, syn.); [Mozambique], Chupenga [Shupanga], 10-12-1883, *Kirk s.n.* (K!, syn.); Mozambique, Delagoa Bay [Maputo], *Speke s.n.* (K!, syn.).[Note 2]

= *C. obtusa* K.Schum. in Engl., Pflanzenwelt Ost-Africas C: 320 (Oct. 1895a).[Note 3]

Type: East Africa, *Stuhlmann 7827* (B†, holo.). Synonymy according to description, also see N.E.Br. 246 (1902) and Bullock 281 (1955).

A suffrutescent climber, with white latex, up to 4 m high. *Stems* woody, slender, up to 4 mm diameter; younger stems green to slightly purplish-green, smooth, glabrous, rarely slightly muricate; older stems light brown, slightly verrucose, glabrous to slightly muricate; interpetiolar ridges villous, colleters present. *Leaves* opposite, axils villous, petiolate; petiole green, glabrous, grooved, 4–10 mm long; blade oblong to oblong-obovate, 28–73(–95) x 13–32(–38) mm, herbaceous, smooth, glabrous, bright green adaxially, pale green abaxially, bright purple spots occasionally present along abaxial side of main vein; margin plane; apex rounded to retuse, apiculate, not recurved; base rounded to obtuse, occasionally cuneate; venation eucamptodromous, rarely brochidodromous, 6–12 secondary veins on either side of main vein, intersecondary veins absent, tertiary venation random reticulate, areole development imperfect, veinlets branching. *Inflorescences* cymose, sub-compact, many-flowered, each cyme consists of 2–7 dichasia, each dichasium terminating in 2–3 monochasia, glabrous, primary peduncle 4–15 mm long, secondary peduncles (2.5–)5–6(–10) mm long, pedicels 2(–4) mm long; bracts opposite, sparsely arranged, glabrous, acicular, 1.0–1.5 mm long, margins glabrous. *Buds* slender, 6–7 mm long, broadly ellipsoid, apices attenuate, full-turn helically twisted. *Sepals* broadly ovate, 1.5–2 x 1 mm, acute, glabrous, rarely fimbriate, colleters conical. *Corolla* yellowish-white, greenish-yellow or yellow, 7–10 mm long; tube shortly campanulate, (1.0–)1.5–2.0 mm long, outside glabrous, inside villous below stamens; lobes spreading, oblong-ovate, 5–8 x 1–1.5 mm, apices acute. *Corona* double; primary corona inserted 0.8–1 mm from corolla tube base, concealed, lobes clavate, apices obtuse or acute, fleshy, 0.5–1 mm long, glabrous, connivent over gynostegium; secondary corona in corolla lobe sinuses, pocket-like, glabrous. *Stamens* inserted 0.4–0.6 mm from corolla tube base; anthers hastate, acuminate, glabrous, 0.5–0.9 mm long, filaments ± 0.2 mm long. *Nectaries* conspicuous, inserted 0.4–0.6 mm from corolla tube base. *Ovaries* 0.5–0.8 x 0.4–0.8 mm; style ± 0.5 mm long, style-head broadly pyramidal, acute to obtuse, ± 0.5 x 0.7 mm. *Translators* narrowly elliptic, ± 0.3 mm long, apices obtuse. *Follicles* pendulous, reflected at 180–225°, cylindrically ovoid, (49–)74–125(–148) x 3–8(–11) mm, dark brown, apices attenuate, bases cuneate. *Seeds* oblong to oblong-obovate, 4–6(–9) x 1–2(–3) mm, dark reddish-brown, slightly warty; coma white, (16–)25–35(–41) mm. (Fig. 4.3.21.1.)

Diagnostic characteristics

Cryptolepis obtusa is a climber from Southern and East Africa. It has large to medium sized, 28–95 x 13–38 mm, oblong to oblong-obovate, herbaceous leaves with rounded to retuse, apiculate apices. This species is most similar to *C. sinensis* from southern Asia, but is distinguished from the latter species by its shorter pedicels, less than 5 mm long, acicular bracts, smaller flowers, with corollas shorter than 10 mm and primary corona lobes clavate. By contrast *C. sinensis* has pedicels longer than 10 mm, triangular bracts, larger flowers with corollas longer than 10 mm and primary corona lobes turbinate.

Distribution and habitat

Cryptolepis obtusa occurs along the north-eastern border of South Africa, in the north of the Limpopo Province, the east of Mpumalanga Province and the north-east of KwaZulu-Natal Province as well as the eastern parts of Swaziland (Fig. 4.3.21.2.). The species is also found in Mozambique, Tanzania, Malawi, Zimbabwe, Zambia and Kenya. Altitude ranges from about 100 to 700 m. It is common in savannah, forest margins and reed beds along rivers and lakes. The habitats include red alluvial loam, sand or silt. Associated species include *Acacia brevispica* Harms subsp. *dregeana* (Benth.) Brenan, *Acacia xanthophloea* Benth., *Capparis sepiaria* L., *Dichrostachys cinerea* (L.) Wight & Arn., *Ficus sycomorus* L., *Grewia* spp., *Lippia javanica* (Burm.f.) Spreng., *Panicum maximum* Jacq., *Pavetta lanceolata* Eckl., *Rauvolfia caffra* Sond., *Tabernaemontana elegans* Stapf and *Trichilia emetica* Vahl. Flowering occurs in late autumn, from April to May.

Notes

1. The name, *Cryptolepis obtusa*, was originally published by Schumann (1894, 1895b). However, none of the publications by Schumann included any description, diagnosis or reference to a description or diagnosis of the species. Consequently none of these publications can be considered as valid publication of the new name. Brown published this name validly in 1895a and he is therefore the author of this species name.

2. Brown (1895a) listed a number of specimens, which are regarded as syntypes of *C. obtusa.* Among these specimens Brown (1895a) listed a specimen collected in Mozambique by *Forbes s.n.*, which could not be located in any herbarium. In Kew Herbarium the type folder of *C. obtusa* contains a specimen collected by *Monteiro J.J. s.n.* at Delagoa Bay, Mozambique. Since this collection is not mentioned by Brown (1895a) it cannot be considered part of the type material of *C. obtusa.*

3. Though both Brown and Schumann published the name *Cryptolepis obtusa* in 1895, the description of Brown is considered to be the prior publication since it appeared in April/May, whereas that of Schumann only appeared in August.

Representative specimens

— **4º25' S, 39º29' E:** Kenya, Kwale District, Buda Mafisini Forest, 8 miles WSW of Gazi, 16-08-1953, *Drummond, R.B.* & *Hemsley, J.H. 3836* (BR).

— **15º23' S, 35º34' E:** Malawi, Zomba District, 3 km W of Lake Chilwa at Katchoka, 01-06-1970, *Brummitt, R.K.* & *Williams 11203* (BR, K, SRGH).

— **17º27' S, 35º04' E:** Mozambique, Tete, Mutarara, 27-10-1971, *Haffern, J.K. 52* (SRGH).

— **16º22' S, 31º35' E:** Zimbabwe, Kaitano, Chiswiti Tribal Trust Land, 08-04-1965, *Bingham, M.T. 1442* (K, SRGH).

— **19º50' S, 32º30' E:** Zimbabwe, Melsetter, Lusitu River, about 5 km upstream from Lusitu, 23-04-1973, *Ngoni, J.F. 218* (BR, K, MO, SRGH).

— **25º14' S, 31º33' E:** South Africa, Mpumalanga, Kruger National Park, N of Malelane, 04-05-1949, *Codd 5508* (K, PRE, SRGH, MO, UPS).

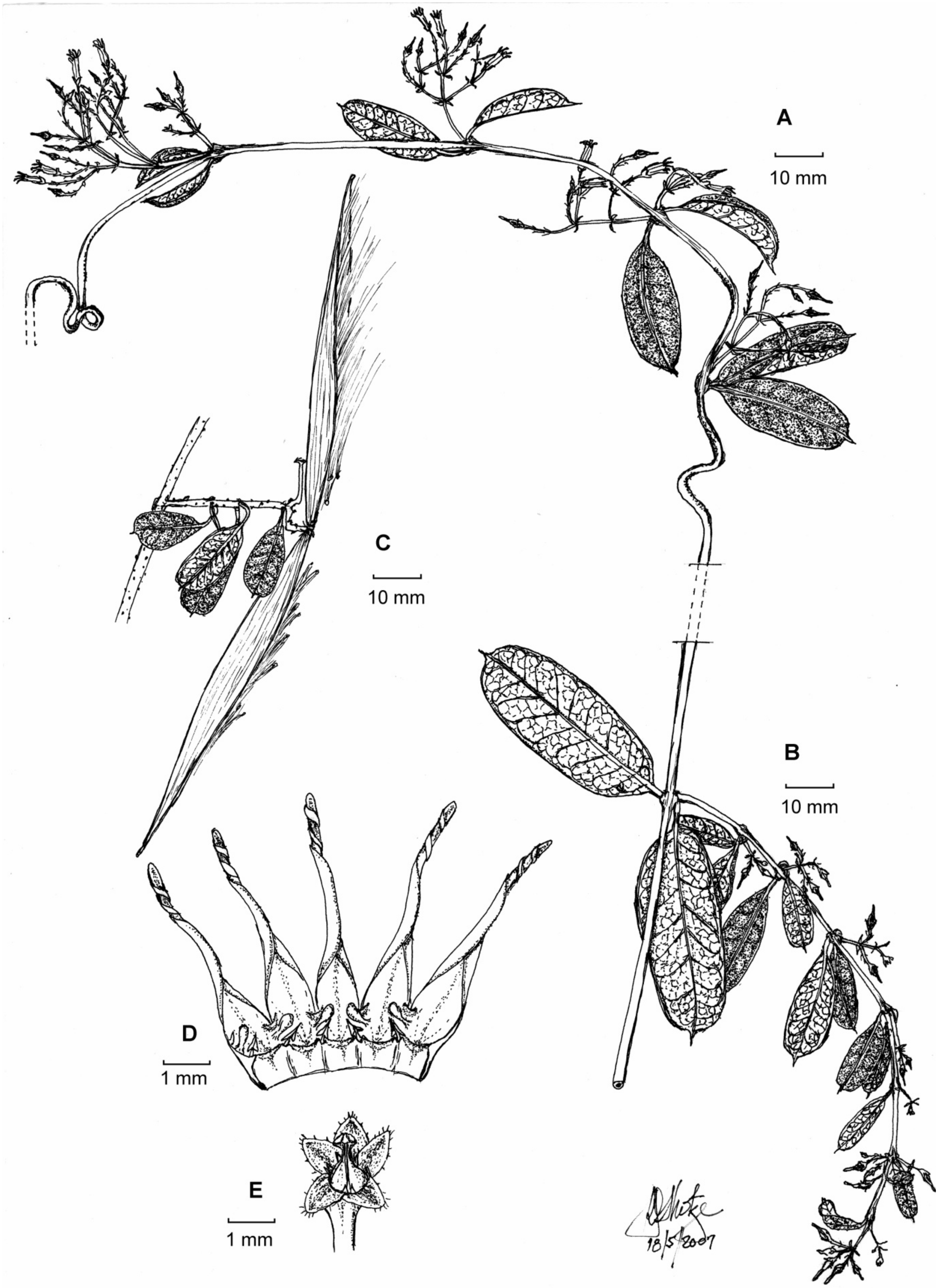


Fig. 4.3.21.1. Illustration of *Cryptolepis obtusa*: (A, B) stem with leaves and inflorescences, (C) stem with leaves and paired follicles, (D) corolla opened showing primary corona of clavate lobes, secondary corona of corolla sinus pockets and stamens with hastate anthers, (E) calyx of hairy sepals and pistil of semi-inferior apocarpous ovaries, style and style-head. Specimens: (A) *Ngoni 218* (SRGH); (B) *Luke & Luke 3755* (K); (C) *Astle 5704* (SRGH); (D–E) *Bingham 1442* (K).

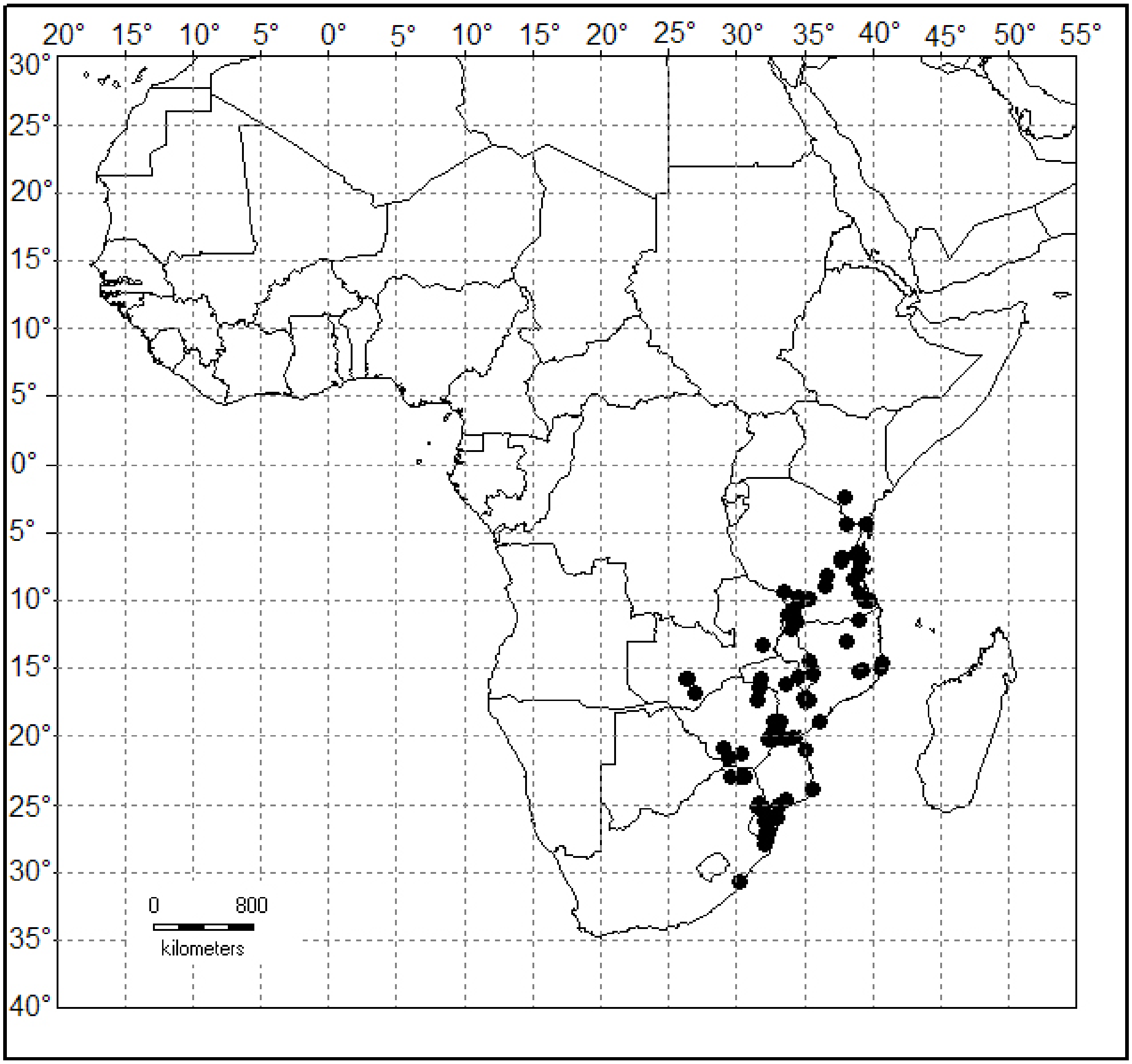


Fig. 4.3.21.2. Known distribution of *Cryptolepis obtusa*.

Leaf micromorphology

Adaxial epidermal cells are more or less isodiametric and tetra- to hexagonal with concave (Fig. 4.3.21.3. A–B) or convex periclinal walls (Fig. 4.3.21.3. C). The anticlinal walls are straight and either raised (Fig. 4.3.21.3. A–B) or sunken (Fig. 4.3.21.3. C). The cuticle is densely striated with straight, parallel striations continuous over intercellular boundaries (Fig. 4.3.21.3. A–C).

The abaxial epidermal cells are more or less isodiametric and tetra- to hexagonal with convex periclinal walls. Anticlinal walls are straight or slightly curved and slightly sunken. The cuticle is strongly striated with striations undulate and arranged in a lattice pattern which is continuous over intercellular boundaries. (Fig. 4.3.21.3. D–F)

The leaves are hypostomatic with stomata randomly orientated and slightly sunken to level with the epidermal surface. Stomata are paracytic with subsidiary cells covered by latticed striations. The guard cells are elliptic with a narrow stomatal ledge. (Fig. 4.3.21.3. D–F)

Seed micromorphology

The adaxial seed surface is covered by evenly distributed protuberances that are formed by raised, deformed epidermal cells (Fig. 4.3.21.4. A–B). Epidermal cells between the protuberances are isodiametric and tetra- to hexagonal. Periclinal walls are convex to occasionally concave while anticlinal walls are straight to curved and deeply sunken. The cells are covered by a granular to weakly striated cuticle (Fig. 4.3.21.4. C).

Abaxially the seed has a narrow, wavy central ridge and thickened margins (Fig. 4.3.21.4. D). The thickened margins are sparsely covered by protuberances that are formed by raised, deformed epidermal cells. Cells between the protuberances are isodiametric and tetra- to hexagonal. Periclinal walls are convex, while anticlinal walls are straight (Fig. 4.3.21.4. E). Cells near the central ridge are isodiametric and tetra- to hexagonal. The periclinal walls are convex to partially concave and anticlinal walls are straight to slightly curved and deeply sunken (Fig. 4.3.21.4. F). Cells on the lower seed surface are covered by a granular cuticle (Fig. 4.3.21.4. F).

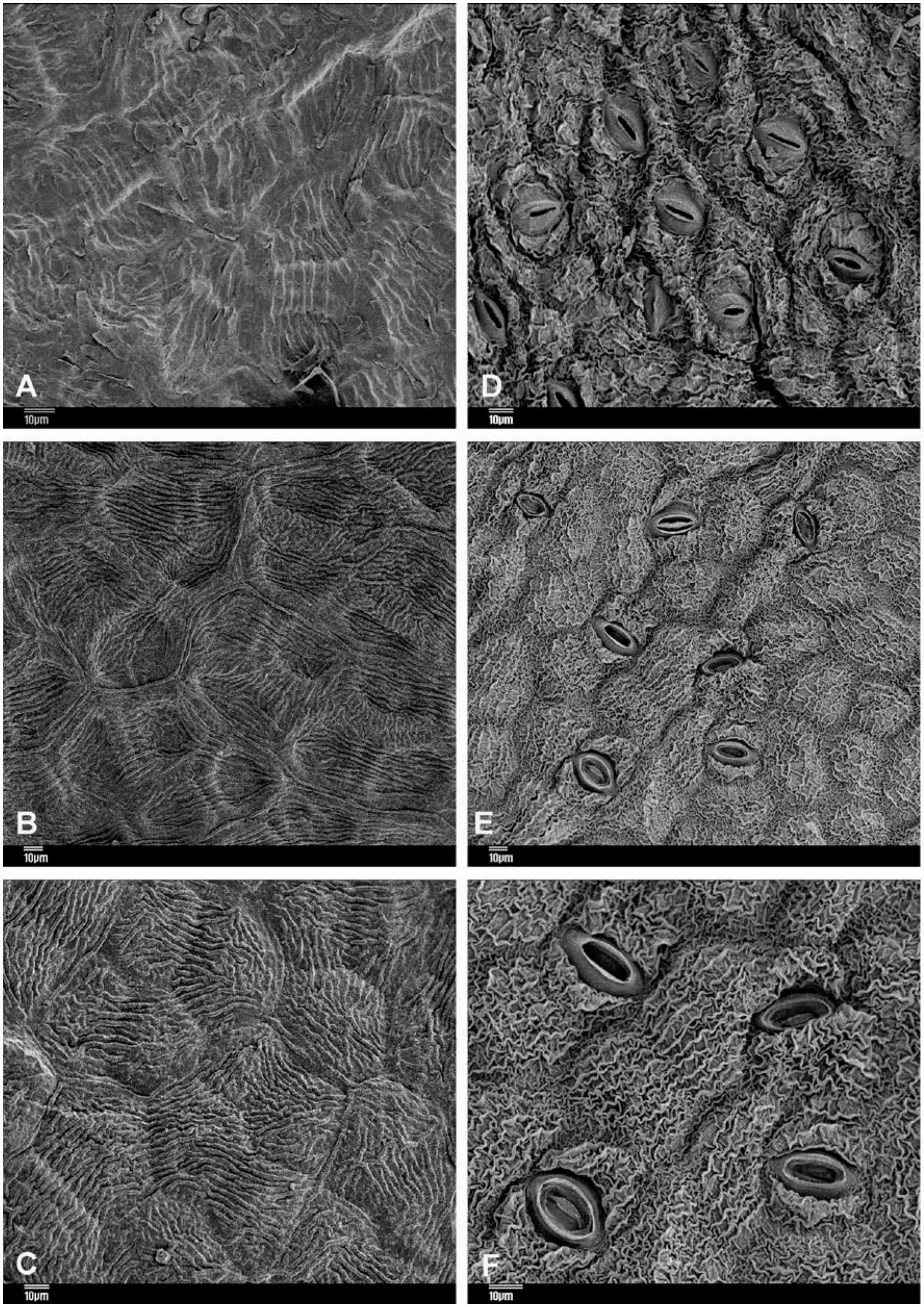


Fig. 4.3.21.3. *Cryptolepis obtusa* leaf epidermal surfaces: (A–B) adaxial epidermal cells with concave periclinal walls and raised anticlinal walls, (C) adaxial epidermal cells with convex periclinal walls and slightly sunken anticlinal walls, (D–F) abaxial epidermis with stomata and latticed striations on the cuticle. Magnification: A = x800; B, E = x500; C–D = x650; F = x900. Specimens: (A, D) *Codd 5508* (SRGH); (B–C, E–F) *Bingham 1442* (K).

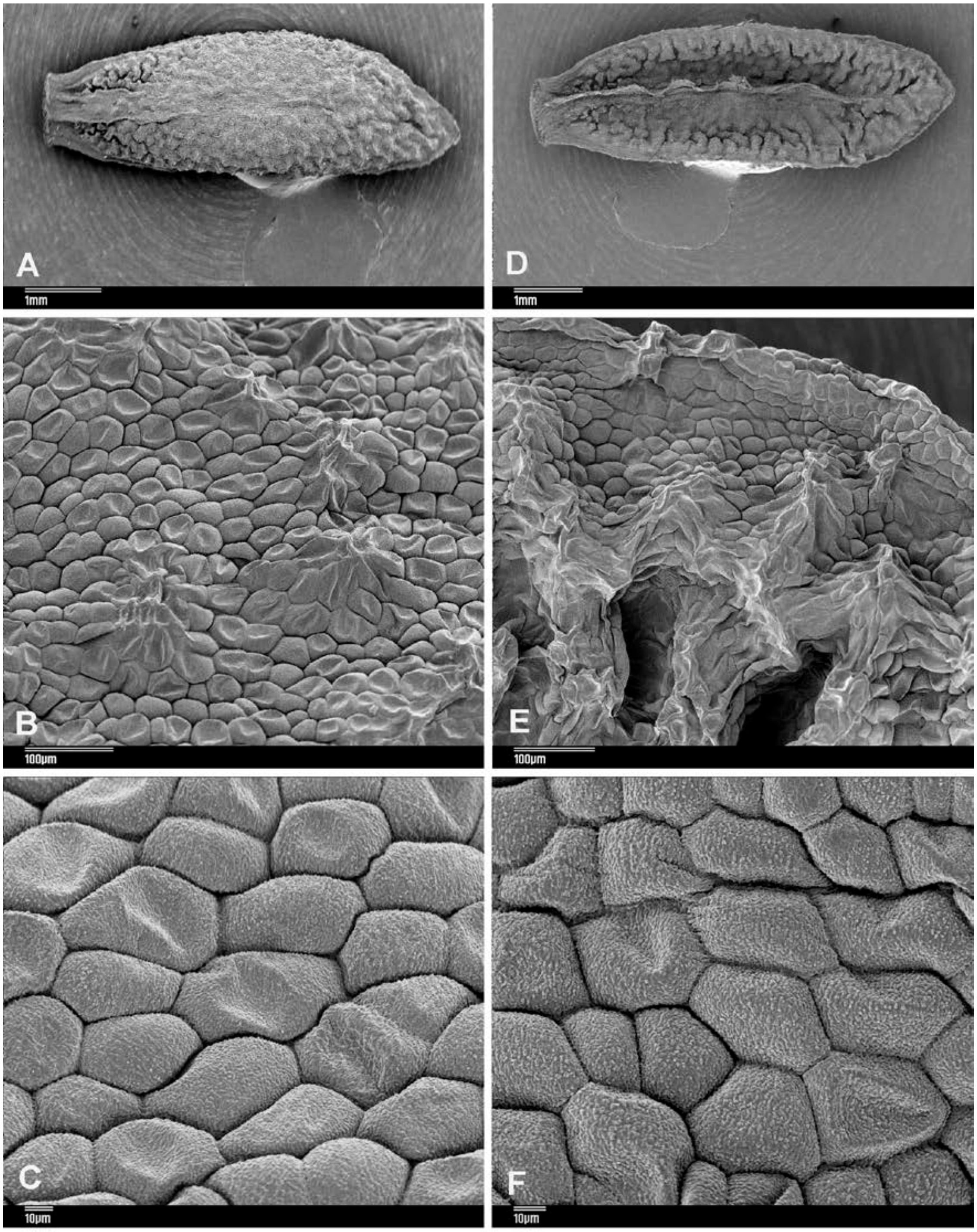


Fig. 4.3.21.4. *Cryptolepis obtusa* seed surfaces: (A) adaxial view of seed, (B) adaxial seed surface with evenly arranged protuberances, (C) cells tetra- to hexagonal with convex periclinal walls and granular cuticle, (D) abaxial view of seed, (E) thickened seed margin with sparsely distributed protuberances, (F) cells tetra- to hexagonal with convex to partially concave periclinal walls and granular cuticle. Magnification: A = x19; B = x220; C = x700; D = x17; E = x200; F = x800. Specimen: (A–F) *Haffern 52* (SRGH).

4.3.22 *Cryptolepis orbicularis* Chiov., Flora Somala 2: 291 (1929); Venter: 137 (2006). **Type:** Somalia, Oltregiuba, Piana di Gobuin di Chisimaio, *Gorini, P. 322* (FT-scan!, holo.).

A dwarf-shrub with white latex. *Stems* woody, twining or prostrate, slender, stem diameter unknown; young stems light grey-brown, smooth, glabrous to slightly puberulous; older stems dark grey-brown, smooth to fissured, glabrous; interpetiolar ridges glabrous, inconspicuous to absent on younger and older branches; brachyblasts rarely present, colleters present. *Leaves* opposite or rarely fascicled on brachyblasts, axils puberulous, sessile; blade broadly elliptic, rarely elliptic, 8–20 x (3–)7–10 mm, coriaceous, light green, puberulent to slightly scabrid on both surfaces; margin plane, occasionally slightly undulate; apex rounded to acute, not recurved, mucronate; mucro prominent, reddish, slightly puberulous; base cuneate, rarely rounded; venation brochidodromous, 3–4 secondary veins on either side of main vein, indistinct, higher order venation indistinct, tertiary veins random reticulate, areoles lacking. *Flowers* solitary, axillary, pedicels 3–5(–8) mm long; bracts opposite, sparsely arranged, glabrous, narrowly elliptic, 1–1.5 mm long, margin glabrous, apices prominently mucronate, villous. *Buds* slender, 5–6 mm long, oblong, apices cuneate, half-turn helically twisted. *Sepals* dark green, narrowly linear to acicular, ± 3 x 0.4 mm, apices mucronate, puberulous, conspicuous, colleters ovate, apices dentate. *Corolla* white, 13–13.5 mm long; tube campanulate, 2.5–3 mm long, glabrous outside and inside; lobes spreading, oblong to obovate, 10–11 x 3–3.5 mm, apices obtuse. *Corona* single; primary corona inserted 1.2–1.5 mm from corolla tube base, included, lobes narrowly clavate, ± 0.8 mm long, glabrous, apices acute, connivent over gynostegium. *Stamens* inserted ± 0.7 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 0.7 mm long, sub-sessile. *Nectaries* inconspicuous, inserted ± 0.4 mm from corolla tube base. *Ovaries* 0.2–0.3 x 0.5–0.7 mm; style ± 0.2 mm long, style-head broadly pyramidal, acute, ± 0.4 x 0.5–0.8 mm. *Translators* narrowly elliptic, ± 0.2 mm long, apices acute. *Follicles* erect, narrowly divaricate at 10°–60°, cylindrical, 65–75 x 3–4 mm, light brown, apices attenuate, bases cuneate. *Seeds* narrowly oblong to oblanceolate, 4–6 x 0.5–0.8 mm, brown, smooth; coma yellowish-white, ± 25 mm long. (Fig. 4.3.22.1.)

Diagnostic characters

Cryptolepis orbicularis is a dwarf-shrub with twining or prostrate stems. The young stems are glabrous to slightly puberulous while older stems are glabrous. The leaves are broadly elliptic, or rarely elliptic, small, 8–20 x (3–)7–10 mm, coriaceous, puberulent to slightly scabrid with rounded to acute apices. This species is most similar to *C. thulinii,* specimens of which were previously included in *C. orbicularis. Cryptolepis orbicularis* is distinguished from *C. thulinii* by its glabrous to slightly puberulous stems, solitary flowers, acicular bracts with prominent mucronate apices, narrowly linear to acicular, mucronate sepals, corolla longer than 13 mm, oblong to obovate petals 10–11 x 3–3.5 mm, single corona and narrowly clavate primary corona lobes. By contrast *C. thulinii* has densely tomentose stems, covered by crispate trichomes, flowers in lax, few-flowered inflorescences, bracts acicular, fimbriate, ovate sepals, corolla shorter than 10 mm, corolla lobes linear 4–5.5 x 0.5–1 mm, corona double and primary corona lobes triangular and flap-like. The follicles of *C. orbicularis* are narrower than 4 mm, while follicles of *C. thulinii* are wider than 5 mm. The seeds of *C. orbicularis* are also smaller than those of *C. thulinii,* being 4–6 x 0.5–0.8 mm in the former species and 7–9 x 2–2.5 mm in the latter species.

Distribution and habitat

Cryptolepis orbicularis is endemic to Somalia (Fig. 4.3.22.2.). It is found at altitudes from 20–360 m. *Cryptolepis orbicularis* grows on coastal dunes or in sandy soil overlaying limestone or sandstone on plains, in open grassland or in disturbed areas which have been cleared of *Vigna sinensis* cultivation or fallow land with residual patches of *Acacia-Commiphora* bushland with shrubs 2–3 m tall. This species is also associated with *Acacia* sp., *Albizia* sp., *Caesalpinia erianthera* Chiov., *Corchorus* sp., *Dichrostachys kirkii* Benth., *Eleinia* sp., *Grewia cerasifera* Chiov., *Helichrysum* sp., *Indigofera* sp., *Rhynchosia* sp., *Stylosanthes* sp., *Tophrosia* sp., *Vernonia* sp. Flowering occurs throughout the year with a peak from April to June.

Representative specimens

— **1º07'47'' N, 43º58'57'' E:** Shabeellaha Hoose Region, Brava [Baraawe] District, 30-04-1983, *Thulin, M*. & *Warfa, A.M. 99* (UPS).

— **1º57'33'' N, 45º12'09'' E:** Banaadir Region, S of Mogadishu, 12-11-1985, *Thulin, M.* & *Warfa, A.M. 5305* (UPS).

— **3º45' N, 47º02' E:** Galguduud Region, Ceeldheer District, 10-05-1990, *Thulin, M., Hedrén, M. & Dahir, A.M. 7410* (K, UPS).

— **4º38' N, 47º41' E:** Mudug Region, Xaradheere District, on road to Bulo Berti, 10-06-1979, *Gillett, J. B., Hemming, C.F. & Watson, R.M. 22534* (EA).

— **5º00' N, 47º59' E:** Mudug Region, Xaradeere District, 1 km S of Ad [Qeycad] on road to Haghadera [Xaradeere], 08-06-1979, *Gillett, J.B., Hemming, C.F. & Watson, R.M. 22484* (EA).

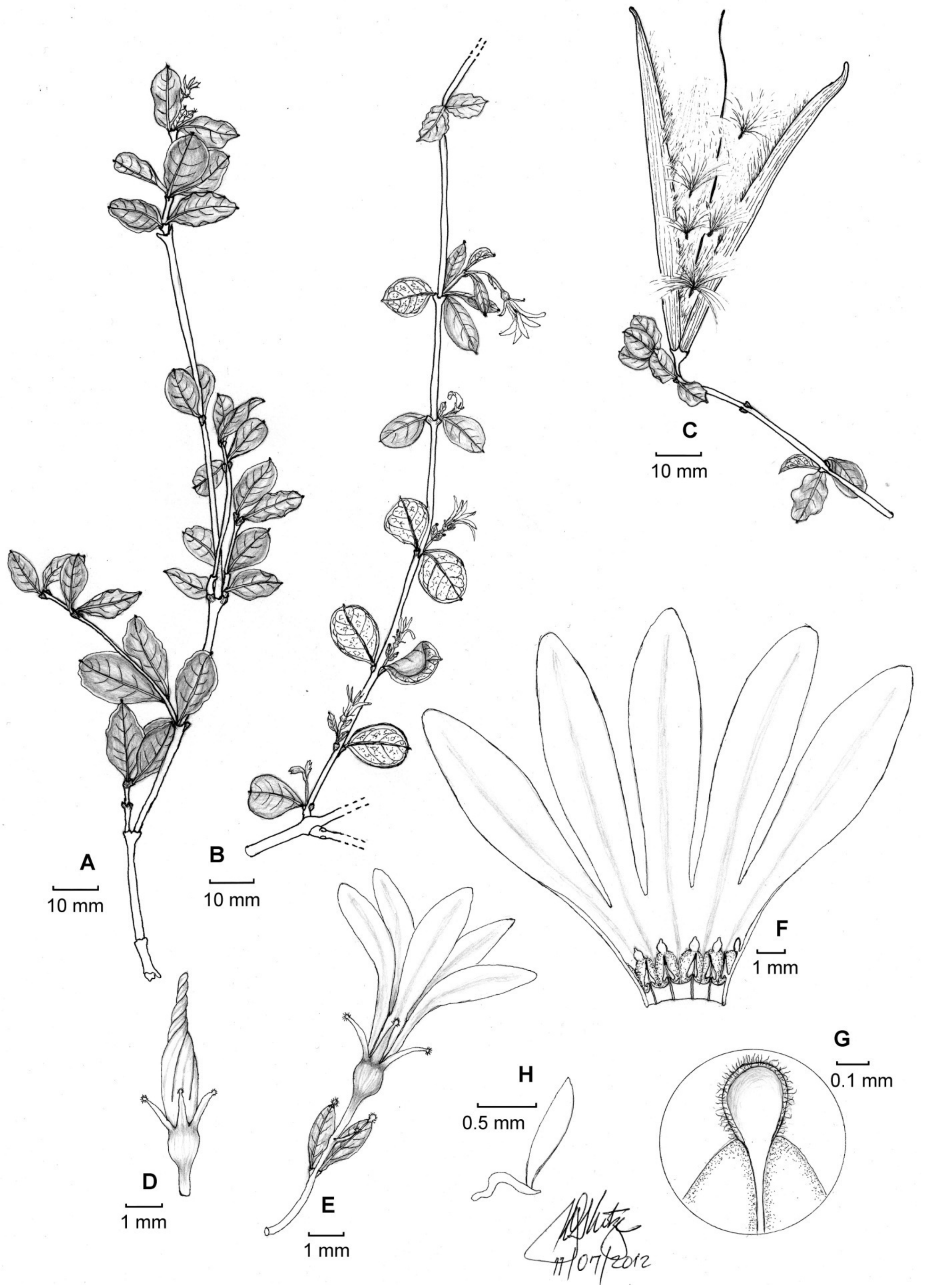


Fig. 4.3.22.1. Illustration of *Cryptolepis orbicularis*: (A, B) stem with leaves and flowers, (C) stem with paired follicles, (D) external view of bud, (E) external view of mature flower, (F) corolla opened showing narrowly clavate primary corona lobes and stamens with narrowly hastate anthers, (G) leaf apex showing mucro, (H) translator. Specimens: (A) *Gillett, Hemming & Watson 22534* (EA); (B) *Thulin & Warfa 5305* (UPS); (C) *Thulin, Hedrén & Dahier 7410* (UPS); (D–H) *Thulin & Warfa 99* (UPS).

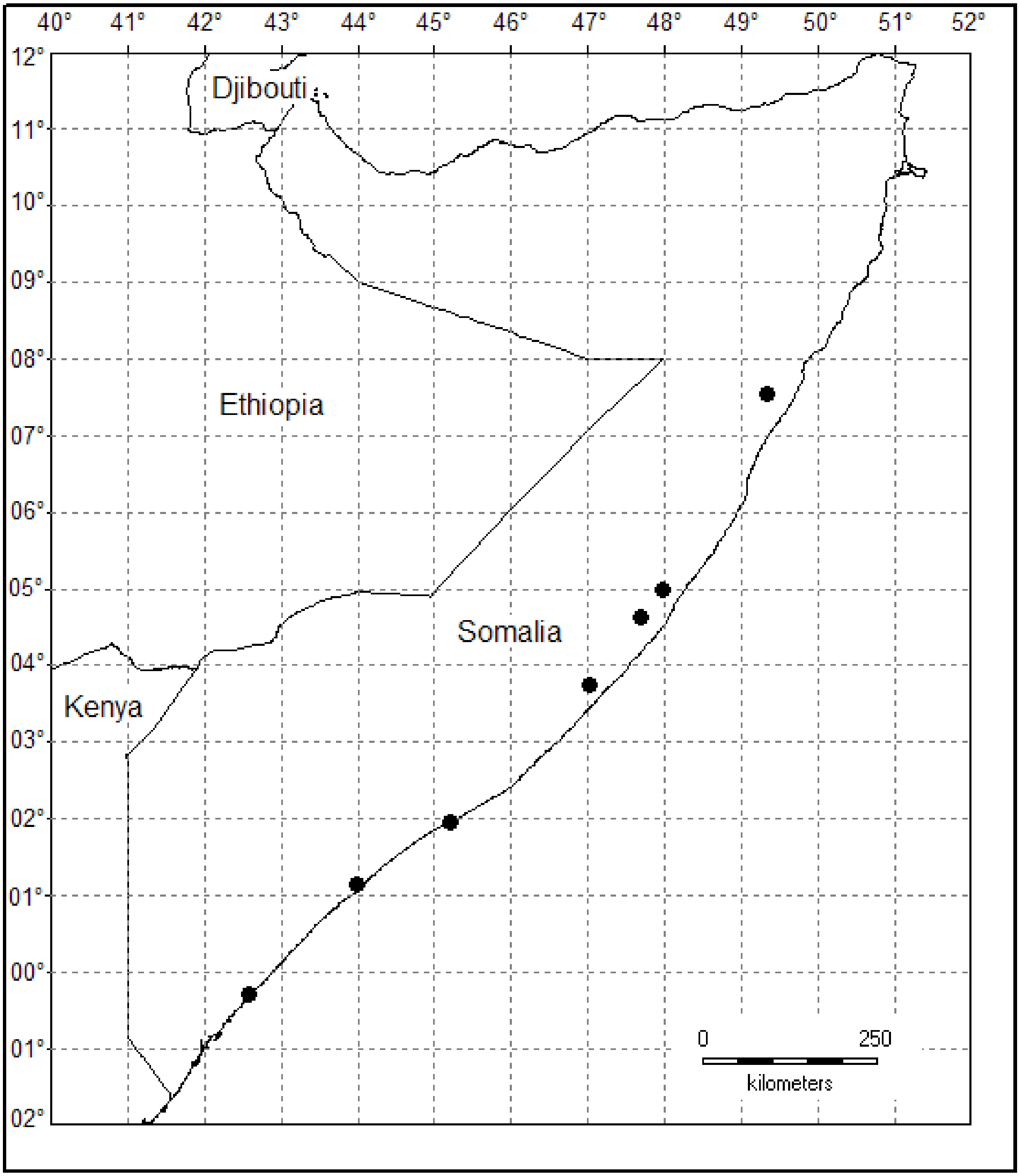


Fig. 4.3.22.2. Known distribution of *Cryptolepis orbicularis*.

Leaf micromorphology

Cells on the adaxial surface are more or less isodiametric and tetra- to hexagonal. Periclinal walls are convex while anticlinal wall boundaries are straight to slightly curved and slightly sunken. The cuticle is slightly striated with straight, parallel striations, continuous over intercellular boundaries. (Fig. 4.3.22.3. A–B)

The abaxial epidermis consists of more or less isodiametric, tetra- to hexagonal cells characterized by convex periclinal walls and straight, slightly sunken anticlinal walls. The cuticle is striated with striations straight to slightly wavy, parallel and continuous over intercellular boundaries. (Fig. 4.3.22.3. D–E)

Short, triangular trichomes with multi-cellular bases are occasionally present on both epidermal surfaces, especially along leaf margins. Trichomes have a nodular surface with cuticular striations radiating from trichome bases. (Fig. 4.3.22.3. C, F)

Leaves are amphistomatic, with nearly equal numbers of stomata on both epidermal surfaces. Stomata are randomly orientated and level with the surrounding epidermal cells (Fig. 4.3.22.3. A–B, D–E). Stomata are paracytic with the cuticle over subsidiary cells smooth (Fig. 4.3.22.3. A–B) to slightly striated with striations perpendicular (Fig. 4.3.22.3 D) to parallel to the stomatal pore (Fig. 4.3.22.3. E). The guard cells are broadly elliptic and are covered by a narrow stomatal ledge (Fig. 4.3.22.3. A–B, D–E).

Seed micromorphology

The adaxial seed coat surface is smooth with indentations formed by collapsed cells (Fig. 4.3.22.4. A–B). Adaxial epidermal cells are isodiametric and tetra- to hexagonal. Periclinal walls are convex, with transverse ridges or indentations, giving the surface a ribbed appearance (Fig. 4.3.22.4. B–C). Anticlinal walls are straight and slightly sunken and the cuticle is smooth (Fig. 4.3.22.4. B–C).

Abaxially the seed has a narrow central ridge and slightly thickened margins (Fig. 4.3.22.4. D). The abaxial surface is uneven, with epidermal cells forming narrow ridges or protuberances (Fig. 4.3.22.4. E). Epidermal cells are isodiametric and tetra- to hexagonal. Periclinal walls are convex while anticlinal walls are straight and sunken. The cuticle is smooth with irregular indentations (Fig 4.3.22.4. F).

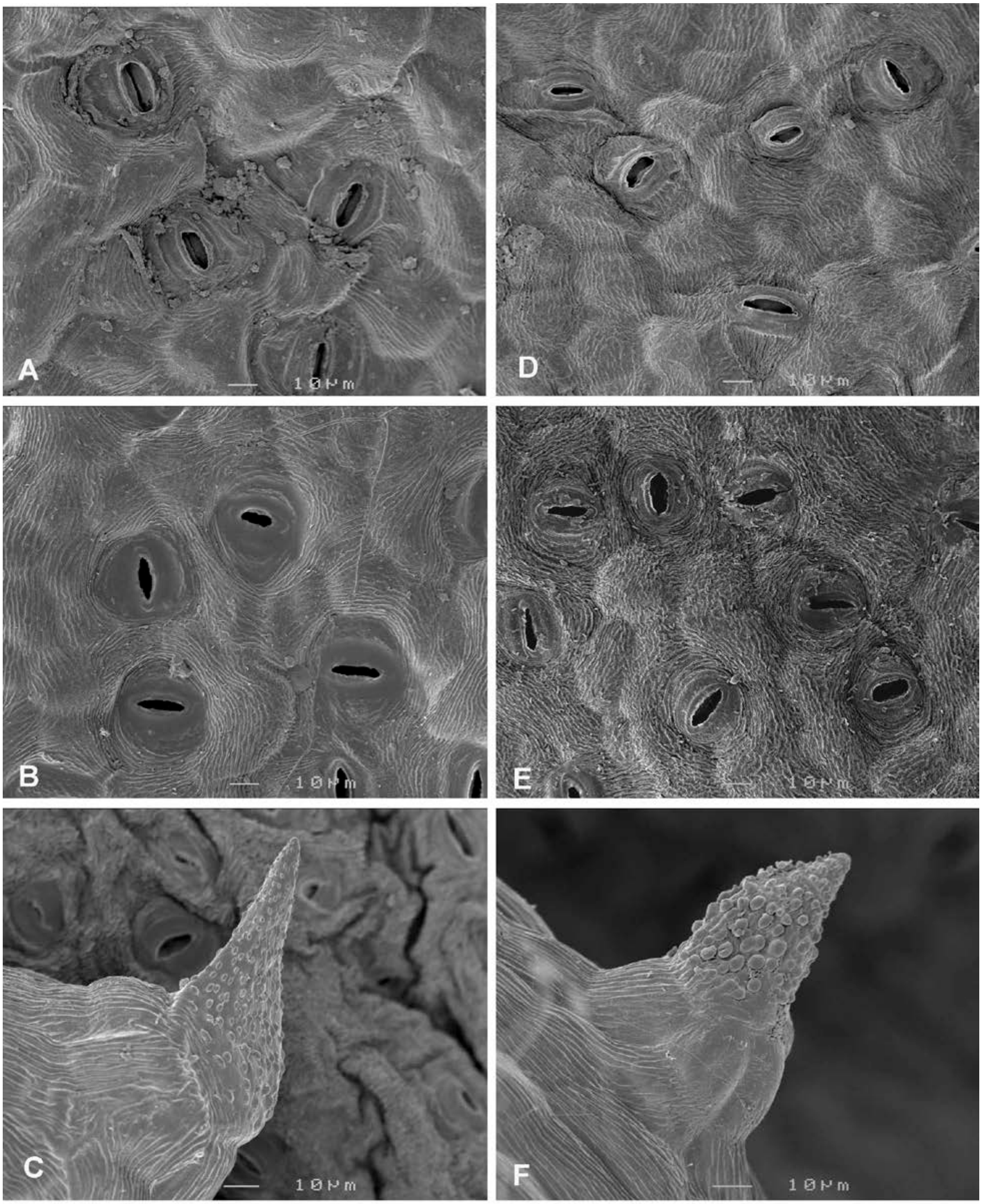


Fig. 4.3.22.3. *Cryptolepis orbicularis* leaf epidermal surfaces: (A–B) adaxial epidermal cells with convex periclinal walls, slightly striated cuticle and stomata, (C) trichome on adaxial leaf surface, (D–E) abaxial epidermis with convex periclinal walls, striated cuticle and stomata, (F) trichome on abaxial leaf surface. Magnification: A–B, D–E = x650; C = x800; F = x900. Specimens: (A, D) *Gillett et al. 22534* (EA); (B, E–F) *Thulin et al. 7410* (UPS); (C) *Thulin et al. 10480* (UPS).

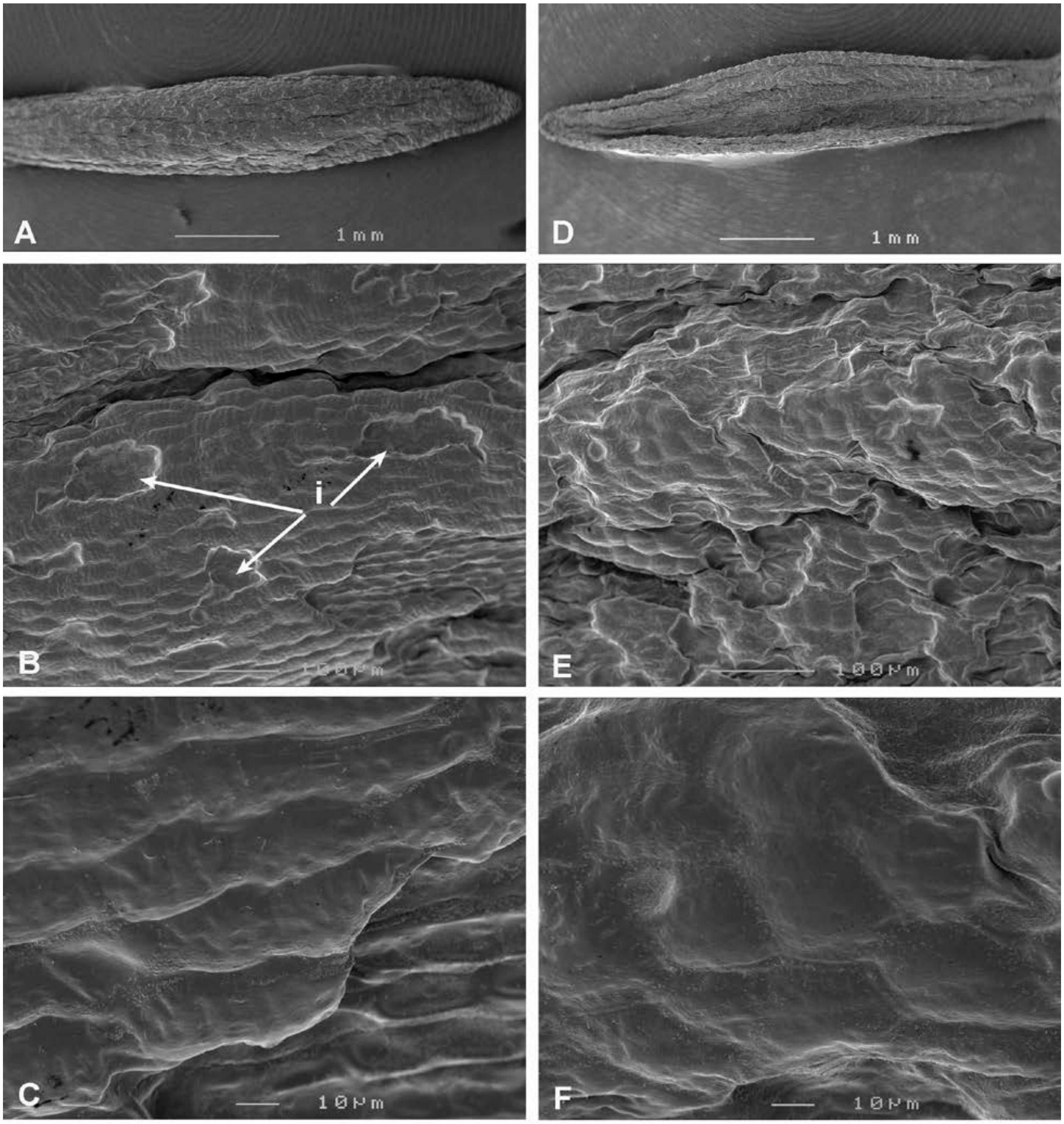


Fig. 4.3.22.4. *Cryptolepis orbicularis* seed surfaces: (A) adaxial view of seed, (B) adaxial seed surface with indentations (i), (C) cells tetra- to hexagonal with convex periclinal walls and smooth cuticle, (D) abaxial view of seed, (E) abaxial seed surface with uneven protuberances or ridges, (F) abaxial cells tetra- to hexagonal with convex periclinal walls and smooth cuticle. Legend: i = indentations. Magnification: A, D = x20; B, E = x220; C–D = x900. Specimen: (A–F) *Thulin et al. 7410* (UPS).

4.3.23 ***Cryptolepis sanguinolenta*** (Lindl.) Schltr., Westafrikanische Kautschuk-Espedition*:* 308 (1900); N.E.Br.: 245 (1902); Hutch. & J.M.Dalz.: 53, f. 195 (1931); Bullock 281 (1955); Venter: 134 (2012). Basionym: *Pergularia sanguinolenta* Lindl. in Curtis's Botanical Magazine 52: t. 2532 (1825), 72 (1826); Decne.: 619 (1844). **Type:** Sierra Leone, *Don, G. anno 0-0-1822* (K!, holo.).[Note 1]

= *C. triangularis* N.E.Br. in Scott Elliot, Botanical Journal of the Linnean Society 30, 92 (1895b)[Note 2], 245 (1902); Hiern: 676 (1898); Hutch. & J.M.Dalz.: 53 (1931); A.Chev.: 428 (1920).
Types: Nigeria, Nupe, *Barter 1333* (K!, lecto., here designated); Nigeria, Abbeokuta, *Barter 3359* (K!, L! (Herb. Lugd. Bat. 908.335-719), syn.); Angola, *Welwitsch 5993* (BR!, K!, LISU-scans [2 sheets]!, syn.).

= *Strophanthus radcliffei* S.Moore, Journal of the Linnean Society 37: 180 (1906).
Type: Uganda, Coast of Victoria Nyanza, *Bagshawe 589* (BM!, holo.).

A climber, with orange to red latex, up to 15 m high. Stems woody, slender, diameter unknown; young stems light reddish-brown, smooth, glabrous; older stems grey-brown, slightly verrucose, bark peeling, glabrous; interpetiolar ridges glabrous to puberulous, conspicuous; colleters present. *Leaves* opposite, axils villous, petiolate; petiole green, glabrous, slightly grooved, (4–)7–12(–17) mm long; blade narrowly to broadly elliptic, 50–80(–120) x 20–32(–48) mm, herbaceous, dark green adaxially, pale green abaxially, sometimes with coppery sheen, glabrous to slightly puberulous; margin plane; apex attenuate to acuminate, glabrous, not recurved; base obtuse to cuneate; venation brochidodromous, conspicuous on abaxial surface, 4–6 secondary veins on either side of main vein, intersecondary venation absent, tertiary veins random reticulate to weakly percurrent, oblique in relation to the primary vein, areoles imperfect, veinlets branched. *Inflorescences* cymose, lax, few- to many-flowered, robust, each cyme consists of 1–3 monochasia or 1–3 dichasia, ending in 1–2 monochasia, primary peduncle (15–)20–30(–35) mm long, secondary peduncles, when present, 18–20 mm long, pedicels 12–16 mm long; bracts opposite, sparsely to densely arranged, glabrous, oblanceolate to spatulate, ± 3 x 1.5 mm, margins glabrous. *Buds* robust, 14–20 mm long, oblong, apices attenuate and clavate, full turn helically twisted. *Sepals* pale green, elliptic to narrowly ovate, 3–6 x 1.2–2 mm, apices glabrous, colleters conical. *Corolla* cream, yellow or greenish-yellow, 13–32 mm long; tube campanulate, 3.5–5 mm long, glabrous outside and inside; lobes reflexed, linear to narrowly ovate, 9.5–27 x 1.5–2.5 mm, apices acute. *Corona* double; primary corona inserted 2.5–3 mm from corolla tube base, included, lobes hastate, fleshy, ± 0.6–0.7 mm long, glabrous, apices acute, connivent over gynostegium, corona lobe bases forming prominent spongy ridges with grooves running down to interstaminal nectar pockets; secondary corona formed by thickened corolla lobe bases. *Stamens* inserted 0.7–1.5 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 1 mm long, filament ± 0.2 mm long. *Nectaries* conspicuous, inserted 0.7–1.5 mm from corolla tube base. *Ovaries* ± 0.8 x 1 mm; style ± 0.2 mm long, style-head broadly pyramidal, apiculate, bifid, ± 0.5 x 1 mm. *Translators* narrowly elliptic, ± 0.8 mm long, apices acute. *Follicles* pendulous, widely divaricate at 180°–220°, cylindrical, falcate, (85–)105–160(–230) x 4–6 mm, light to dark brown, apices attenuate, bases cuneate. *Seeds* narrowly elliptic, 6–8 x 1.5–2 mm, dark brown, smooth; coma white to yellowish-white, 30–40 mm long. (Fig. 4.3.23.1.)

Diagnostic characteristics

Cryptolepis sanguinolenta is a large climber, with orange to red latex. It has large, 50–80(–120) x 20–32(–48) mm, narrowly to broadly elliptic, herbaceous leaves with attenuate to acuminate apices. This species is distinguished from all similar, large-leaved climbing *Cryptolepis* species, by a combination of orange to red latex, oblanceolate to spatulate bracts, buds with prominent clavate apices, corona double and primary corona lobes hastate.

Distribution and habitat

Cryptolepis sanguinolenta is widespread throughout Central and West Africa, growing from Senegal to Angola along the west coast, and Uganda and Tanzania towards the east coast of Africa (Fig. 4.3.23.2.). It grows at altitudes of 0–1400 m in deciduous to evergreen forest, thicket and disturbed marginal habitat and plantations on hill sides and in valleys. This species is found in red brown clayey loams with varying sand and fire-carbon content and varying soil depth with some exposed rock such as granite or laterite. Associated species include *Julbernardia unijugata* J.Léonard*, Baphia punctulata* Harms*, Holoptelea grandis* Mildbr.*, Diospyros abyssinica* (Hiern) F.White*, Cynometra alexandri* C.H.Wright*, Kiggelaria* sp.*, Pseudospondias microcarpa* Engl.*, Bulbostylis* sp., *Rinorea* spp*.* and Acanthaceae*.* Flowering occurs throughout the year with a peak from May to July.

Notes

1. Lindley (1825) did not designate a type specimen in his description of *Pergularia sanguinolenta,* but an illustration accompanied the description. This illustration was based on a plant cultivated in the garden of the Horticultural Society at Chiswick, grown from seed collected by G. Don in 1822. A specimen of this species, collected by G. Don in 1822, is housed at K and since it is the only specimen which can be connected to the original description, it is considered to be the holotype.

2. Brown (1895b) published the description of *Cryptolepis triangularis* before he determined that his plant was the same species as *Pergularia sanguinolenta* Lindl., after which he placed his *Cryptolepis triangularis* N.E.Br. as a synonym under *Pergularia sanguinolenta* Lindl. (Brown, 1902).

Representative specimens

— **0º29' N, 30º23' E:** Uganda, Kabarole District, Kibale Forest, Ngogo, 15-06-1997, *Eilu, G. 112* (K).

— **3º24' N, 11º47' E:** Cameroon, Yaounde [District], Colline Rocheuse de Mokomessi [Hill], 20 km NNW of Zoetele, which lies 35 km NNW of Sangmelima, 07-07-1972, *Letouzey, R. 11442* (COI, K).

— **4º08' N, 24º06' E:** Putu District, near Niomgasa and Wembo [Airport], 06-1931, *Lebrun, J. 3210* (BR).

— **4º40' S, 29º37' E:** Tanzania, Kigoma District, Gombe Stream Reserve, along the path to Peak Ridge from NP.H2., 06-05-1992, *Mbango, F. & Lyanga, M. 1115* (K).

— **7º22' S, 20º51' E:** Angola, Nordeste da Lunda, [Lunda Norte Province], Dundo District, near Luachima River, 11-1946, *Gossweiler, J. 13921* (BM, K).

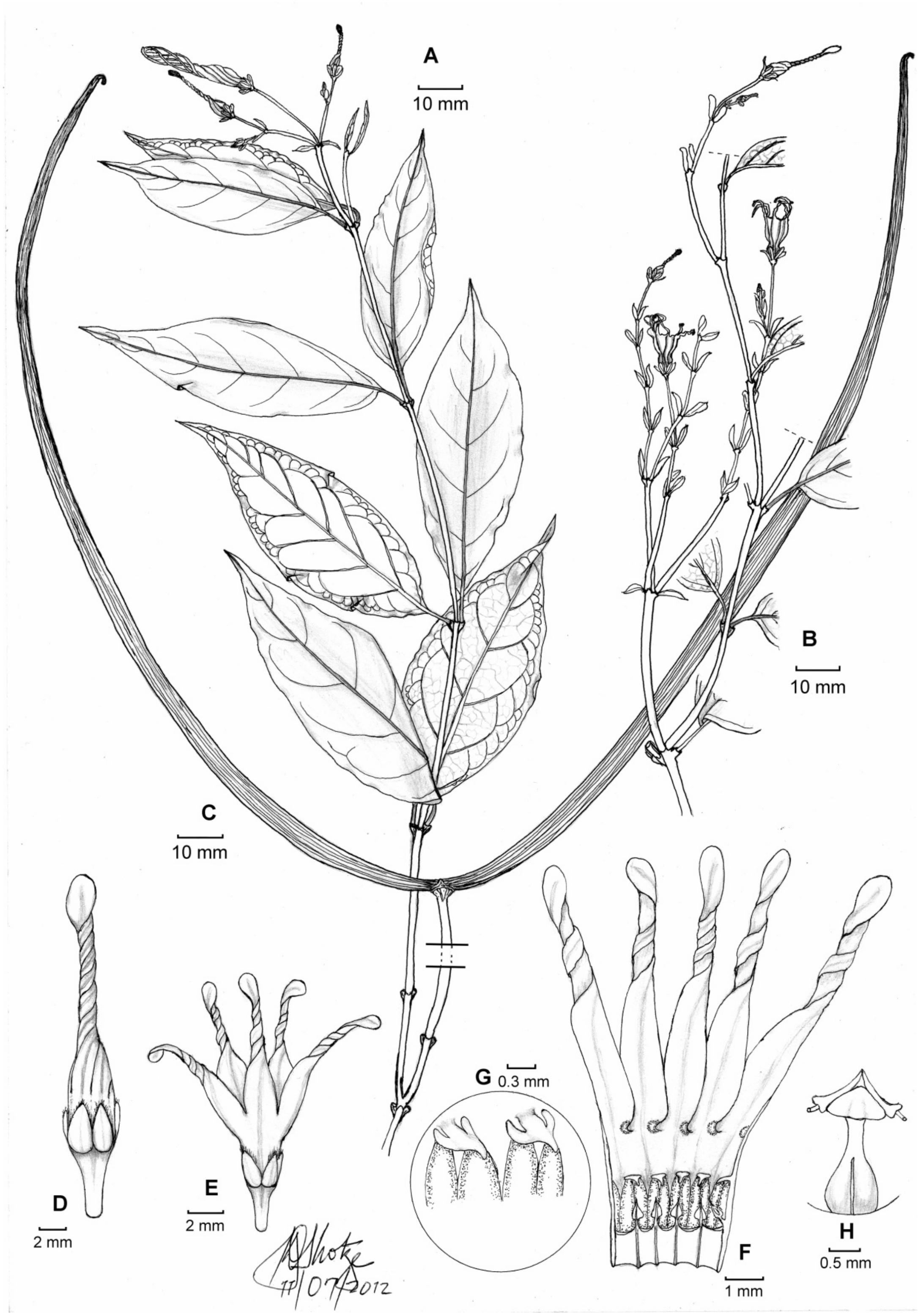


Fig. 4.3.23.1. Illustration of *Cryptolepis sanguinolenta*: (A) stem with leaves and inflorescence, (B) stem with inflorescences showing spatulate bracts, (C) paired follicles, (D) external view of bud, (E) external view of mature flower with helically twisted corolla lobes, (F) corolla opened showing hastate primary corona lobes with prominent coronal feet, secondary corona at corolla lobe bases, stamens with narrowly hastate anthers and nectaries, (G) hastate, horizontally orientated corona lobes with prominent coronal feet, (H) pistil of semi-inferior apocarpous ovaries, style and style-head with anthers connivent over style-head. Specimens: (A) *Mbango & Lyanga 1115* (K); (B, D–E) *Daramola 38040* (WAG); (C) *Le Testu 2569* (BM); (F–H) *Eilu 112* (K).

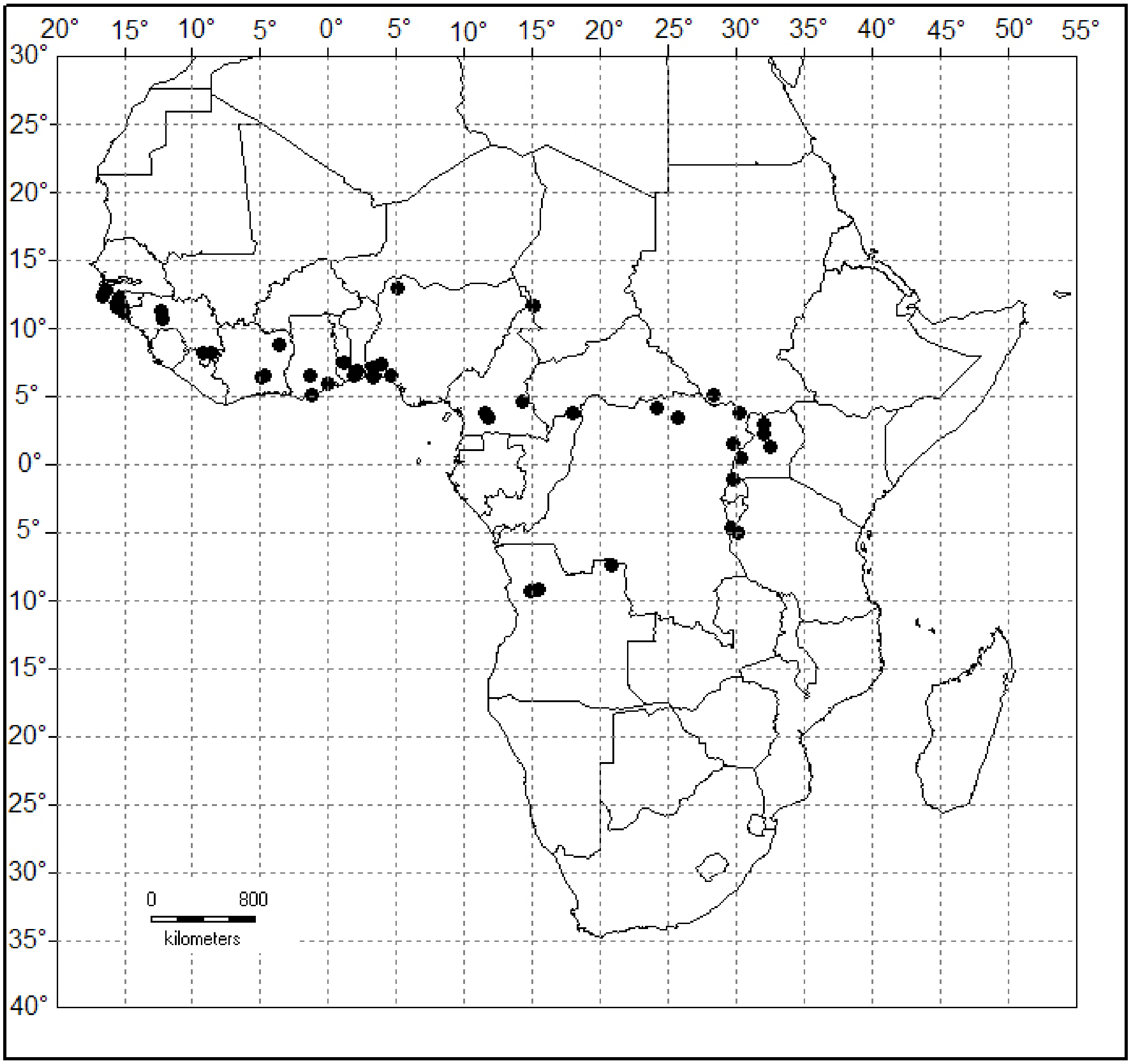


Fig. 4.3.23.2. Known distribution of *Cryptolepis sanguinolenta*.

Leaf micromorphology

Cell shape on the adaxial epidermal surface is isodiametric and penta- to hexagonal. Periclinal walls are tabular while anticlinal walls are straight and level with the epidermal surface. The cuticle is striated, with striations straight or slightly wavy, randomly orientated and continuous over intercellular boundaries. (Fig. 4.3.23.3. A–C)

Abaxial epidermal cells are isodiametric and tetra- to hexagonal. Periclinal walls are tabular, while anticlinal walls are straight and level with the epidermal surface. The cuticle is striated, with striations straight or slightly wavy, parallel and continuous over intercellular boundaries. (Fig. 4.3.23.3. D–F)

Leaves are hypostomatic with stomata randomly orientated and level with surrounding epidermal cells. Stomata are paracytic with the cuticle covering subsidiary cells smooth (Fig. 4.3.23.3. E) to striated and striations parallel or perpendicular to the stomatal pore (Fig. 4.3.23.3. D, F). Guard cells are narrowly elliptic and covered by a broad stomatal ledge (Fig. 4.3.23.3. D–F).

Seed micromorphology

The adaxial seed surface is smooth (Fig. 4.3.23.4. A). Adaxial epidermal cells are elongated and tetra- to hexagonal. Periclinal walls are concave while anticlinal walls are straight and slightly sunken. The cuticle is finely striated, with striations randomly orientated and restricted to individual cells (Fig. 4.3.23.4. B–E).

Abaxially the seed has a narrow central ridge and prominently thickened seed margins (Fig. 4.3.23.5. A). The surfaces between the ridge and seed margins are smooth. Cells are isodiametric to elongated and tetra- to hexagonal. Periclinal walls are concave to tabular, while anticlinal walls are straight and raised to slightly sunken. The cuticle has a coarse to fine, granular appearance (Fig. 4.3.23.5. B–E).

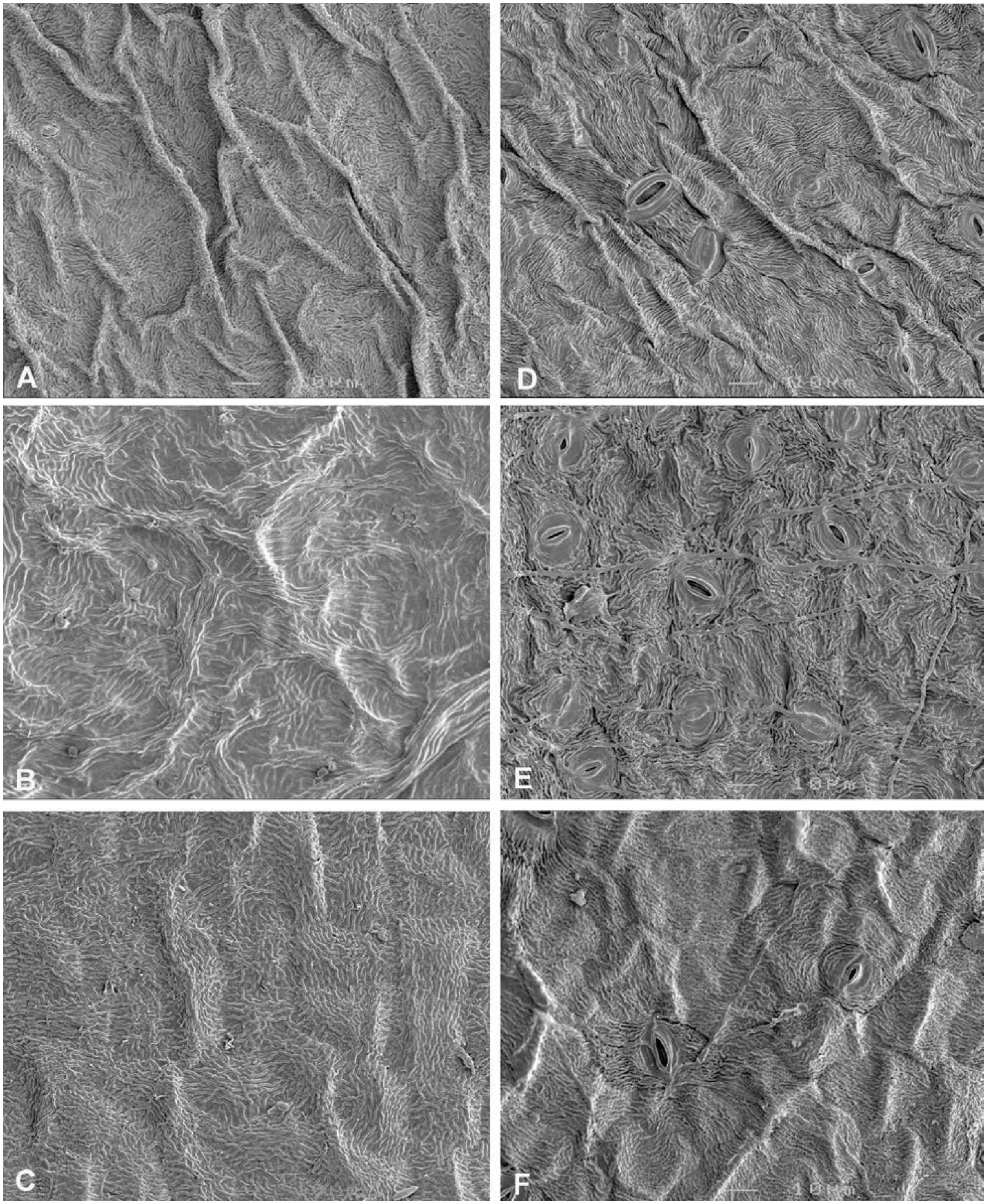


Fig. 4.3.23.3. *Cryptolepis sanguinolenta* leaf epidermal surfaces: (A–C) adaxial epidermal cells with tabular periclinal walls and striated cuticle, (D–F) abaxial epidermis with tabular periclinal walls, striated cuticle, and stomata, Magnification: A–F = x650. Specimens: (A, D) *Clutton-Brock 354A* (EA); (B, E) *Letouzey 11442* (COI); (C, F) *Sheil 1640* (K).

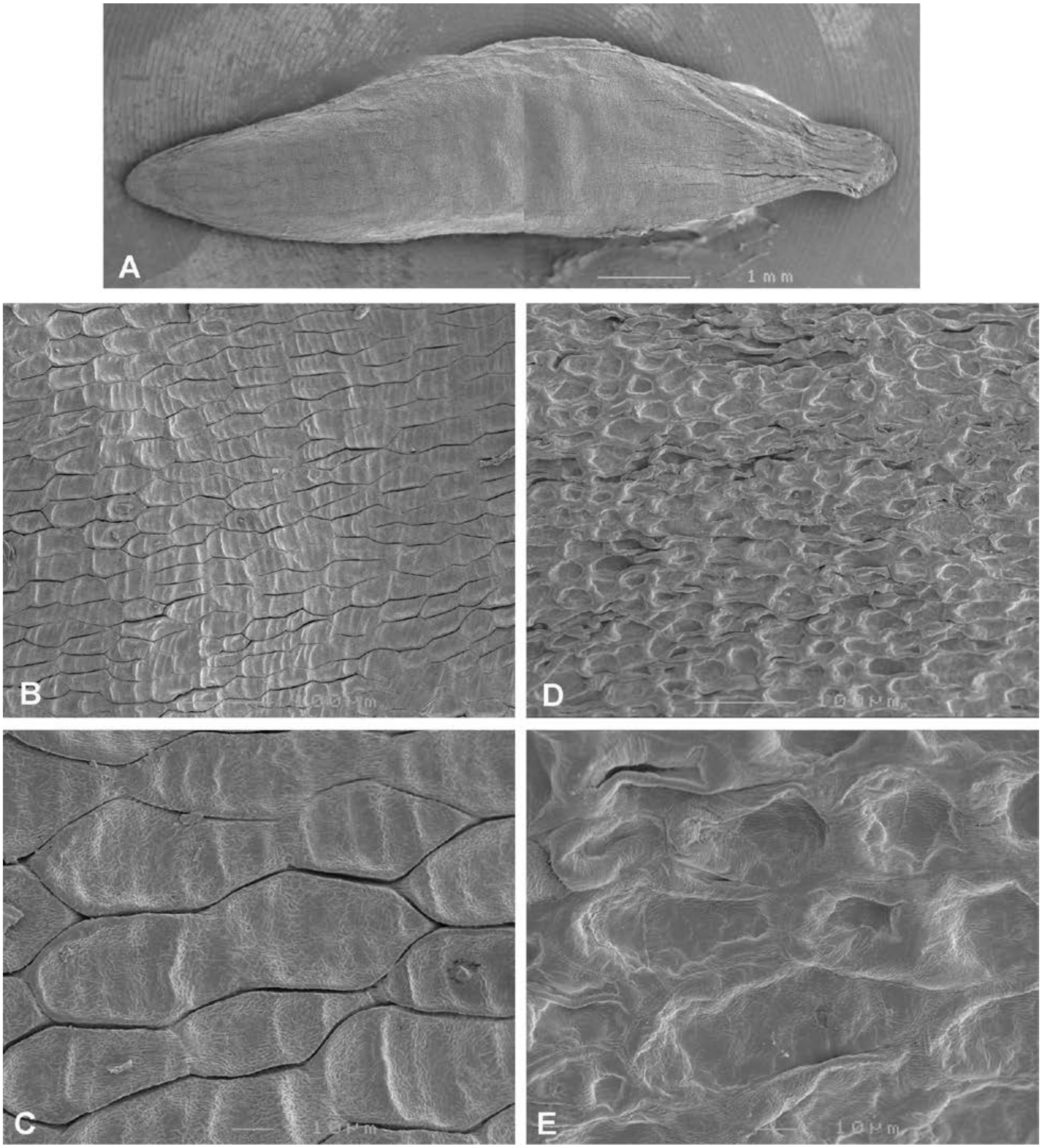


Fig. 4.3.23.4. *Cryptolepis sanguinolenta* seed surface: (A) adaxial view of seed, (B, D) adaxial seed surface uniform, (C, E) cells elongate, tetra- to hexagonal with convex periclinal walls and finely striated cuticle. Magnification: A = x20; B, D = x220; C, E = x900. Specimens: (A–C) *Santo 1739* (K); (D–E) *Adam 11758* (MO).

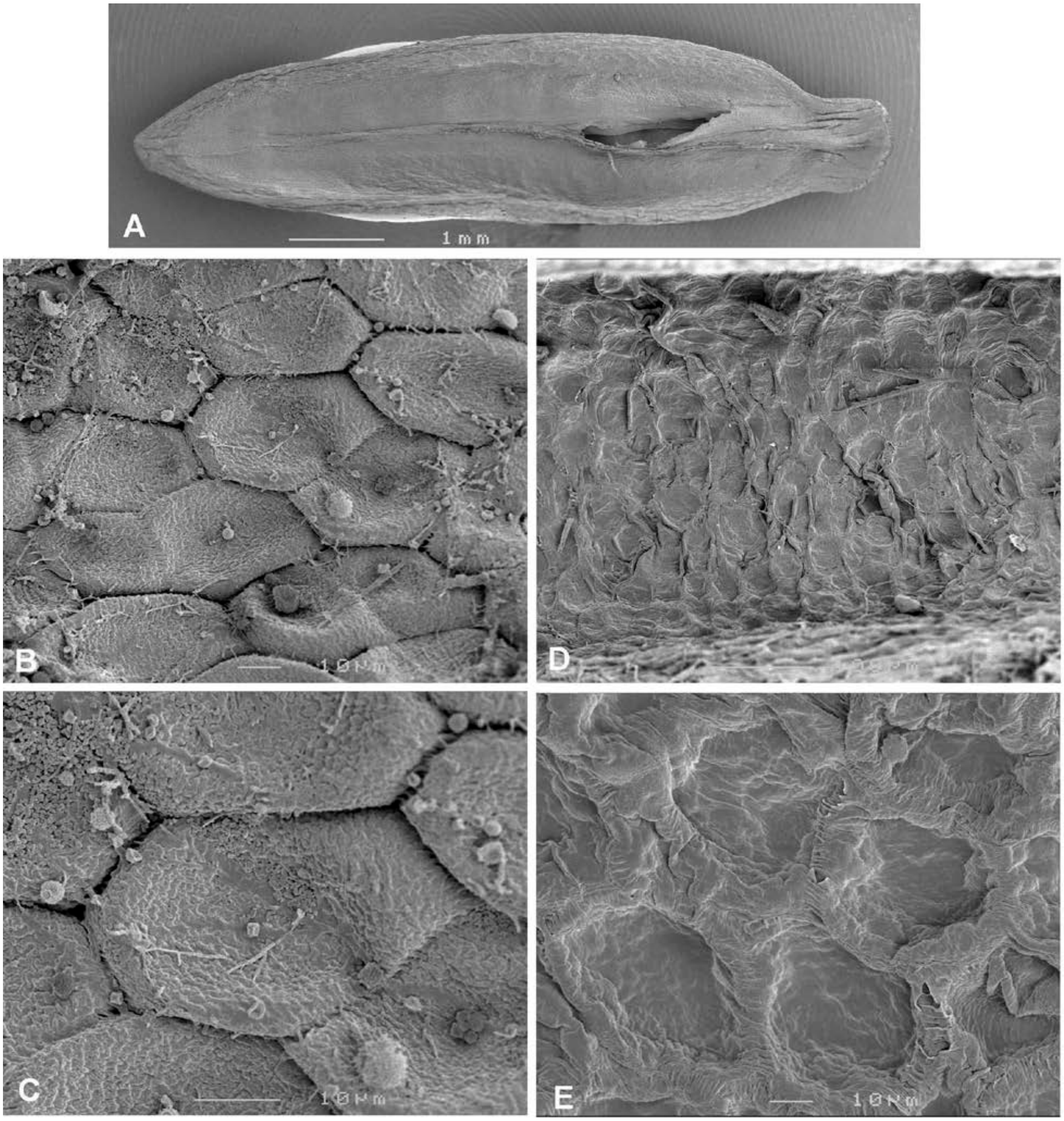


Fig. 4.3.23.5. *Cryptolepis sanguinolenta* seed surface: (A) abaxial view of seed, (B–E) cells with concave periclinal walls and granular cuticle. Magnification: A = x20; B, E = x900; C=x1800; D = x220. Specimens: (A–C) *Santo 1739* (K); (D–E) *Adam 11758* (MO).

4.3.24 *Cryptolepis sinensis* (Lour.) Merr., The Philippine Journal of Science 15(3): 254 (1919); Bullock: 282 (1955). Basionym: *Pergularia sinensis* Lour., Flora Cochichinensis 1: 169 (1790).

Type: China, Guangdong, Honam Island, *Levine 356* (GH, neo., designated by Li (1991); A, isoneo). Note 1

= *Emericia sinensis* (Lour.) Schult. in Roem. & Schult., Systema Vegetabilium, 4: 402 (1819); Merr. 245 (1919). Basionym: *Pergularia sinensis* Lour., Flora Cochichinensis 1: 169 (1790). Synonymy after Merrill (1919).

Type: Homotypic with *Pergularia sinensis* Lour. Note 1

= *Periploca chinensis* (Lour.) Spreng., Systema Vegetabilium 1:836 (1825); Merr. 245 (1919). Note 2 Basionym: *Pergularia sinensis* Lour., Flora Cochichinensis 1: 169 (1790). Synonymy after Merrill (1919).

Type: Homotypic with *Pergularia sinensis* Lour. Note 1

= *Vallaris sinensis* (Lour.) G.Don, A General History of the Dichlamydeous plants 4: 79 (1838), Merr.: 245 (1919). Basionym: *Pergularia sinensis* Lour., Flora Cochichinensis 1: 169 (1790). Synonymy after Merrill (1919).

Type: Homotypic with *Pergularia sinensis* Lour. Note 1

= *C. edithae* (Hance) Benth. in Benth. & Hook.f., Genera Plantarum 2(2): 741 (1876a). Basionym: *Aganosma edithae* Hance, Annales des Sciences Naturelles Botanique 5(5): 227 (1866).

Type: China, Sintang, *Hance 10576* (P!, holo.; K!, BM!, P!, iso.).

= *C. elegans* Wall. ex G.Don, A General History of the Dichlamydeous plants 4: 82 (1838); Drury: 254 (1866); Hook.f.: 6 (1883); K.Schum.: 219 (1895b).

Type: Bangladesh, Sylhet, *Wall. Cat. 1639* (K-W 1693.1!, lecto. here designated; BM!, K-W [2 sheets]!, K!, isolecto.).

= *C. javanica* (Blume) Blume, Museum Botanicum Lugduno-Batavum sive stirpium exoticarum, novarum vel minus cognitarum es vivis aut siccis brevis exposition et descriptio 1: 146 (1850); K.Schum.: 219 (1895b). Basionym: *Leposma javanicum* Blume, Bijdragen tot de Flora van Nederlandsch Indië: 1049 (1825), 7 (1828).
Type: [Indonesia], [East] Java, Koeripan, *Herb. Lugd. Bat. L898,166-349* (L!, holo.).

= *C. laxiflora* Blume, Museum Botanicum Lugduno-Batavum sive stirpium exoticarum, novarum vel minus cognitarum es vivis aut siccis brevis exposition et descriptio 1: 147 (1850). Synonymy after Bullock (1955). Note 3
Type: *Echites laxiflora* in Herb. Zipp. (collection of Alexander Zippelius?) (L?, holo.).

= *C. pauciflora* (Roxb.) Wight, Icones Plantarum Indiae Orientalis 2: t. 493 (1843). Basionym: *Nerium pauciflorum* Roxb. Hortus Bengalensis: 104 (1814); 691 (1832).
Type: India, Orissa, *Herb. Rottlerianum 43* (K!, holo.).

A semi-evergreen climber, with white latex, up to 2.5 m high. *Stems* woody, slender, twining, up to 3 mm diameter; young stems brown, smooth, glabrous; older stems dark brown, bark peeling, smooth; interpetiolar ridges glabrous, inconspicuous on young stems, absent on older stems; colleters present. *Leaves* opposite, axils villous, petiolate; petiole brown, glabrous, slightly grooved, 4–9 mm long; blade oblong, 40–70(–85) x (11–)20–32 mm, herbaceous, dark green adaxially, pale green abaxially, glabrous; margin plane; apex obtuse-apiculate, occasionally acute, glabrous, not recurved; base rounded to truncate; venation brochidodromous, inconspicuous on adaxial surface, conspicuous on abaxial surface, 6–7 secondary veins on either side of main vein, intersecondary venation absent to weakly developed, tertiary veins random reticulate, areole development incomplete, veinlets simple to branched once. *Inflorescences* cymose, lax, many-flowered, slender, each cyme consists of 1–4 dichasia, each ending in 1–3 monochasia, primary peduncle (15–)16–30(–40) mm long, secondary peduncles 10–25 mm long, pedicels 10–20 mm long; bracts opposite, sparsely arranged, glabrous, triangular, ± 1 mm long, margins slightly fimbriate. *Buds* robust, 12–19 mm long, oblong, apices attenuate, full turn helically twisted. *Sepals* light green, narrowly ovate, 1.5–2.5 x 0.9–1.5 mm, apices glabrous, colleters ovate, apices dentate. *Corolla* white to pale yellow, 10–22 mm long; tube urceolate, 4–5 mm long, glabrous outside and inside; lobes reflexed, linear, 6–17 x 2 mm, apices acute. *Corona* double; primary corona inserted 2–3 mm from corolla tube base, included, lobes turbinate, fleshy, 0.7–1 mm long, glabrous, apices attenuate, connivent over gynostegium, corona lobe bases extending into prominent spongy ridges; secondary corona pockets in corolla lobe sinuses. *Stamens* inserted ± 1 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 1 mm long, filaments ± 0.3 mm long. *Nectaries* conspicuous, inserted ± 0.3 mm from corolla tube base. *Ovaries* ± 0.5 x 1 mm; style 0.5–1 mm long, style-head pyramidal, acute, ± 0.8 x 0.8 mm. *Translators* narrowly elliptic, ± 0.6 mm long, apices acute. *Follicles* pendulous, widely divaricate, rarely reflexed at 160°–180°(–125°), cylindrical, 115–170 x 5–10 mm, brown, apices attenuate, bases cuneate. *Seeds* elliptic, 7–8 x 1.8–2 mm, reddish-brown, smooth; coma white to yellowish-white, 25–42 mm long. (Fig. 4.3.24.1.)

Diagnostic characteristics

Cryptolepis sinensis is a semi-evergreen climber from southern Asia. It has large, 40–70(–85) x (11–)20–32 mm, oblong to oblong-ovate, herbaceous leaves with obtuse, apiculate or occasionally acute apices. This species is most similar to *C. obtusa* from Southern and East Africa, but is distinguished from the latter species by its longer pedicels, longer than 10 mm, triangular bracts, larger flowers, with corollas longer than 10 mm and primary corona lobes turbinate. By contrast *C. obtusa* has pedicels shorter than 5 mm, acicular bracts, small flowers, with corollas shorter than 10 mm and primary corona lobes clavate.

Distribution and habitat

Cryptolepis sinensis is widespread throughout southern Asia, growing from India to Taiwan, the Philippines and the southern islands of Indonesia (Fig. 4.3.24.2.). It grows on limestone hills, mountains and in ravines in dry to moist sandy soil, at altitudes of 25–1150 m. This species occurs in open scrub, semi-evergreen scrub jungle and along paddy fields. Associated species are not known. Flowering occurs throughout the year with a peak from May to July.

Notes

1. Loureiro (1790) did not cite any specimens in his original description of *Pergularia sinensis* nor did any of the authors of subsequently published names based on Loureiro's binomial (Roemer & Schultes, 1819; Sprengel, 1825; Don, 1838). The original material used by Loureiro could not be located. From his discussion of *Cryptolepis sinensis* Merrill (1919) clearly also did not see Loureiro's specimens and made the synonymy based on Loureiro's description. Merrill (1919) cited a number of voucher specimens: *Merrill 10806, Levine 356, Levine 1850, Levine 3201.* According to the specimen database of BH and A, two specimens of *Levine 356* were designated as neotype and isoneotype respectively by Li (1991). No publication of Li (1991) could be found and, since correspondence with these two herbaria has remained unanswered, it is unclear whether the designation was done on the specimens themselves, in which case the designation of neotypes has not been published. None of the other specimens cited by Merrill (1919) could be located.

2. Merrill (1919) incorrectly cited *Periploca chinensis* Spreng. as *Pergularia chinensis* Spreng. in a list of synonyms of *Cryptolepis sinensis* (Lour.) Merr.

3 Blume (1850) cited a specimen identified as *Echites laxiflora* in Herb. Zipp., probably the collection of Alexander Zippelius, under his description of *Cryptolepis laxiflora*. The name *Echites laxiflora* is consequently a *nom. nud. in sched*. which was used to construct the validly published name, *Cryptolepis laxiflora.* The specimen representing *Echites laxiflora* is the holotype of *C. laxiflora,* since it is the only specimen cited in the original description (Blume, 1850). According to Stafleu and Cowan (1876) the collection of Alexander Zippelius was included in the collection at Leiden Herbarium (L). However, this specimen has not been located at L and its location is yet to be verified.

Representative specimens

— 12º46'20" N, 124º03'26" E: Philippines, Luzon, Sorsogon Province, Mount Bulusan, near Irosin, 09-1916, *Elmer, A.D.E. 17399* (BM, K).

— 18º34'52" N, 82º58'22" E: India, Orissa [Odisha State], Koraput District, Pottangi, 10-07-1950, *Mooney, H.F. 3847* (K).

— 21º55'58" N, 120º49'45" E: Taiwan, South Cape, 04-1895, *Henry, A. 626* (K).

— 23º10' N, 113º17' E: China, [Guangdong Province], Canton, 14-06-1884, *Sampson, T. 413* (BM).

— 26º48' N, 87º55' E: Nepal, [Eastern Region], 5 miles E of Soktim T.E., 24-05-1971, *Stainton, J.D.A. 6894* (BM).

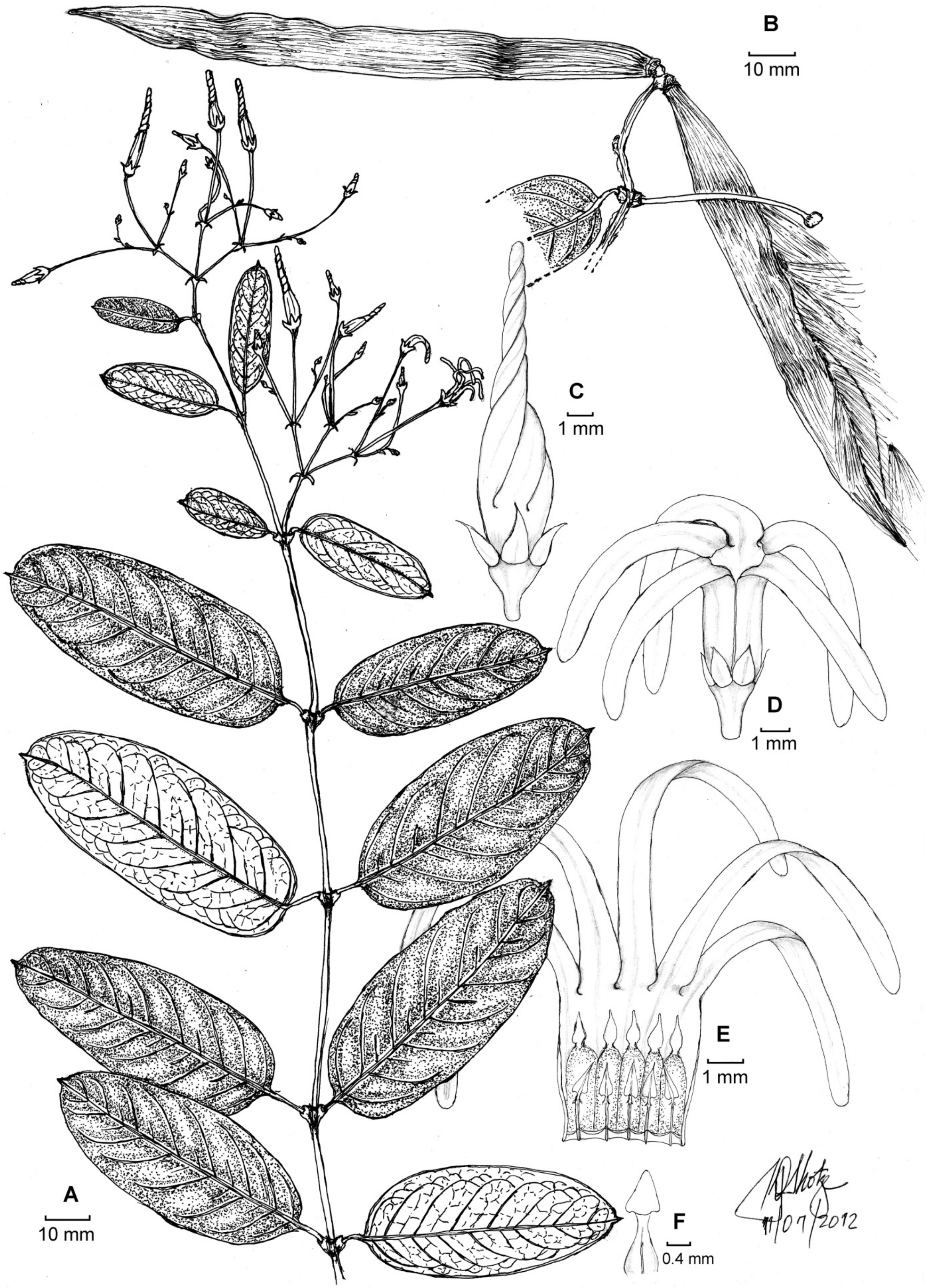


Fig. 4.3.24.1. Illustration of *Cryptolepis sinensis*: (A) stem with leaves and inflorescences, (B) stem with paired follicles, (C) external view of bud, (D) external view of mature flower, (E) corolla opened showing corolla lobes, turbinate primary corona lobes, secondary corona of inconspicuous pockets in corolla lobe sinuses and stamens with narrowly hastate anthers, (F) pistil of semi-inferior apocarpous ovaries, style and style-head. Specimens: (A, C–F) *Sampson 413* (BM); (B) *Henry 626* (K).

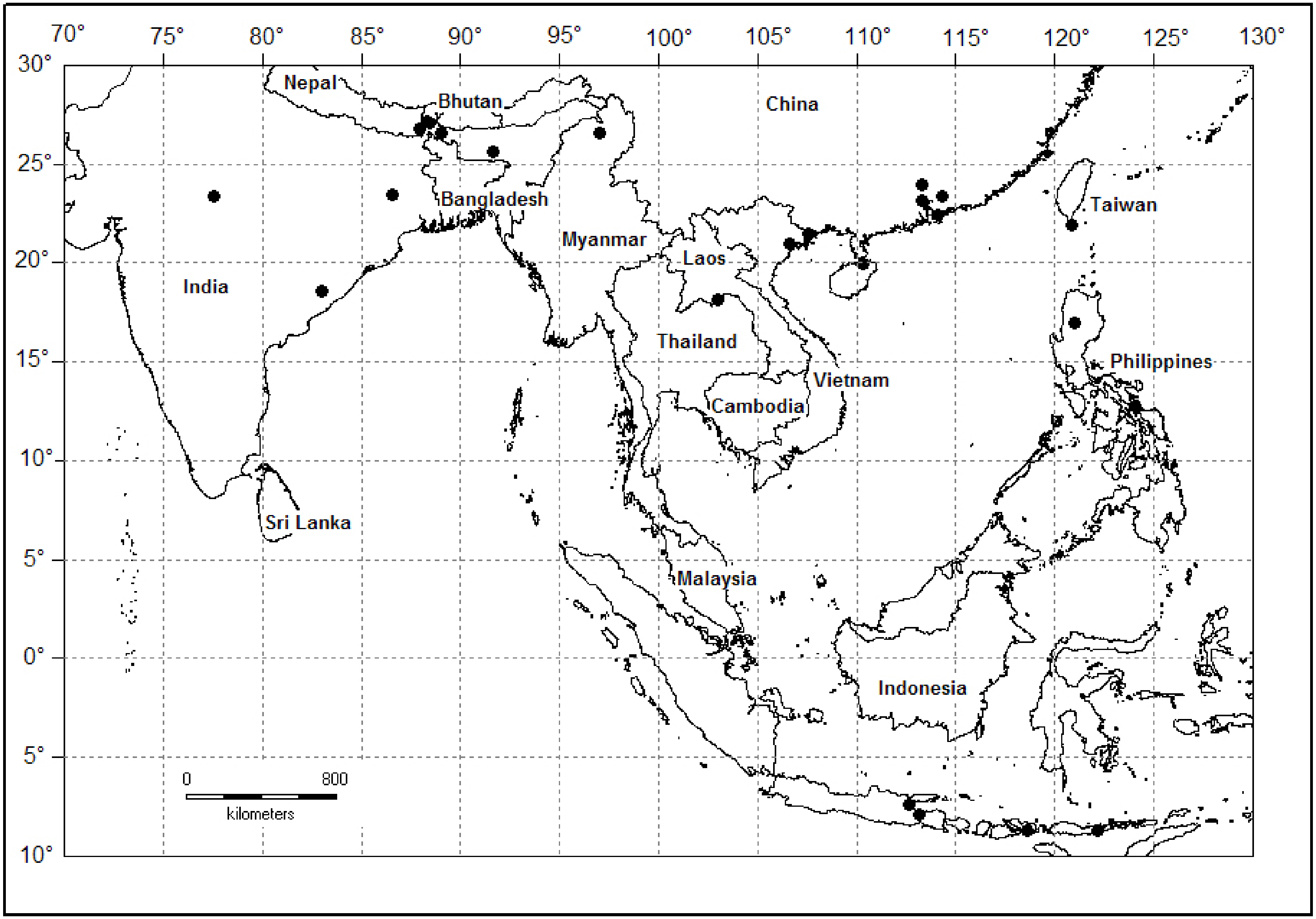


Fig. 4.3.24.2. Known distribution of *Cryptolepis sinensis*.

Leaf micromorphology

Cells on the adaxial epidermal surface are isodiametric and tetra- to hexagonal. Periclinal walls are tabular, while anticlinal walls are straight and slightly sunken (Fig. 4.3.24.3. A–C). The cuticle is densely (Fig. 4.3.24.3. A) to slightly striated (Fig. 4.3.24.3. B–C), with striations wavy and randomly orientated (Fig. 4.3.24.3. A–B) or straight, parallel and continuous over intercellular boundaries (Fig. 4.3.24.3. C). Some cuticular folding may occur, following anticlinal walls (Fig. 4.3.24.3. A).

Abaxial epidermal cells are isodiametric and tetra- to hexagonal. Periclinal walls are convex (Fig. 4.3.24.3. D–E) to tabular (Fig. 4.3.24.3. F), while anticlinal walls are curved to wavy and slightly (Fig. 4.3.24.3. F) deeply sunken (Fig. 4.3.24.3. D–E). The cuticle is densely striated, with striations randomly orientated and wavy, crossing intercellular boundaries (Fig. 4.3.24.3. D–F).

Leaves are hypostomatic with stomata randomly orientated and level with surrounding epidermal cells. Stomata are paracytic and the cuticle covering subsidiary cells is heavily striated with wavy, randomly orientated striations. Guard cells are narrowly elliptic and covered by a narrow stomatal ledge. (Fig. 4.3.24.3. D–F)

Seed micromorphology

The adaxial seed surface is covered by sparsely arranged longitudinal ridges, formed by raised, slightly compressed elongated epidermal cells (Fig. 4.3.24.4. A–B). Epidermal cells between ridges are more or less isodiametric and penta- to hexagonal. Periclinal walls are concave, while anticlinal walls are straight and deeply sunken. The cuticle has a coarse, granular appearance (Fig. 4.3.24.4. C–E).

Abaxially the seed has a narrow central ridge and thickened seed margins (Fig. 4.3.24.3. A). The surfaces between the ridge and seed margins are smooth with small, sparsely arranged protuberances formed by raised, compressed epidermal cells (Fig. 4.3.24.5. B). Cells on the abaxial surface are isodiametric and tetra- to hexagonal. Periclinal walls are concave, while anticlinal walls are straight to curved and slightly sunken. The cuticle has a coarse, granular appearance (Fig. 4.3.24.5. C–E).

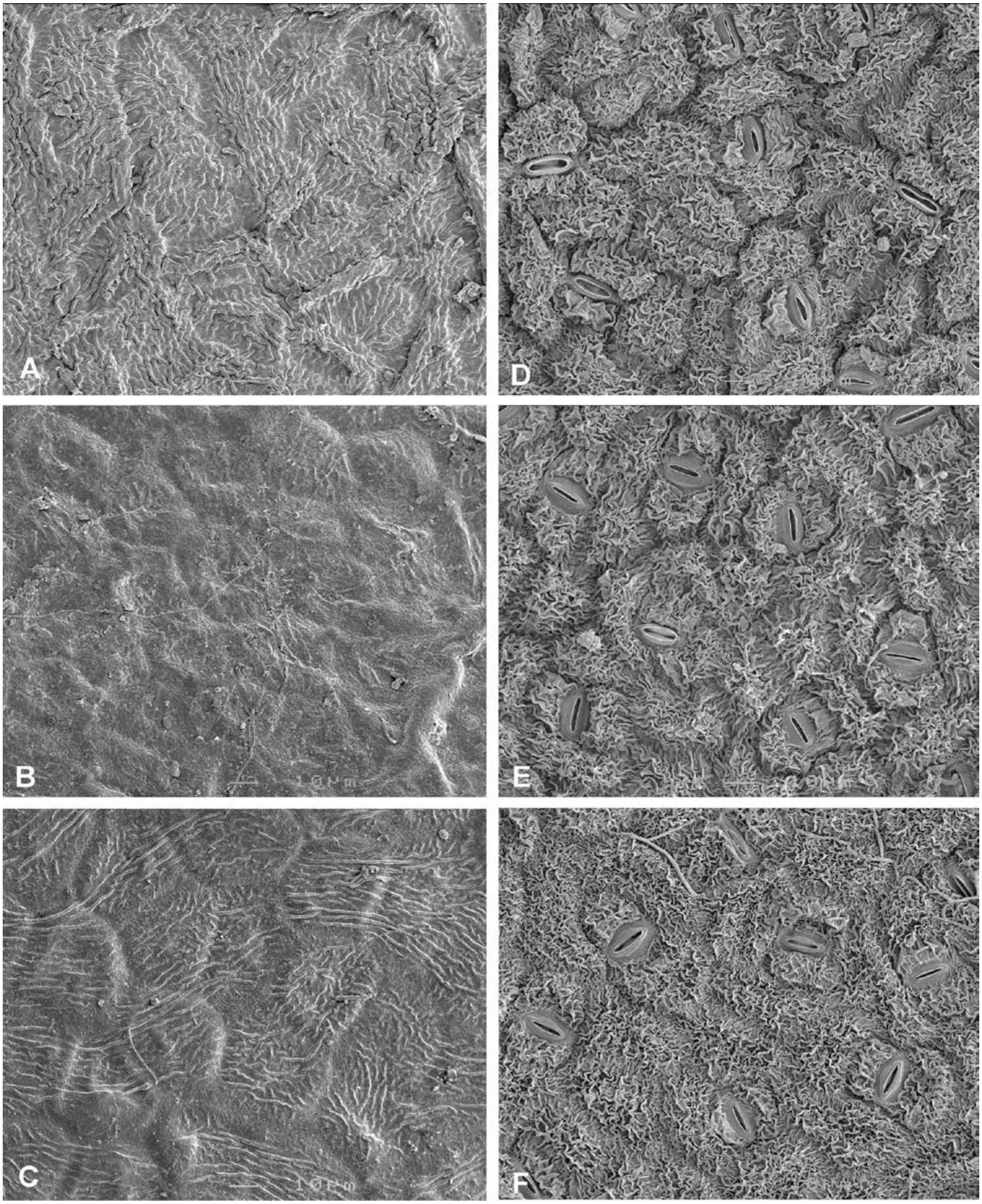


Fig. 4.3.24.3. *Cryptolepis sinensis* leaf epidermal surfaces: (A) adaxial epidermal cells with tabular periclinal walls, densely striated cuticle and cuticular folds, (B–C) adaxial epidermal cells with tabular periclinal walls and slightly striated cuticle, (D–F) abaxial epidermis with convex periclinal walls, sunken anticlinal walls, densely striated cuticle and stomata. Magnification: A–F = x650. Specimens: (A, D) *Mooney 3847* (K); (B, E) *Parry 721* (K); (C, F) *C.h. 400* (K).

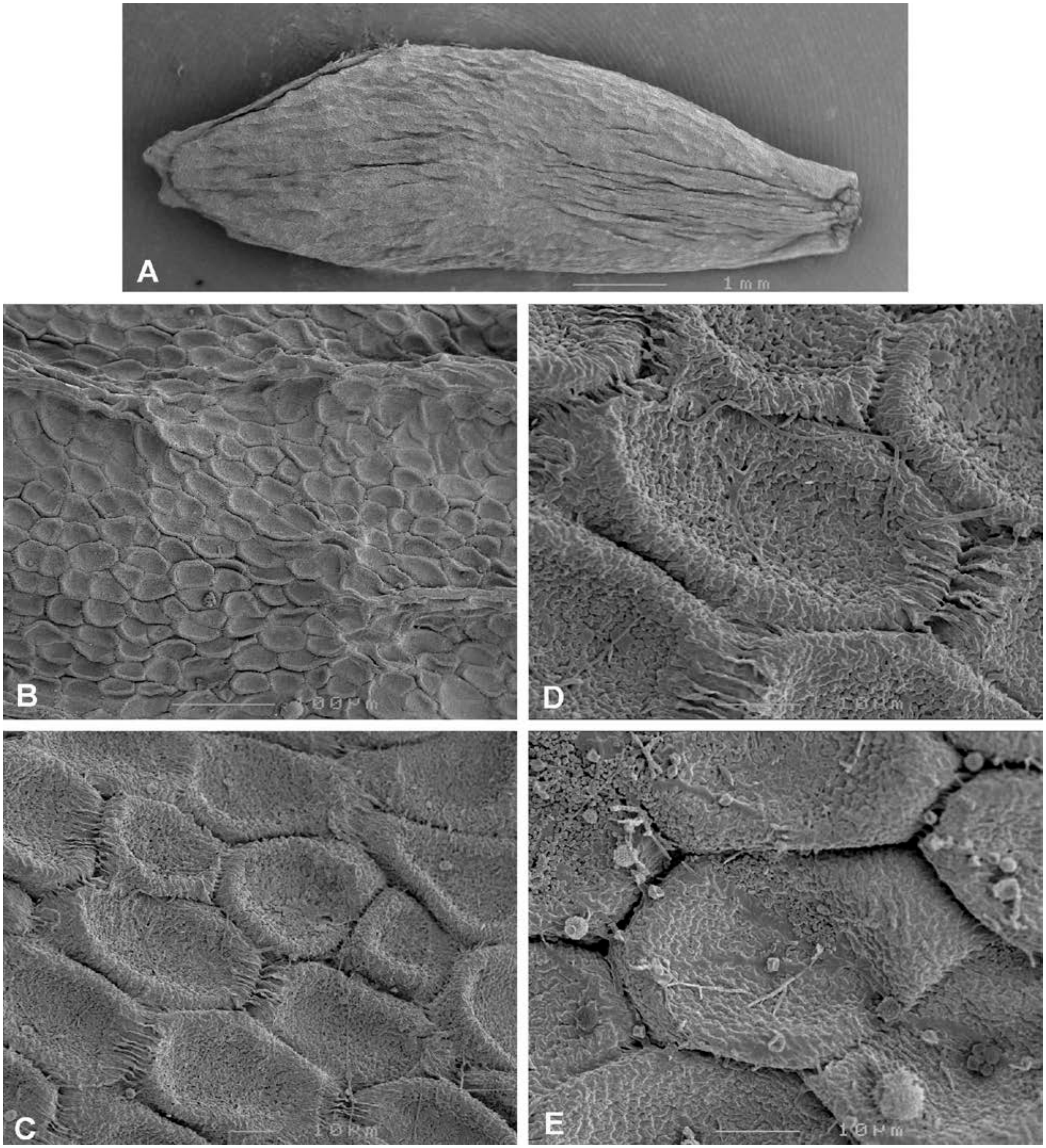


Fig. 4.3.24.4. *Cryptolepis sinensis* seed surface: (A) adaxial view of seed, (B) adaxial seed surface with inconspicuous ridges, (C) cells tetra- to hexagonal with convex periclinal walls and sunken anticlinal walls, (D, E) cells covered by a granular cuticle. Magnification: A = x20; B = x220; C, E = x900; D = x1800. Specimens: (A–D) *Henry 626* (K); (E) *Gamble 7650* (K).

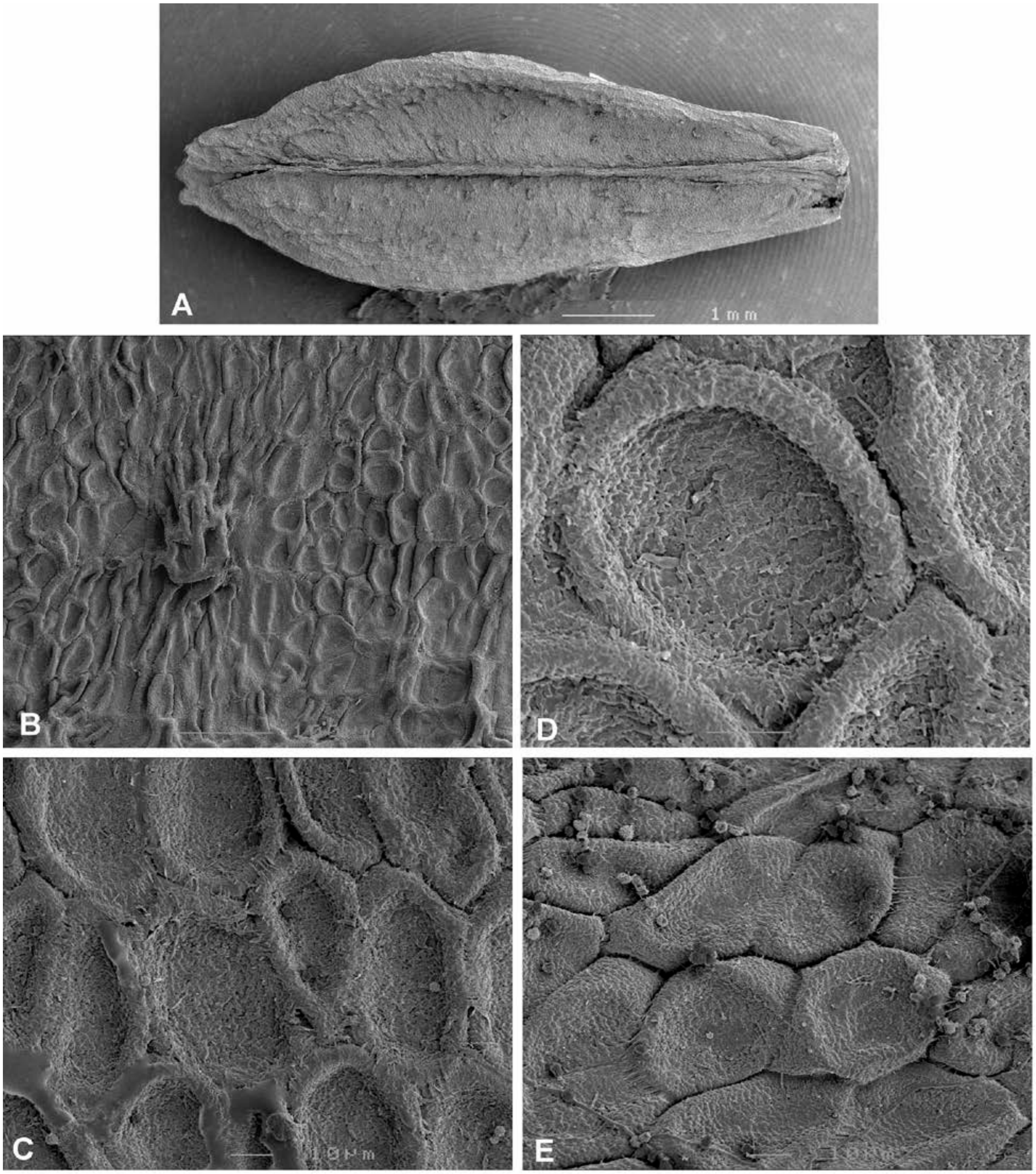


Fig. 4.3.24.5. *Cryptolepis sinensis* seed surface*,* (A) abaxial view of seed, (B) abaxial surface between central ridge and seed margin with small protuberances, (C–E) cells with concave periclinal walls, slightly sunken anticlinal walls and granular cuticle, Magnification: A = x20; B = x220, C, E =x900; D = x1800. Specimens: (A–D) *Henry 626* (K); (E) *Gamble 7650* (K).

4.3.25 *Cryptolepis socotrana* (Balf.f.) Venter in Venter & R.L.Verh., Taxon 46(4): 713 (1997). Basionym: *Cochlanthus socotranus* Balf.f. in Proceedings of the Royal Society of Edinburg 12: 79 (1884), 167 (1888).
Type: Socotra, Haghier Mountains, *Balfour, I.B. 525* (E!, holo.; BM!, GH, K!, OXF, iso.).

= *Socotranthus socotranus* (Balf.f.) Bullock, Kew Bulletin 19: 203 (1964).
Type: Homotypic synonym.

A shrub, with white latex, up to 2.5 m high. *Stems* woody, pendulous, slender, stem diameter unknown; young stems light brown to reddish, smooth, slightly puberulous; older stems grey, smooth, glabrous; interpetiolar ridges puberulous on young stems, absent on older stems, colleters present. *Leaves* opposite, axils slightly villous, sessile to sub-sessile; petiole green, glabrous, slightly grooved, ± 0.5 mm long; blade broadly elliptic to orbicular, 35–45 x 24–40 mm, coriaceous, glabrous, glaucous to pale green; margin plane, slightly fimbriate; apex rounded, rarely retuse, apiculate, glabrous to slightly fimbriate, not recurved; base cordate; venation brochidodromous, 5–6 secondary veins on either side of main vein, composite intersecondary veins present, often inconspicuous, tertiary veins reticulate, areole development incomplete. *Inflorescences* cymose, compact, many-flowered, each cyme consists of 3–7 dichasia, ending in 1–3 monochasia, primary peduncle 9–11 mm long, secondary peduncles 7–20 mm long, pedicels 2–3 mm long; bracts opposite, densely packed, glabrous, acicular, 1–1.5 mm long, margins fimbriate. *Buds* robust, 10–11 mm long, narrowly ovoid, apices acute, full turn helically twisted. *Sepals* dark green, narrowly triangular, 2.5–3 x 0.7–1 mm, glabrous to puberulous, margins fimbriate, colleters ovoid, apices dentate. *Corolla* white to pale yellow, 11–15 mm long; tube campanulate, ± 2 mm long, glabrous outside and inside; lobes spreading, oblong, 10–13 x 2 mm, apices obtuse. *Corona* single; primary corona inserted ± 1 mm from corolla tube base, included, lobes clavate with prominent feet, fleshy, ± 1 mm long, glabrous, apices bilobed and hooded; hood subtending or enclosing bilobed apex (Fig. 4.3.25.1. H–I); connivent over gynostegium. *Stamens* inserted ± 0.9 mm from corolla tube base on inner face of coronal feet; anthers hastate, attenuate, glabrous, 0.8–1 mm long, sub-sessile. *Nectaries* conspicuous, inserted ± 0.5 mm from corolla tube base, fused to style-head. *Ovaries* 0.3–0.8 x 0.8–1 mm; style ± 0.2 mm long, style-head conical, cuspidate, bifid, ± 0.8 x 0.7 mm. *Translators* narrowly elliptic, ± 0.7 mm long, apices acute. *Follicles* pendulous, widely divaricate to reflexed at 180°–210°, broadly keel-shaped, falcate, 37–

44 x 11–17 mm, dark brown to pale greenish, apices acute, recurved, bases cuneate. *Seeds* elliptic, ± 3.5 x 2 mm, dark brown, warty; coma white to yellowish-white, ± 7 mm long. (Fig. 4.3.25.1.)

Diagnostic characteristics

Cryptolepis socotrana is a shrub, 1–2.5 m high, with pendulous stems. The leaves are sessile to sub-sessile while the leaf blade is broadly elliptic to orbicular, large, 35–45 x 24–40 mm, coriaceous with the apex rounded, rarely retuse, apiculate. This species is distinguished from two species with similar growth form, *C. arbuscula* and *C. migiurtina*, which have smaller, obovate leaves, less than 30 x 18 mm. *Cryptolepis socotrana* is most similar to *C. macrophylla,* which is a tree, with leaves very similar in size and shape to those of *C. socotrana. Cryptolepis socotrana* is characterised by compact, many-flowered inflorescences, corollas white to pale yellow, longer than 10 mm, corona lobes clavate with apices bilobed and hooded and follicles unique, broadly keel-shaped, falcate, 37–44 x 11–17 mm. *Cryptolepis macrophylla* is characterised by lax, few-flowered inflorescences, corollas brownish and shorter than 10 mm while the primary corona lobes are clavate, with pyramidal apices and follicles are narrowly ovoid, 40–95 x 8–14 mm.

Distribution and habitat

Cryptolepis socotrana is endemic to the island Socotra (Fig. 4.3.25.2.). Plants grow on cliffs and boulder strewn wadi slopes, associated with limestone at altitudes from 30–200 m. A note on the specimen collected by *Miller et al. 10289* (E) indicates that this species is common in the ravines of south-draining wadis. *Cryptolepis socotrana* is associated with succulent semi-desert scrub dominated by an *Adenium* sp., *Acacia pennivenia* Balf.f.*, Commiphora ornifolia* (Balf.f.) J.B.Gillett*, Croton socotranus* Balf.f.*, Drostenia* sp.*, Ficus salicifolia* Vahl and *Ziziphus spina-christi* Willd*.* Flowering occurs from September to March, with a peak in February.

Representative specimens

— **12º20'13'' N, 53º36'46'' E:** Socotra, Nogad Plain, Qa'arah, 03-10-1998, *Miller, A.G., Hyam, Al Khulaidi, Salaiman & Talib M.16133* (E).

— **12º20'14'' N, 54º00'34'' E:** Socotra, Nogad Plain, Wadi Irih, 1 km from mouth, 06-02-1990, *Miller, A.G., Bazara'a, M., Guarino, L. & Kassim, N. M. 10289* (E).

— **12º21' N, 53º34' E:** Socotra, 1 km E of Ras Kattanahan, 16-01-1994, *Thulin, M.* & *Gifri, A.N. 8571* (K).

— **12º25'55'' N, 54º00'21'' E:** Socotra, Nogad Plain, Wadi Irih draining S into Nogad plain due S of Hadiboh, 28-02-1989, *Miller, A.G., Guarino, L., Obadi, N., Hassan, M. & Mohammed, N. M.8528* (E).

— **12º29'42'' N, 54º19'52'' E:** Socotra, Killisan, 22-09-1998, *Miller, A.G., Hyam, Al Khulaidi, Salaiman & Talib M.16010* (E).

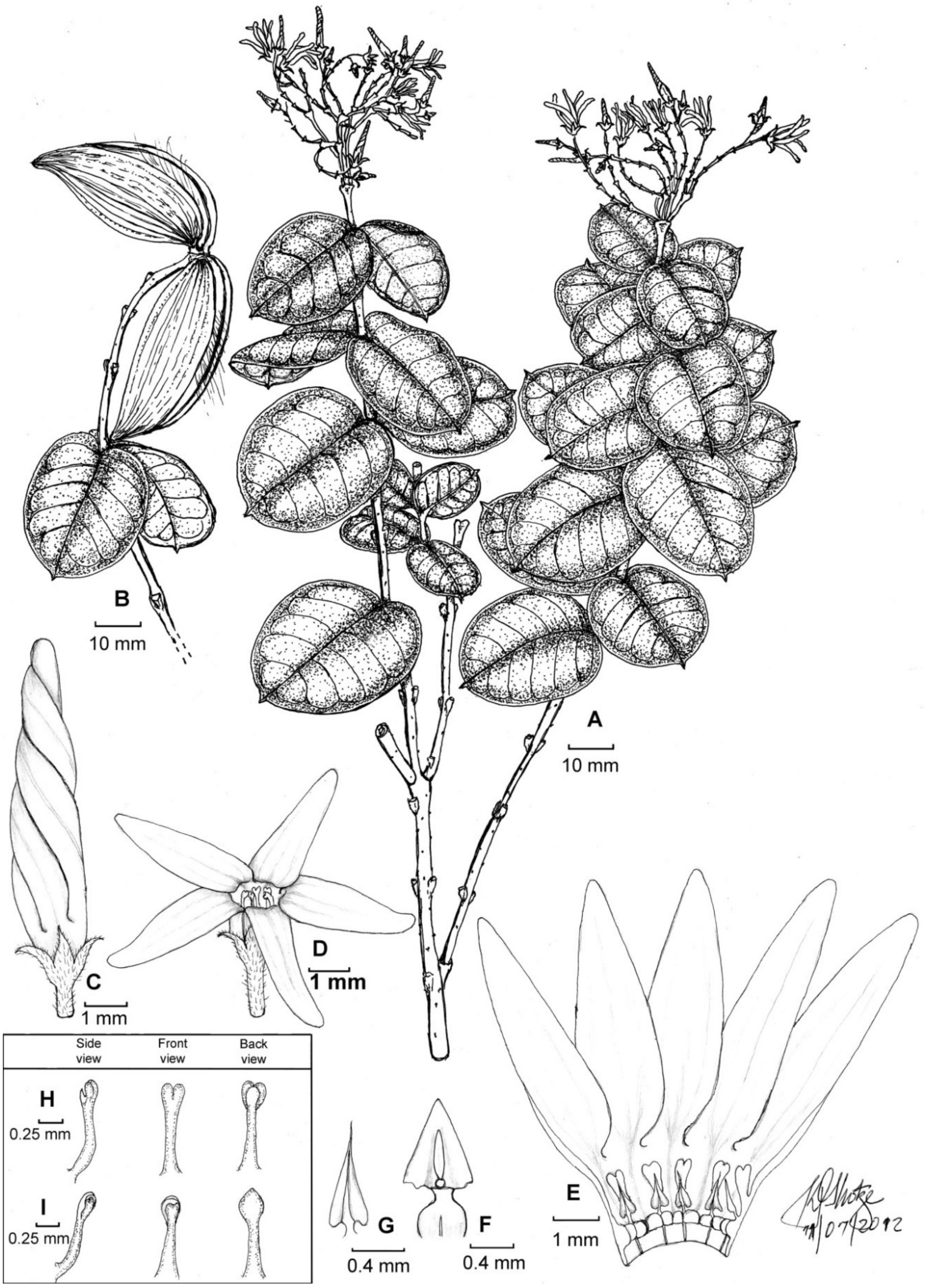


Fig. 4.3.25.1. Illustration of *Cryptolepis socotrana*: (A) stem with leaves and inflorescences, (B) stem with leaves and paired follicles, (C) external view of bud, (D) external view of mature flower, (E) corolla opened showing clavate, bilobed primary corona lobes with prominent coronal feet, stamens inserted on coronal feet, (F) pistil of semi-inferior apocarpous ovaries, style and conical style-head with translator, (G) stamen with narrowly hastate anther, (H) clavate corona lobe with bilobed apex subtended by hood, (I) clavate corona lobe with bilobed apex enclosed by hood. (A–B, F) Adapted from Balfour (1888); Specimens: (C–D, I) *Morris 21* (E); (E, G–H) *Miller et al. M.10289* (E).

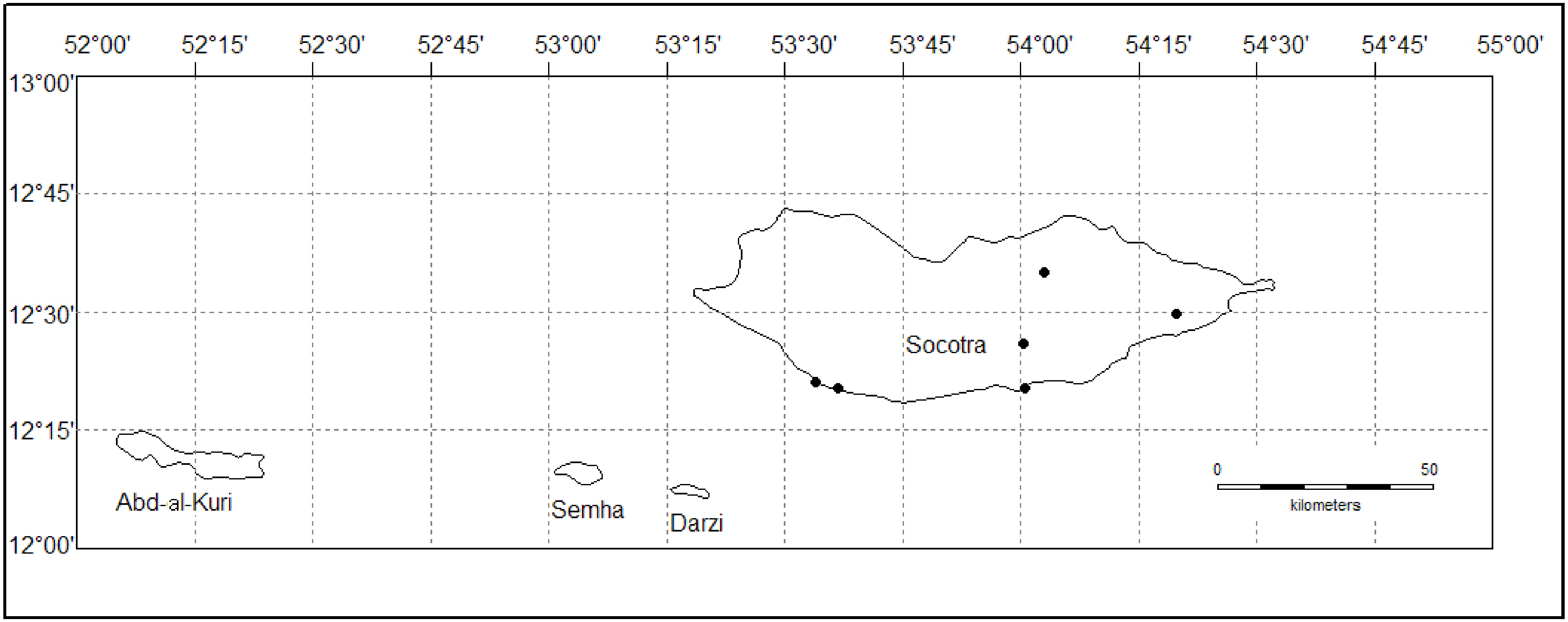


Fig. 4.3.25.2. Known distribution of *Cryptolepis socotrana*.

Leaf micromorphology

Adaxial and abaxial epidermal surfaces are indistinguishable. Epidermal cells are isodiametric and tetra- to hexagonal. Periclinal walls are tabular to slightly convex and anticlinal wall boundaries are slightly sunken or level with the epidermal surface. The cuticle is sparsely striated, these being randomly orientated and continuous over intercellular boundaries (Fig. 4.3.25.3. B, E). Epidermal features are often completely obscured by a dense covering of wax platelets which are orientated perpendicular to the epidermal surface (Fig. 4.3.25.3. A, C, D, F).

Leaves are amphistomatic with randomly orientated stomata. The number of stomata on the adaxial and abaxial epideris is similar. Stomata are deeply sunken with narrowly elliptic guard cells, covered by a narrow stomatal ledge. Subsidiary cells are obscured by densely packed wax platelets. (Fig. 4.3.25.3. A–F)

Seed micromorphology

The entire adaxial seed surface is rough with cells clustered into tightly packed warts. The warts vary in shape and size and show no clear pattern of organization (Fig. 4.3.25.4. A). On the warts protuberances, formed by contorted epidermal cells, are interspersed by isodiametric, tetragonal epidermal cells (Fig. 4.3.25.4. B, E). Periclinal walls of these cells are convex while anticlinal walls are straight to curved and slightly sunken. The cuticle is smooth to finely granular (Fig. 4.3.25.4. C, F).

The seed margins are recurved, obscuring the lower seed surface and only the narrow central ridge is visible (Fig 4.3.25.4. D).

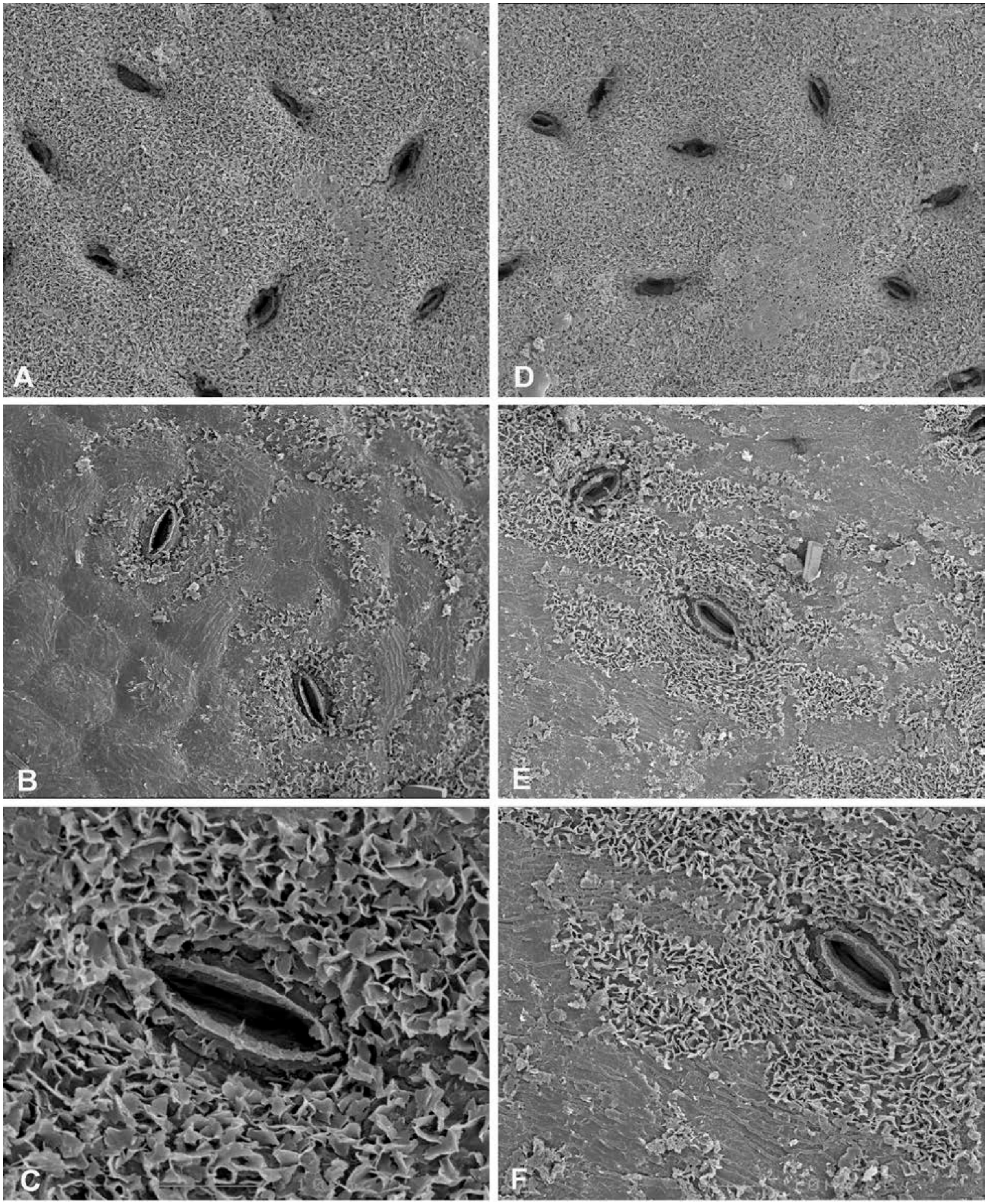


Fig. 4.3.25.3. *Cryptolepis socotrana* leaf epidermal surfaces: (A) adaxial epidermal surface covered by densely packed wax platelets and sunken stomata, (B) adaxial epidermal cells with slightly convex periclinal walls, stomata and wax platelets, (C) stoma on adaxial epidermal surface with subsidiary cells covered by densely packed wax platelets, (D) abaxial epidermal surface covered by densely packed wax platelets and sunken stomata, (E) abaxial epidermis with tabular periclinal walls, stomata and wax platelets, (F) stoma on abaxial epidermis, subsidiary cells covered by densely packed wax platelets. Magnification: A–B, D–E = x650; C = x2500; F = x1200. Specimens: (A, D) *Thulin & Gifri 8571* (K); (B–C, E–F) *Popov GP/So/275* (BM).

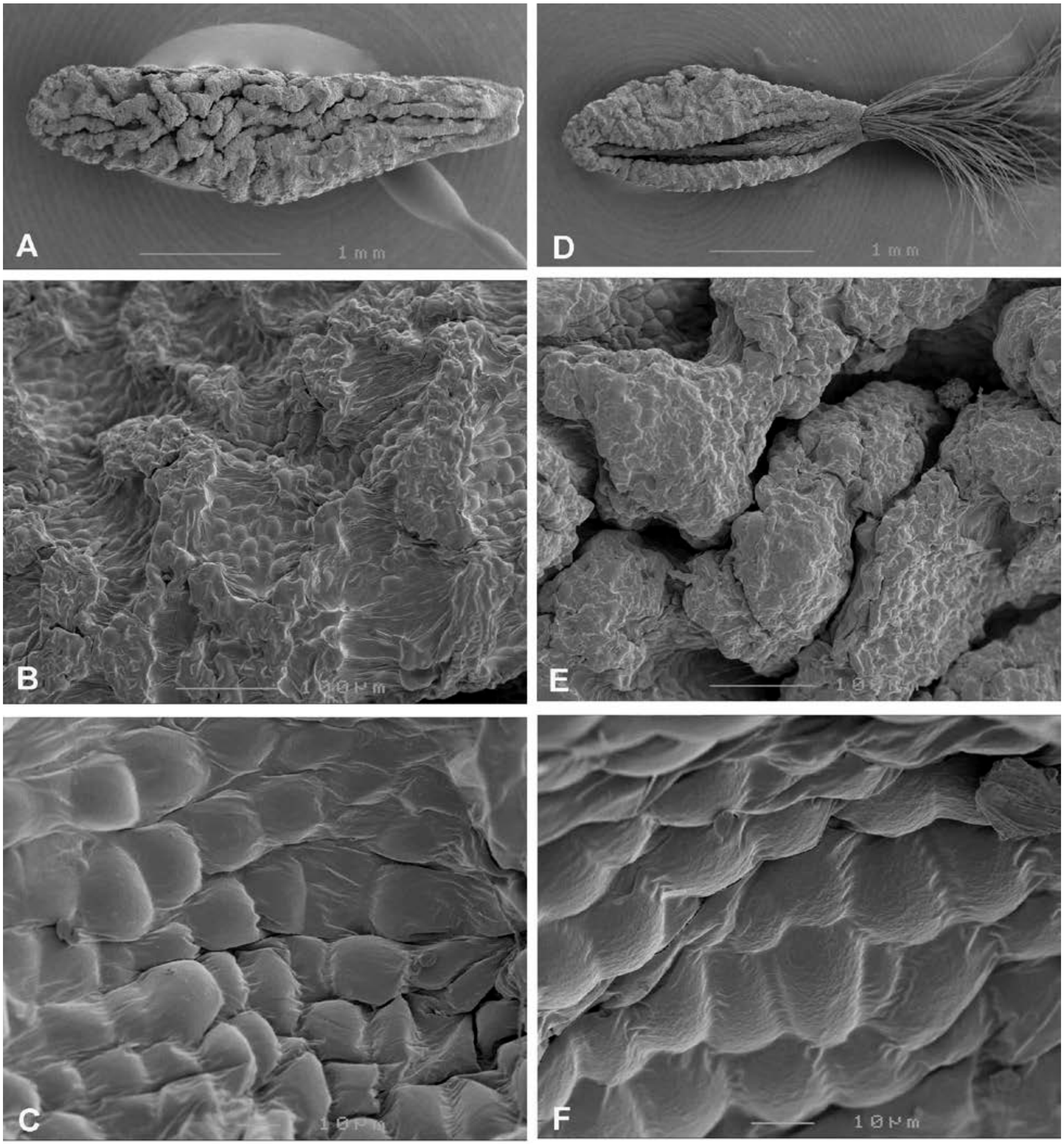


Fig. 4.3.25.4. *Cryptolepis socotrana* seed surfaces, (A) adaxial view of seed with warts, (B) adaxial seed surface with protuberances on surface of wart, (C, F) adaxial surface showing tetragonal cells with convex periclinal walls, slightly sunken anticlinal walls and smooth cuticle, (D) abaxial view of seed with recurved seed margins obscuring abaxial surface, (E) warts on recurved adaxial surface. Magnification: A = x20; B, E = x220; C = x900; D = x30; F = x1300. Specimen: (A–F) *Popov GP/So/275* (BM).

4.3.26 *Cryptolepis somaliensis* Venter & Thulin in Venter et al., South African Journal of Botany 72: 141 (2006a); Venter: 137 (2006).

Type: Somalia, Nugaal, 19 km along track from Gaalogod to Gradeen, *Thulin, Dahir, Khalid & Osman 10509* (UPS-scan!, holo.).

An erect dwarf shrub, with white latex, up to 0.4 m high. *Stems* woody, branching, slender, diameter unknown, nodes tumid, lateral shoots opposite; young stems light brown, smooth, glabrous; older stems greyish-brown, verrucose, glabrous, bark flaky; interpetiolar ridges present, colleters inconspicuous. *Leaves* opposite or fascicled, axils slighltly villous, sessile; blade oblong, 7–12 x 1–2 mm, semi-succulent, glabrous, light green; margin entire; apex obtuse to retuse, mucronate, glabrous to fimbriate, not recurved; base obtuse; venation indistinct, main vein prominent below, higher order venation invisible. *Inflorescences* cymose, robust, compact, few-flowered, each cyme consisting of 1 dichasium, ending in 1–2 monochasia, primary peduncle ± 1 mm long, pedicels ± 1 mm long; bracts sparsely arranged, glabrous, triangular, ± 0.5 mm long, margins fimbriate. *Buds* slender, 3–4 mm long, conical, apices half turn helically twisted. *Sepals* light green, triangular, apices attenuate with reddish mucro, ± 1 x 1 mm, succulent, margins glabrous to fimbriate. *Corolla* yellow, succulent, 3.5–5 mm long; tube campanulate, 1.5–2 mm long, outside glabrous, inside papillose below corona lobes; lobes spreading, triangular to ovate, 2–3 x 1 mm, apices obtuse to acute. *Corona* double; primary corona inserted ± 1 mm from corolla tube base, lobes clavate, ± 5 mm long, papillose spots present; secondary corona pockets in corolla lobe sinuses, reddish. *Stamens* inserted ± 0.3 mm from corolla tube base; anthers hastate, ±1 mm long, apices shortly apiculate, villous. *Nectaries* inserted ± 0.3 mm from corolla tube base, pocket-like. *Ovaries* ± 0.5 mm long; style ± 0.5 mm long, dilating terminally; style-head pentangular-deltoid, apex bifid, ± 1 x 1 mm. *Translators* spatulate, ± 0.3 mm long, apices acute. *Follicles* unknown. *Seeds* unknown. (Fig. 4.3.26.1.)

Diagnostic characters

Cryptolepis somaliensis is an erect dwarf-shrub. The leaves are oblong, small, 7–12 x 1–2 mm and semi-succulent. This species is distinguished from some species with similar growth form and semi-succulent leaves by a combination of flowers in compact, few-flowered inflorescences and clavate, not filiform, primary corona lobes. *Cryptolepis somaliensis* is most similar to *C. nugaalensis, C. stefaninii* and *C. yemenensis*, which all have flowers in inflorescences and clavate corona lobes. *Cryptolepis stefaninii* is most easily distinguished in this group, having larger leaves than the other three species, with leaf sizes 25–47 x 3–7 mm and corona lobes reddish with bilobed apices. *Cryptolepis nugaalensis* is distinguished from *C. somaliensis* and *C. yemenensis* by larger flowers, corolla longer than 9 mm and corolla lobes linear, longer than 7 mm and glabrous anthers. By contrast *C. somaliensis* and *C. yemenensis* both have corollas shorter than 6 mm, corolla lobes triangular, ovate or oblong, shorter than 4 mm and *C. somaliensis* has primary corona lobes ± 1 mm long and villous anthers, while *C. yemenensis* has primary corona lobes of about 0.4 mm long and glabrous anthers.

Distribution and habitat

Cryptolepis somaliensis is endemic to Somalia (Fig. 4.3.26.2.). It grows in shallow soil on arid limestone plains, at altitudes around 180 m. *Cryptolepis somaliensis* is associated with xerophytic scrub. The single flowering specimen was collected in May.

Leaf micromorphology

Cells on both adaxial and abaxial epidermal surfaces are similar, more or less isodiametric and tetra- to hexagonal. The periclinal walls are tabular while the anticlinal wall boundaries are straight and level with the epidermal surface. The cuticle is smooth or rarely slightly striated with straight, parallel striations, which are restricted to individual cells. Wax platelets may be sparsely arranged on both leaf surfaces. (Fig. 4.3.26.3. A–F)

Leaves are amphistomatic, with stomata more numerous on the abaxial surface than on the adaxial surface. Stomata are randomly orientated and sunken below the epidermal surface. Stomata are paracytic with striations on subsidiary cells perpendicular to the stomatal pore. The guard cells are broadly elliptic and are covered by a broad stomatal ledge. (Fig. 4.3.26.3. C, F)

Seed micromorphology

Seeds unknown.

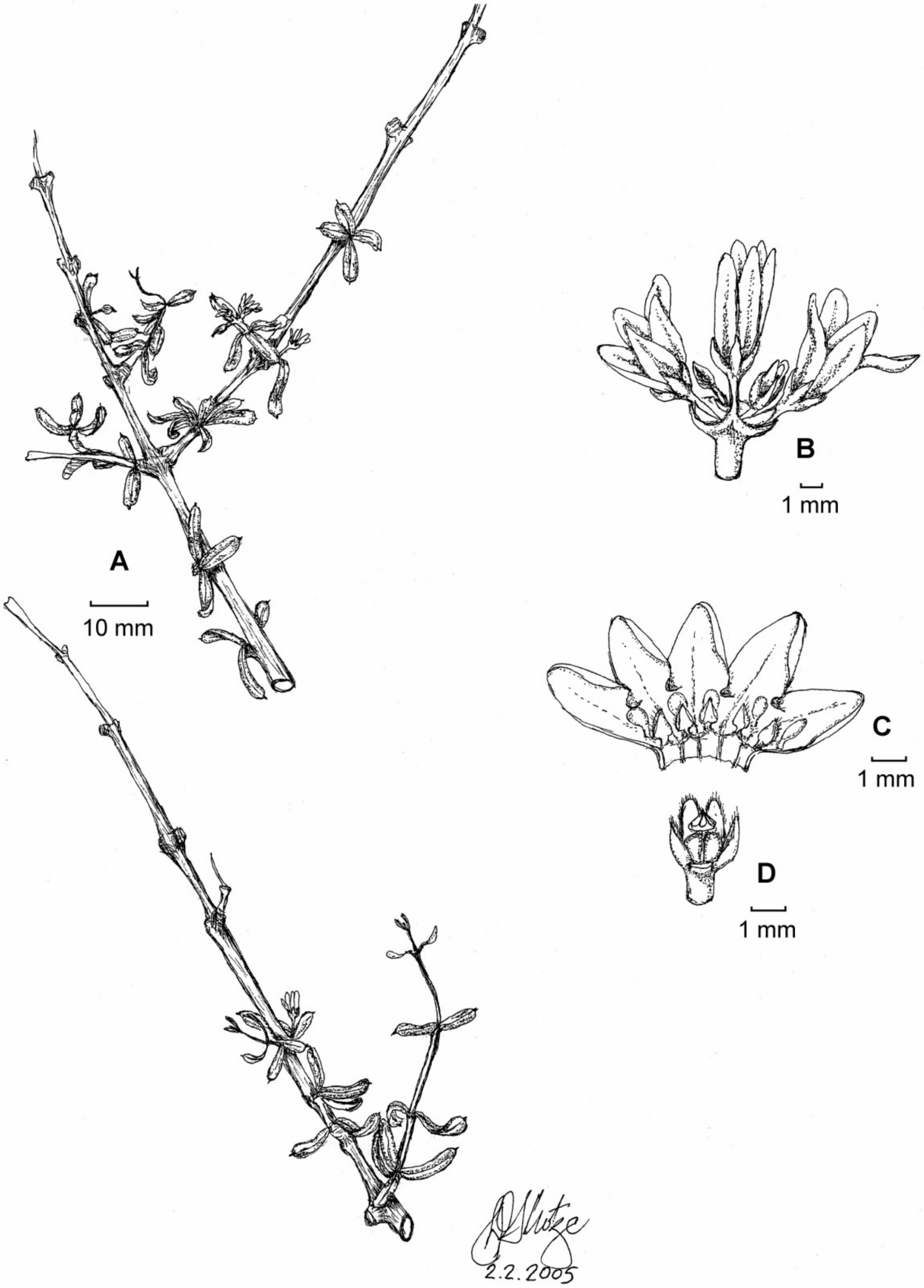


Fig. 4.3.26.1. Illustration of *Cryptolepis somaliensis*: (A) stems with leaves and inflorescences; (B) inflorescence; (C) corolla opened showing clavate primary corona lobes, secondary corona pockets in corolla lobe sinuses and villous anthers; (D) calyx with front sepal removed to reveal pistil of semi-inferior ovaries. Specimen: (A–D) *Thulin et al. 10509* (UPS). Reproduced with permission of the South African Journal of Botany.

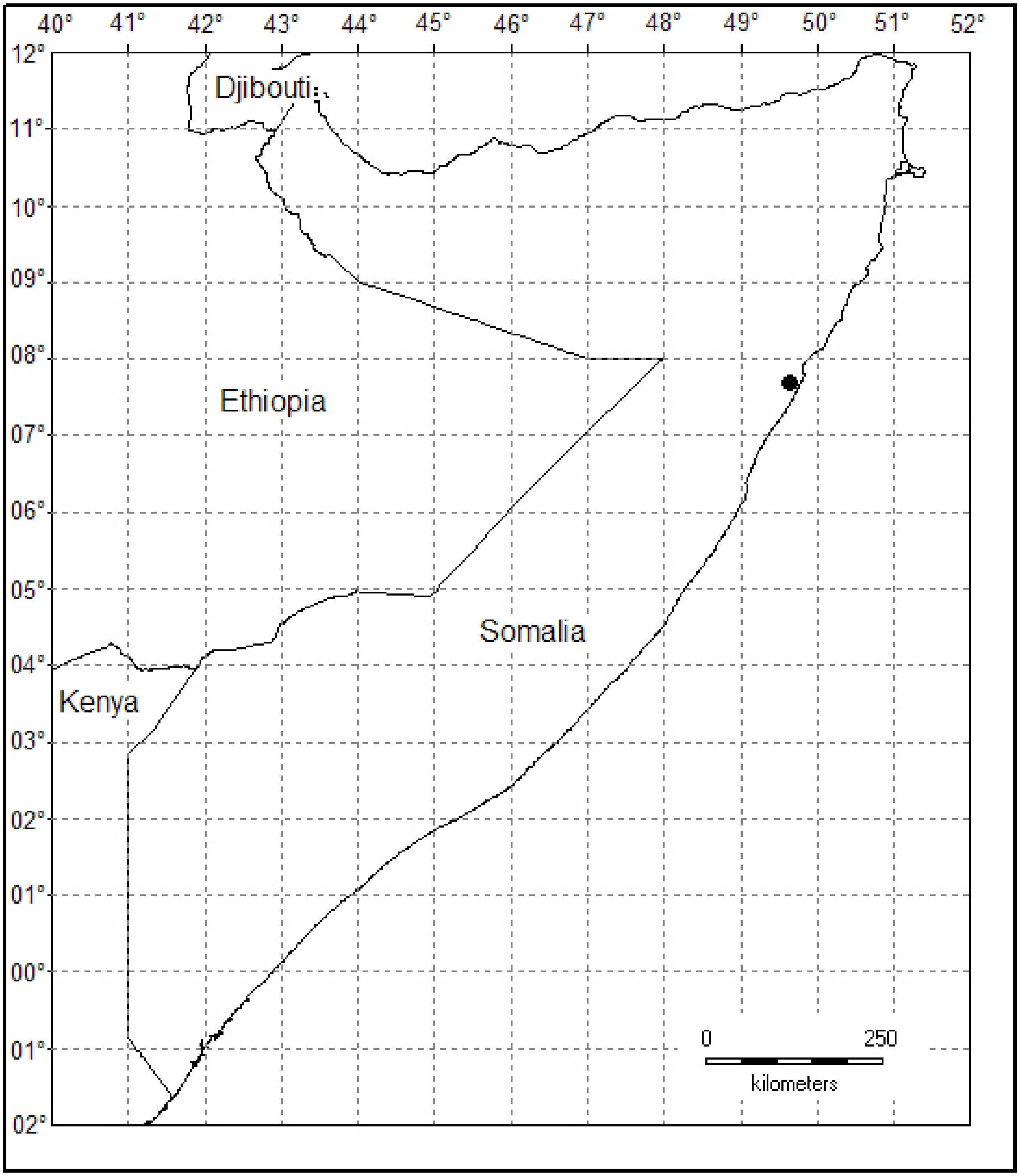


Fig. 4.3.26.2. Known distribution of *Cryptolepis somaliensis*.

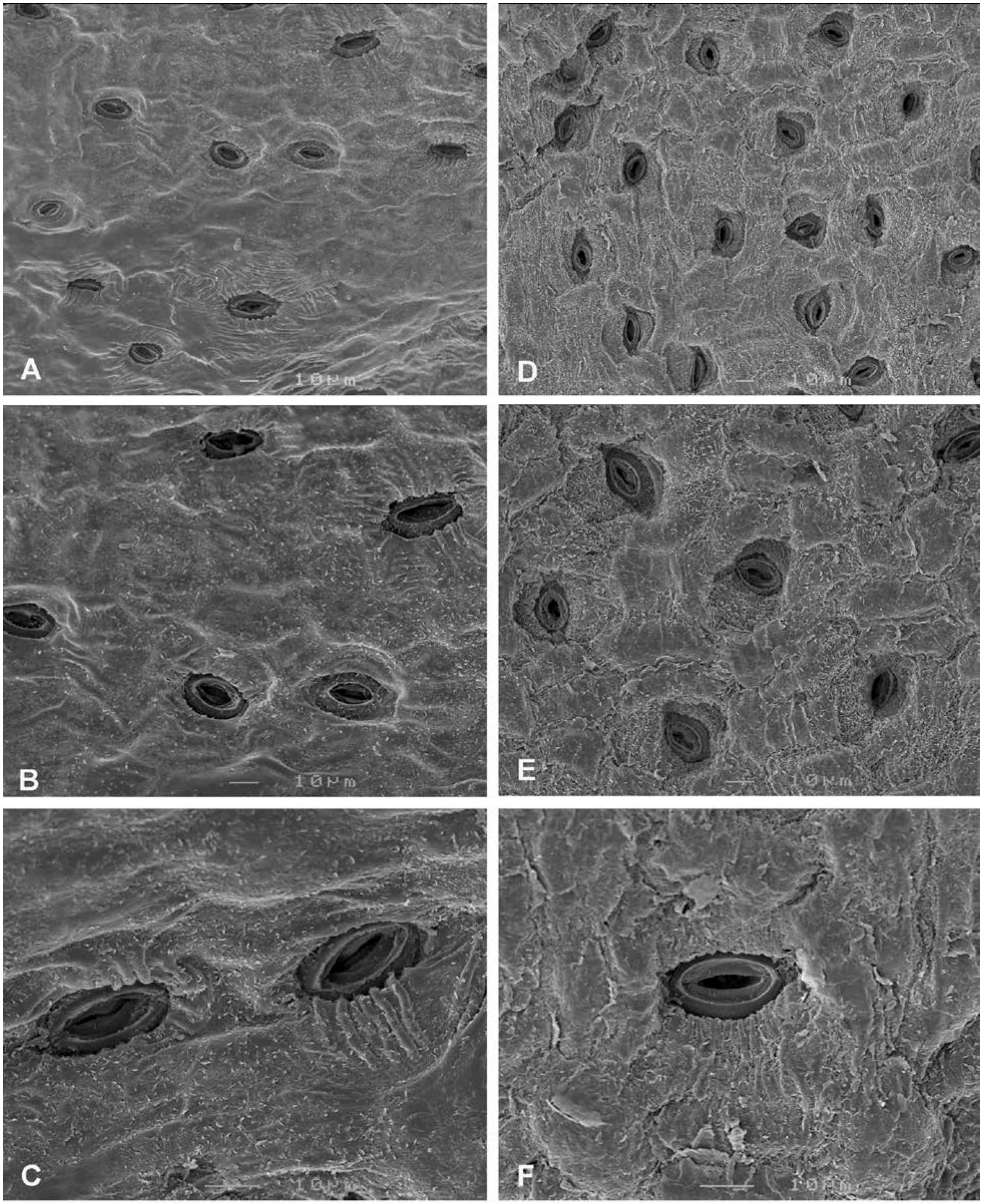


Fig. 4.3.26.3. *Cryptolepis somaliensis* leaf epidermal surfaces: (A–C) adaxial epidermal cells with tabular periclinal walls, smooth to slightly striated cuticle, stomata and sparsely arranged wax platelets, (D–F) abaxial epidermis with tabular periclinal walls, slightly striated cuticle, stomata and sparsely arranged wax platelets. Magnification: A, D = x400; B, E = x650; C, F = x1200. Specimen: (A–F) *Thulin 10509* (UPS).

4.3.27 ***Cryptolepis stefaninii*** Chiov., Flora Somala: 218 (1929); Venter: 138 (2006).

Type: Somalia, Bacino del Darror, Halil Damòlle, *Puccioni & Stefanini 1001* (FT-scan!, holo.).

A shrub, with white latex, up to 1.5 m high, branching from the base. *Stems* woody, erect, slender, stem diameter unknown; young stems reddish-brown, smooth, densely puberulous; older stems pale to dark grey, bark fissured and cracked, glabrous to slightly puberulous; interpetiolar ridges villous, conspicuous on young and older branches, colleters inconspicuous. *Leaves* opposite, axils villous, petiolate; petiole green, puberulous, slightly grooved, 3–6 mm long; blade oblong to oblong-obovate, 25–47 x 3–7 mm, semi-succulent, bright green, glabrous; margin plane; apex acute, occasionally apiculate, glabrous, not recurved; base attenuate; main vein sunken on adaxial surface, higher order venation not visible. *Inflorescences* cymose, compact, few-flowered, each cyme consists of 1 dichasium, ending in 1–2 monochasia, primary peduncle 3–5 mm long, secondary peduncles 1–3 mm long, pedicels 1.5–3 mm long; bracts opposite, sparsely arranged, glabrous, triangular, 0.5 mm long, margins glabrous. *Buds* robust, 4–5 mm long, broadly ovoid, apices obtuse, slightly turned. *Sepals* light green, ovate, 1.5–1.8 x 1–1.2 mm, glabrous, apices acute, margins glabrous to fimbriate, colleters translucent and inconspicuous, ovate, apices dentate. *Corolla* greenish-yellow to yellow, tinged red on outside, 4–5 mm long; tube campanulate, ± 2 mm long, glabrous outside and inside; lobes spreading, obovate, 2–3 x 1 mm, apices obtuse, apiculate. *Corona* single; primary corona inserted ± 1 mm from corolla tube base, exserted from corolla mouth, lobes reddish, clavate, fleshy, 1–1.5 mm long, glabrous, apices bilobed, connivent over gynostegium. *Stamens* inserted ± 0.5 mm from corolla tube base; anthers hastate, attenuate, villous, ± 0.8 mm long, filaments ± 0.2 mm long. *Nectaries* inconspicuous, inserted ± 0.3 mm from corolla tube base. *Ovaries* ± 0.8 x 0.6 mm; style ± 0.2 mm long, style-head pyramidal, cuspidate, ± 0.7 x 0.6 mm. *Translators* elliptic, ± 0.6 mm long, apices retuse. *Follicles* erect, divaricate at 80°–90°, narrowly ovoid, 20–35 x 3–4 mm, brown, apices attenuate, bases cuneate. *Seeds* narrowly rhombic, 2.2–3 x 0.7–1 mm, light brown, finely granular; coma white to yellowish-white, ± 11 mm long. (Fig. 4.3.27.1.)

Diagnostic characteristics

Cryptolepis stefaninii is a shrub, with erect, non-twining stems. The leaves are oblong, rarely oblong-obovate, with acute, occasionally apiculate apices, medium-sized, 25–47 x 3–7 mm, and semi-succulent. This species can be distinguished from several other species with semi-succulent leaves by its flowers which are arranged in compact, few-flowered inflorescences and clavate, not filiform, primary corona lobes. *Cryptolepis stefaninii* is most similar to *C. nugaalensis, C. somaliensis* and *C. yemenensis*, which all have flowers in inflorescences and clavate corona lobes. *Cryptolepis stefaninii* is most easily distinguished in this group, having larger leaves than the other three species, with leaf sizes 25–47 x 3–7 mm and corona lobes reddish with bilobed apices.

Distribution and habitat

Cryptolepis stefaninii is endemic to Somalia (Fig. 4.3.27.2.). It grows on gypsum hills at altitudes from 600–800 m, often in overgrazed or eroded areas. Associated species include *Commiphora* sp.*, Lannea* sp. and *Euphorbia* sp. Flowering occurs from May to June.

Representative specimens

— **8º21'42'' N, 48º25'50'' E:** Somalia, Nugaal Region, Garoowe District, 6.4 km S of Garue [Garoowe], 14-06-1958, *Hemming, C.F. 1372* (K).

— **8º24'35'' N, 47º18'56'' E:** Somalia, Nugaal Region, 8 km S of Las Anod [Laascaanood], 30-12-1972, *Bally, P.R.O.* & *Melville, R. 15400* (K).

— **9º05' N, 48º40' E:** Somalia, Nugaal Region, Halin District, 5 km E of Halin along road to Gardo [Qardho], 21-06-1985, *Thulin, M.* & *Warfa, A.M. 5417* (UPS).

— **9º05' N, 48º40' E:** Somalia, Nugaal Region, 03-12-1980, *Beckett, J.J. 652* (K).

— **10º13' N, 49º02' E:** Somalia, Bari Region, 6 km from Dalweyn along road to Qardho, 04-05-2001, *Thulin, M., Dahir, A., Khalid, A. & Osman, A. 10422* (K, UPS).

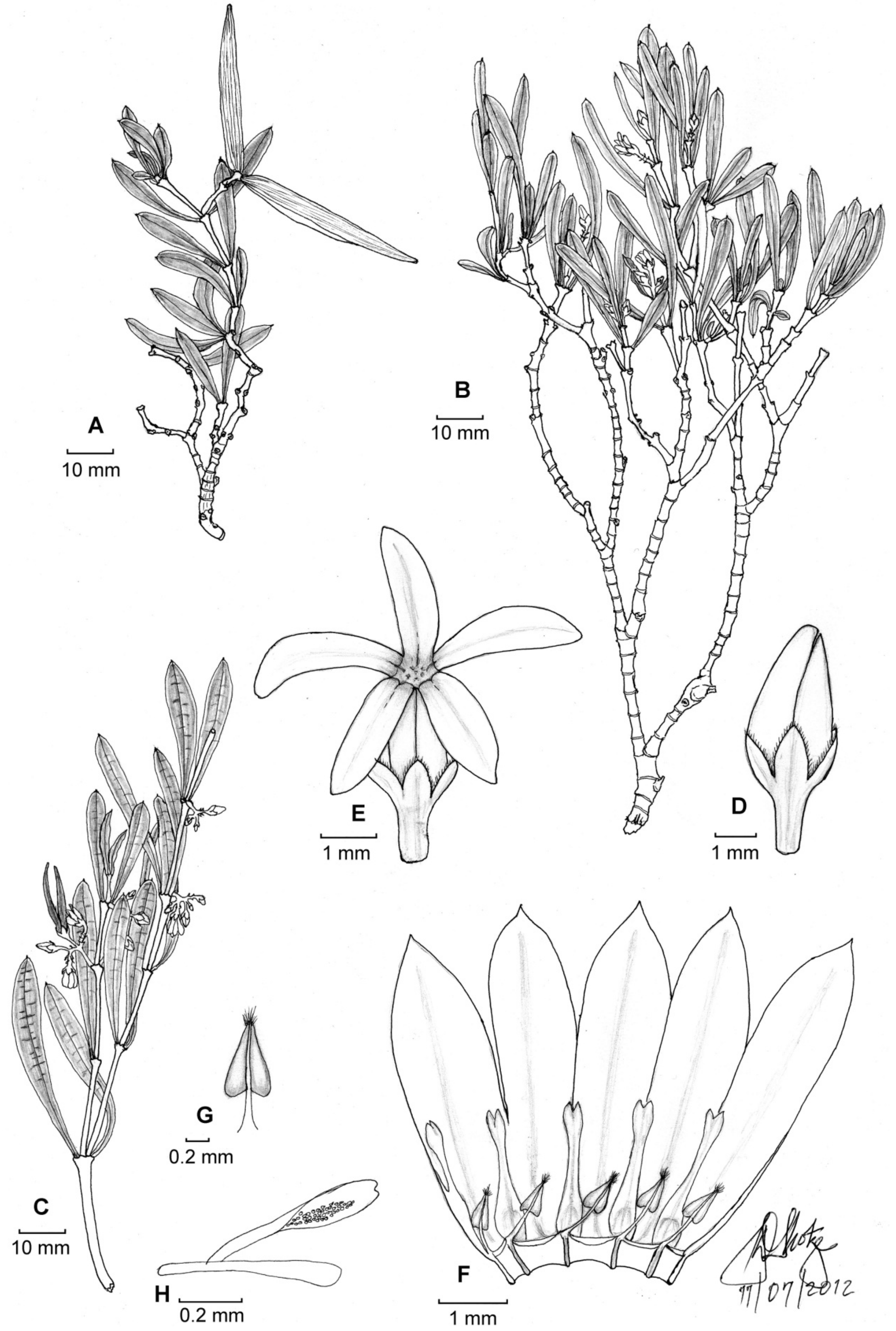


Fig. 4.3.27.1. Illustration of *Cryptolepis stefaninii*: (A) stem with leaves and paired follicles, (B–C) stem with leaves and inflorescences, (D) external view of bud, (E) external view of mature flower, (F) corolla opened showing clavate, bilobed primary corona lobes with prominent coronal feet and stamens with narrowly hastate anthers, (G) stamen with hastate anther, apex villous, (H) translator with retuse apex. Specimens: (A) *Bally & Melville 15400* (K); (B, F) *Thulin et al. 10422* (UPS); (C–E, G–H) *Thulin & Warfa 5417* (UPS).

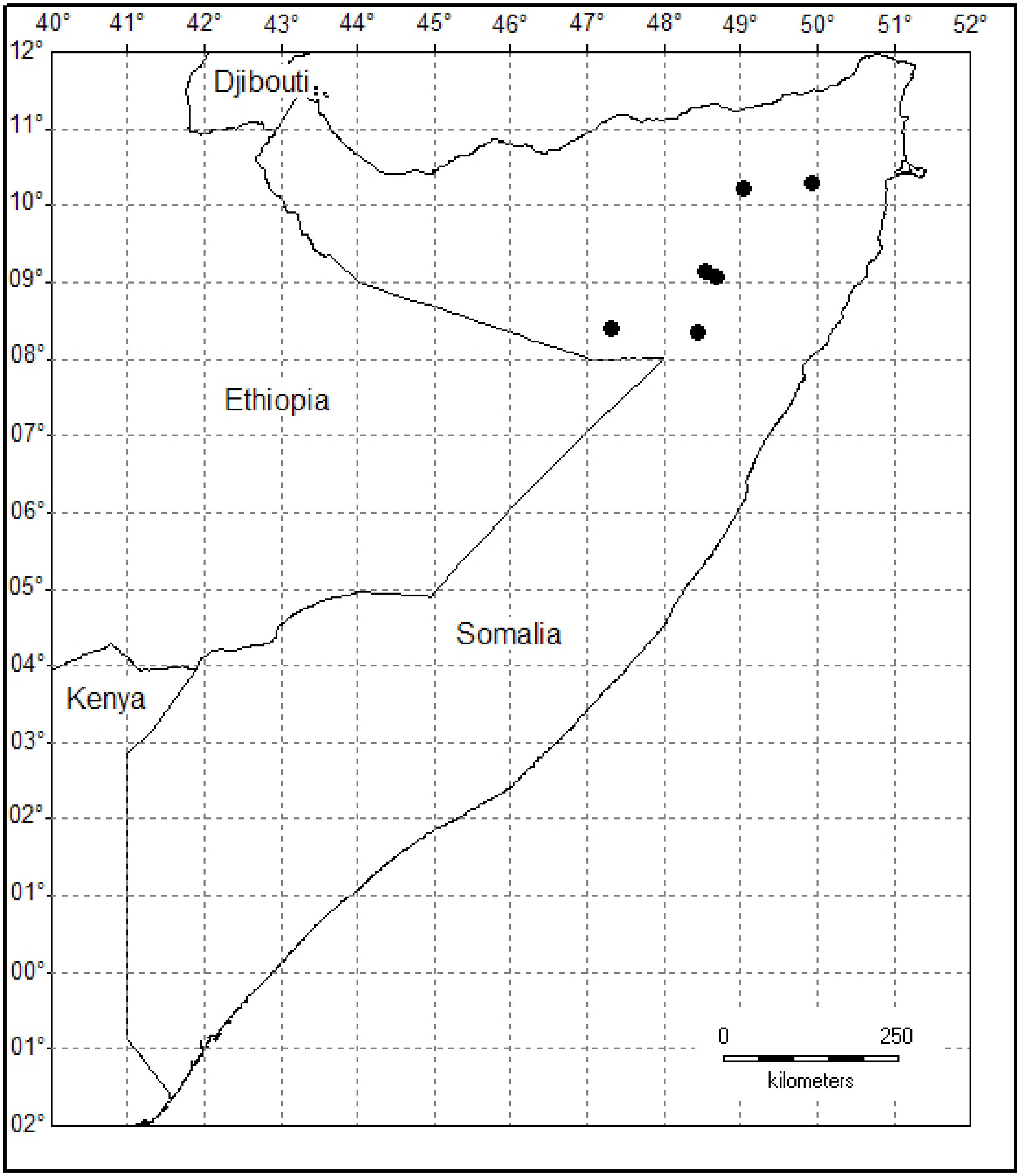


Fig. 4.3.27.2. Known distribution of *Cryptolepis stefaninii*.

Leaf micromorphology

The adaxial and abaxial epidermal surfaces are similar. Cell shape is isodiametric and penta- to hexagonal. Periclinal walls are strongly convex while anticlinal walls are straight to slightly curved and deeply sunken. The cuticle is densely striated with striations wavy, randomly orientated, radiating from the centre of each epidermal cell and continuous over intercellular boundaries. (Fig. 4.3.27.3. A–F)

Leaves are amphistomatic with stomata randomly orientated. The number of stomata on the adaxial and abaxial epideris is similar. Stomata are paracytic and subsidiary cells are very prominent, raised above and obscuring guard cells and the stomatal pore. Subsidiary cells are covered by a heavily striated cuticle, with striations perpendicular to the stomatal pore. (Fig. 4.3.27.3. A–F)

Seed micromorphology

The adaxial seed surface is characterized by intersecting ridges, giving the surface a honeycomb appearance (Fig. 4.3.27.4. A–B). Epidermal cells are more or less isodiametric and tetra- to hexagonal. Periclinal walls are concave while anticlinal walls are straight and level with the epidermal surface. The cuticle is smooth (Fig. 4.3.27.4. C).

Abaxially the seed has a narrow central ridge (Fig. 4.3.27.4. D). On either side of the central ridge the surface has a honeycomb appearance, with intersecting ridges (Fig. 4.3.27.3. E). Epidermal cells are more or less isodiametric and tetra- to hexagonal. Periclinal walls are concave while anticlinal walls are straight and level with the epidermal surface. The cuticle is smooth (Fig. 4.3.27.4. F).

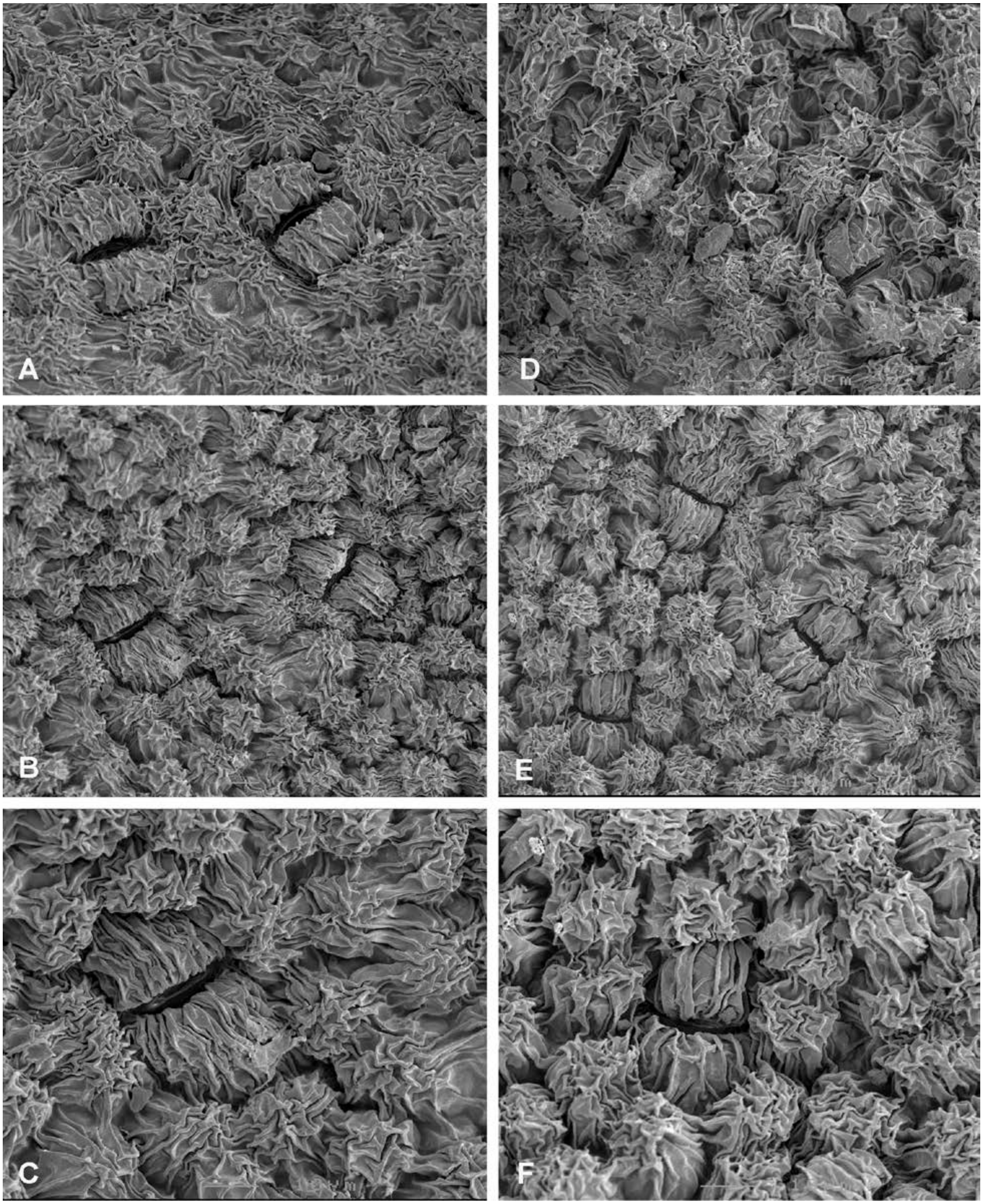


Fig. 4.3.27.3. *Cryptolepis stefaninii* leaf epidermal surfaces: (A–C) adaxial epidermal cells with convex periclinal walls, deeply sunken anticlinal walls, densely striated cuticle and sunken stomata, (D–F) abaxial epidermal cells with convex periclinal walls, deeply sunken anticlinal walls, densely striated cuticle and sunken stomata, Magnification: A–B, D–E = x650; C, F = x1200. Specimens: (A, D) *Beckett 856* (K); (B–C, E–F) *Gillett 23935* (K).

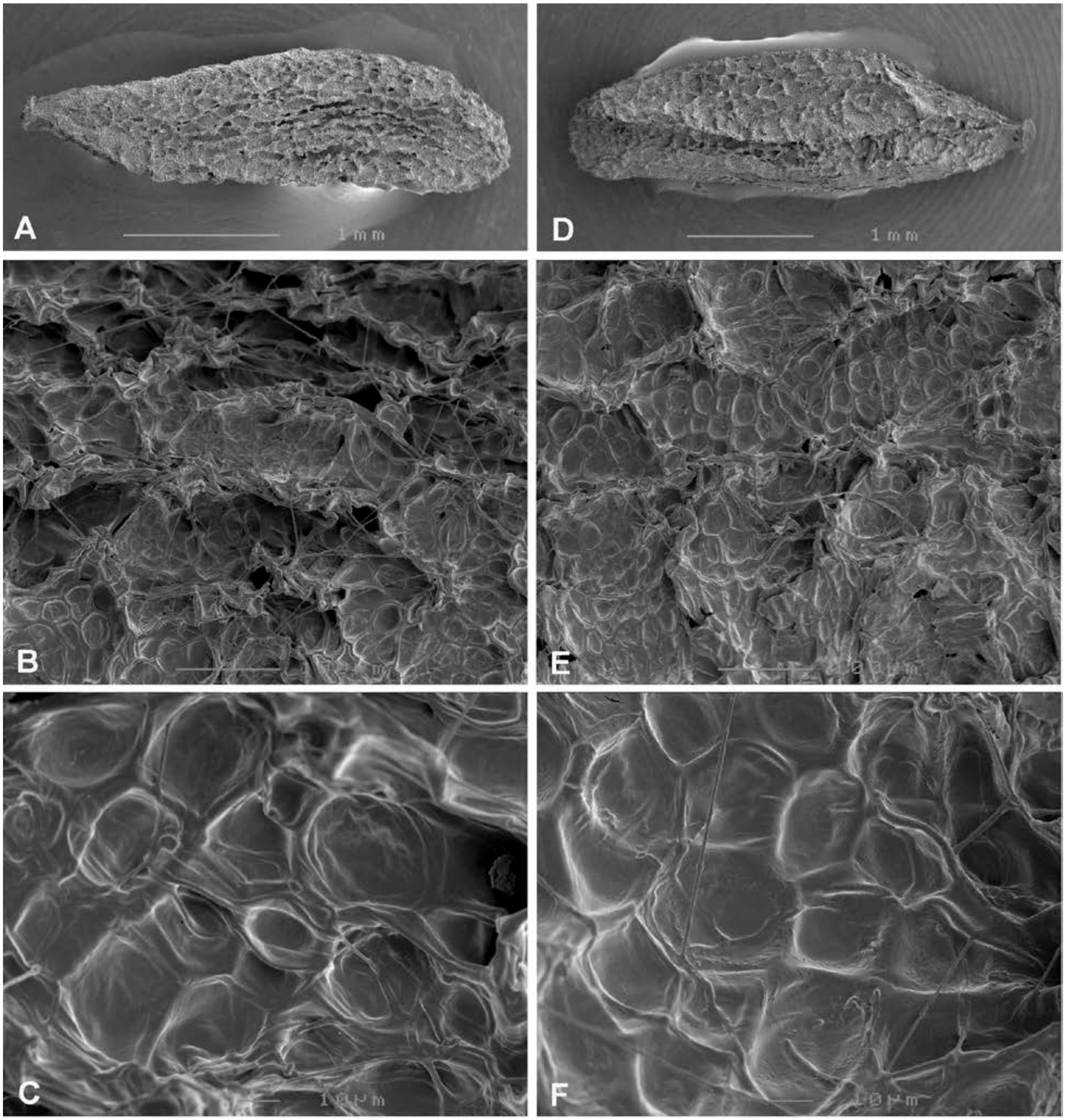


Fig. 4.3.27.4. *Cryptolepis stefaninii* seed surfaces: (A) adaxial view of seed, (B) adaxial seed surface with ridges, (C) cells on adaxial surface between ridges tetra- to hexagonal with convex periclinal walls and anticlinal walls level with the seed surface, (D) abaxial view of seed, (E) abaxial seed surface with ridges, (F) cells on abaxial surface between ridges tetra- to hexagonal with convex periclinal walls and anticlinal walls level with the seed surface. Magnification: A = x33; B, E = x220; C, F = x900; D = x26. Specimen: (A–F) *Bally & Melville 15400* (K).

4.3.28 ***Cryptolepis thulinii*** L.Joubert *sp. nov.*

Cryptolepis thulinii is a dwarf-shrub or climber with stems twining, densely tomentose and covered by crispate trichomes. Leaves are petiolate, while the blade is orbicular, or rarely broadly elliptic, and sparsely to densely tomentose on both surfaces. Flowers are borne in lax, few-flowered inflorescences. Bracts are acicular with fimbriate margins. Sepals are ovate and the corolla is shorter than 10 mm, with corolla lobes linear. The corona is double with the primary corona lobes triangular and flap-like.

Type: Somalia, Shabeellaha Dhexe Region, Balad [Balcad] District, 5 km along road from Balad to Mogadishu, 12-11-1985, *Thulin, M.* & *Warfa, A.M. 5287* (UPS!, holo.; K!, iso.).[Note 1]

A dwarf-shrub or climber, with white latex, up to 1.5 m high. *Stems* woody, twining, slender, up to 4 mm diameter; young stems reddish-brown, smooth to verrucose, tomentose, trichomes characteristically crispate; older stems light grey-brown, verrucose, densely tomentose to glabrous, brachyblasts occasionally present; interpetiolar ridges tomentose, inconspicuous to absent on both younger and older branches; colleters inconspicuous. *Leaves* opposite or rarely fascicled on brachyblasts, axils tomentose, petiolate; petiole green, tomentose, shallowly grooved, 3–4 mm long; blade orbicular, rarely broadly elliptic, (6–)11–18 x (4–)9–16 mm, coriaceous, light green, sparsely to densely tomentose on both surfaces; margin plane; apex rounded, rarely retuse, apiculate, occasionally mucronate, but mucro inconspicuous, slightly tomentose, not recurved; base rounded; venation eucamptodromous, 3–4 secondary veins on either side of main vein, indistinct, higher order venation indistinct, tertiary veins random reticulate, areoles lacking. *Inflorescences* cymose, lax, few-flowered, each cyme consists of 1–3 monochasia or 1–2 dichasia, each ending in 1–2 monochasia primary peduncle 6–20 mm long, tomentose, secondary peduncles 6–8 mm long, pedicels 6–7 mm long; bracts opposite, sparsely to densely arranged, tomentose, acicular, 1–2 mm long, margins fimbriate. *Buds* slender, ± 7 mm long, ovoid, apices attenuate, full turn helically twisted. *Sepals* dark green, ovate, ± 2 x 0.8 mm, acute, puberulous, colleters conical. *Corolla* cream or greenish, 6.5–9.5 mm long; tube campanulate, 2.5–4 mm long, glabrous outside, villous inside; lobes spreading, linear, 4–5.5 x 0.5–1 mm, apices obtuse. *Corona* double; primary corona inserted 1–1.5 mm from corolla tube base, included, lobes triangular, flap-like, 0.3–0.7 mm long, glabrous; apices apiculate, connivent over gynostegium; secondary corona in corolla lobe sinuses, pocket-like, villous. *Stamens* inserted ± 0.8 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 0.5 mm long, filaments ± 0.2 mm long. *Nectaries* conspicuous, inserted ± 0.8 mm from corolla tube base. *Ovaries* ± 0.5 x 0.7 mm; style ± 0.3 mm long, style-head broadly pyramidal, acute, ± 0.4 x 0.5 mm. *Translators* narrowly elliptic, ± 0.2 mm long, apices acute. *Follicles* erect, divaricate at 80°–100°, cylindrical, 60–120 x 5–6 mm, brown, apices attenuate, bases cuneate. *Seeds* elliptic, 7–9 x 2–2.5 mm, reddish-brown, smooth; coma yellowish-white, ± 22 mm long. (Fig. 4.3.28.1.)

Diagnostic characteristics

Cryptolepis thulinii is a dwarf-shrub or climber with twining stems. The leaves are orbicular or rarely broadly elliptic, small, 6–18 x (4–)9–16 mm, coriaceous, sparsely to densely tomentose with rounded or retuse, apiculate apices. This species is most similar to *C. orbicularis,* under which its specimens were previously included*. Cryptolepis thulinii* is distinguished from *C. orbicularis* by its densely tomentose stems, covered by crispate trichomes, flowers in lax, few-flowered inflorescences, bracts acicular, fimbriate, ovate sepals, corolla shorter than 10 mm, corolla lobes linear 4–5.5 x 0.5–1 mm, corona double and primary corona lobes triangular and flap-like. *Cryptolepis orbicularis* is characterised by its glabrous to slightly puberulous stems, solitary flowers, narrowly elliptic bracts with prominent mucronate apices, narrowly linear to acicular, mucronate sepals, corolla longer than 13 mm, oblong petals 10–11 x 3–3.5 mm, single corona and narrowly clavate primary corona lobes. The follicles of *C. orbicularis* are narrower than 4 mm, while follicles of *C. thulinii* are wider than 5 mm. The seeds of *C. orbicularis* are also smaller than those of *C. thulinii,* being 4–6 x 0.5–0.8 mm in the former species and 7–9 x 2–2.5 mm in the latter.

Distribution and habitat

Cryptolepis thulinii is endemic to Somalia (Fig. 4.3.28.2.). It grows on red sandy soil overlaying limestone at altitudes from 40–250 m. *Cryptolepis thulinii* is a component of open *Acacia-Commiphora* bushland with shrubs 1.2–5 m tall. It is associated with *Boswellia microphylla* Chiov.*, Acacia bussei* Harms ex B.Y.Sjöstedt*, Acacia edgeworthii* T.Anderson, *Acacia mellifera* Benth.*, Acacia senegal* Wild.*, Acridocarpus* sp., *Adansonia* sp., *Albizia* sp., *Carphalea glaucescens* (Hiern) Verdc.*, Combretum* sp., *Commiphora africana* (A.Rich.) Engl.*, Cordia* sp.*, Croton* sp.*, Dalbergia* sp., *Entada leptostachya* Harms*, Gardenia fiorii* Chiov.*, Grewia* sp., *Gnidia* sp., *Gyrocarpus* sp., *Loewia glutinosa* Urb., *Sesamothamnus* sp. and a *Triumfetta* sp. Flowering occurs throughout the year.

Notes

1. The epithet honours Mats Thulin of Uppsala University, Sweden, who actively collected plants in Somalia, including two specimens of the newly described species. He also edited the Flora of Somalia volume 3 dealing with the Apocynaceae.

Representative specimens

— 2º21' N, 45º25' E: Somalia, Shabeellaha Dhexe Region, Balad [Balcad] District, 1 km S of Balad [Balcad], on track to Uarsciek [Warshiikh], 16-05-1983, *Thulin, M. & Warfa, A.M. 4712* (K, UPS).

— 2º24' N, 42º57' E: Somalia, Bay Region, Dinsoor [Diinsoor] District, Bur Kurtungale, 23-02-1982, *Beckett, J.J.* & *White, R. 1610* (K).

— 3º21' N, 45º40' E: Somalia, Hiiraan Region, Jalalaksi [Jalalaqsi] District, 8 km SE of Jalalaksi [Jalalaqsi], 29-10-1987, *Kuchar, P. 17552* (UPS).

— 5º40' N, 47º57' E: Somalia, Mudug Region, 10 km N of Ad, on road from Wisil, 08-06-1979, *Gillett, J.B., Hemming, C.F. & Watson, R.M. 22455* (EA).

— 0º10' S, 41º36' E: Somalia, Jubbada Hoose Region, 38 km E of Hoswein [Hoosingo] on Kisimaio [Kismaayo] Road, 04-07-1983, *Gillett, J.B., Hemming, C.F., Watson, R.M. & Julin, H. 25286* (EA, K).

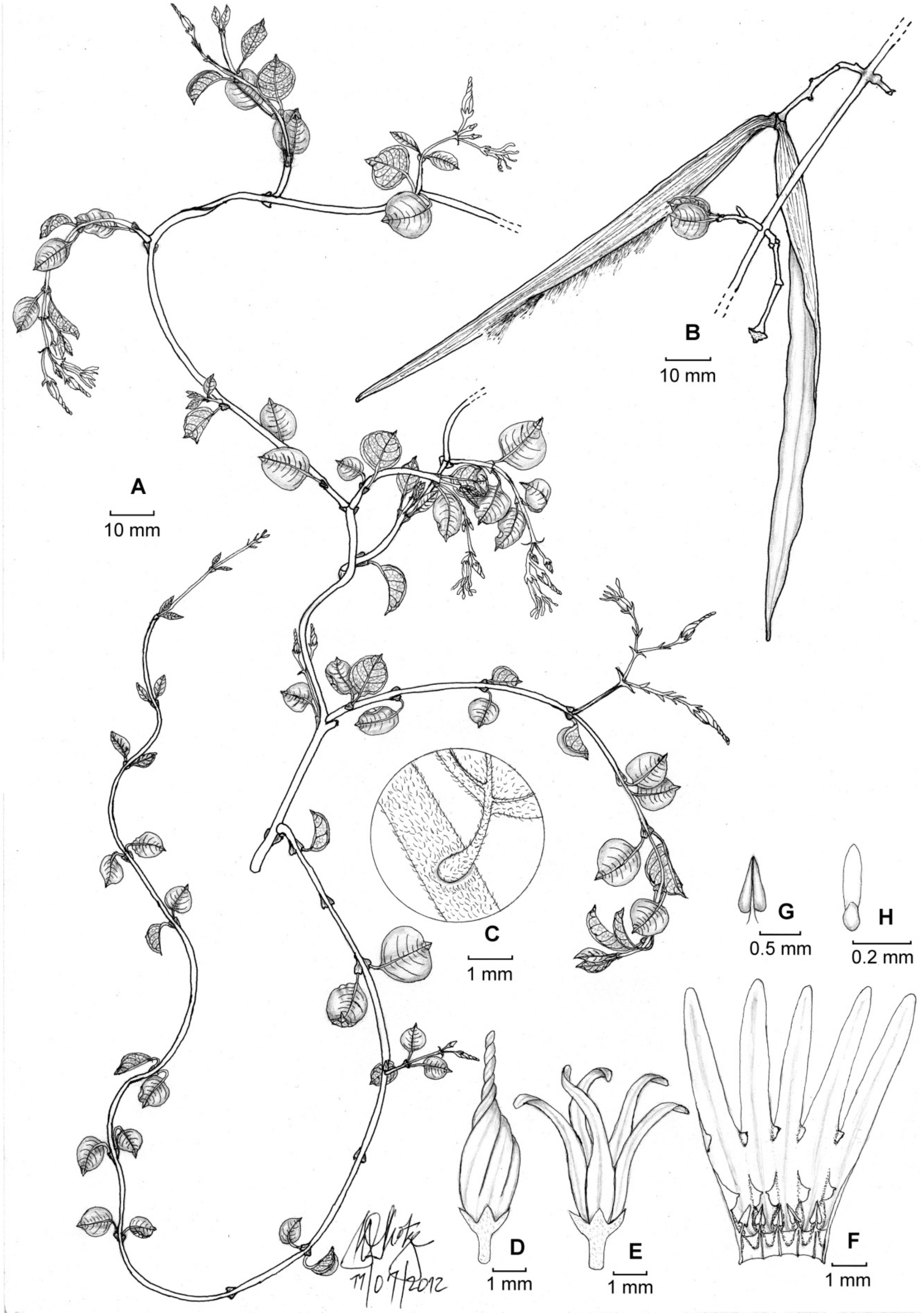


Fig. 4.3.28.1. Illustration of *Cryptolepis thulinii*: (A) stem with leaves and inflorescences, (B) stem with paired follicles, (C) stem covered with crispate trichomes, (D) external view of bud, (E) external view of mature flower, (F) corolla opened showing triangular, flap-like primary corona lobes, secondary corona pockets in corolla lobe sinuses, stamens with narrowly hastate anthers and prominent nectaries, (G) stamen with anther narrowly hastate, glabrous, (H) translator. Specimens: (A, C–G) *Thulin & Warffa 5287* (UPS); (B) *Gillett et al. 25286* (EA); (H) *Kuchar 17552* (UPS).

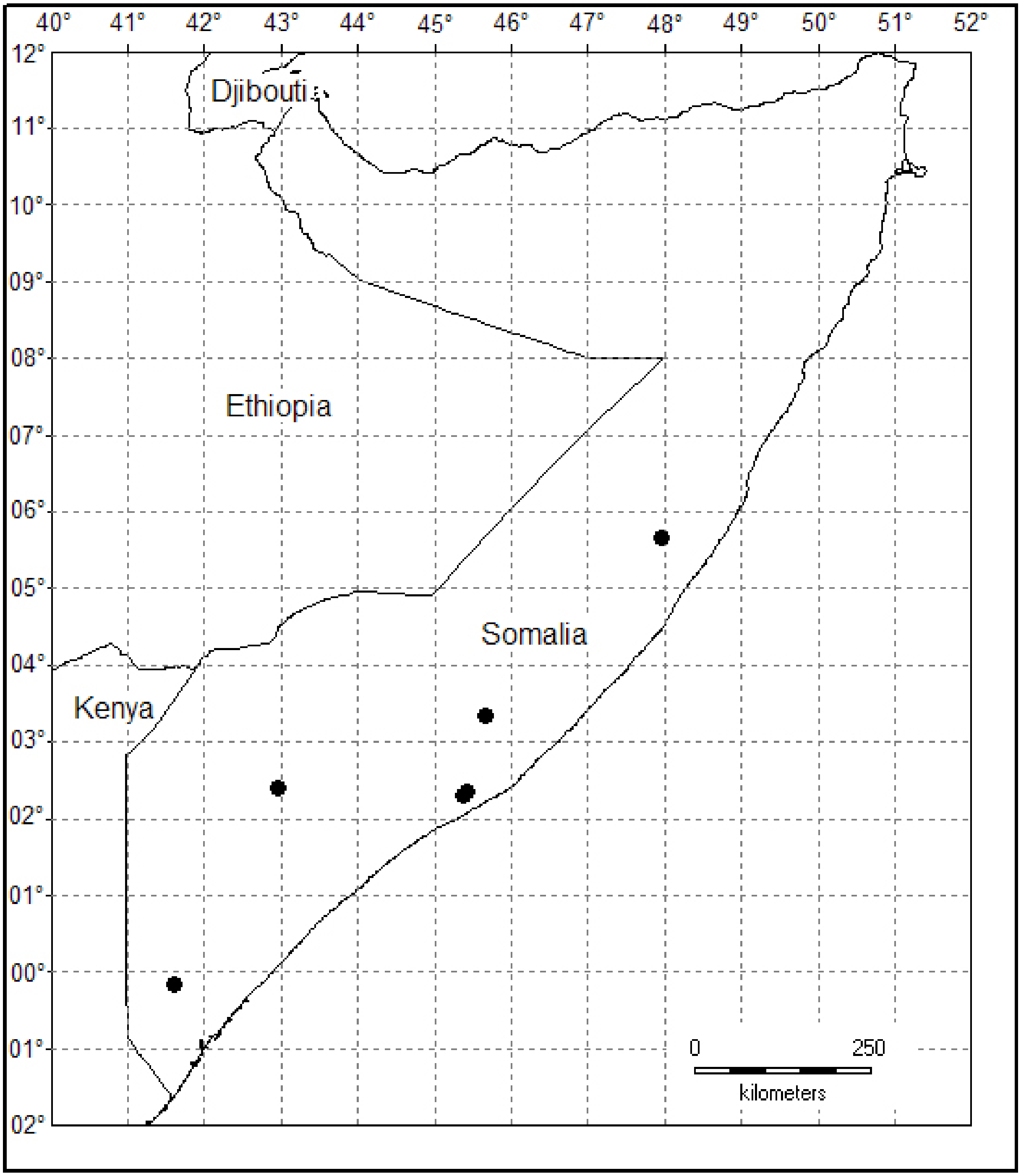


Fig. 4.3.28.2. Known distribution of *Cryptolepis thulinii*.

Leaf micromorphology

Leaf micromorphology of this species is highly variable. Cell shape on the adaxial epidermal surface may be isodiametric and penta- to hexagonal (Fig. 4.3.28.3. C), but cell shape is often obscured by cuticular folds (Fig. 4.3.28.3. A–B). Cuticular patterning is variable, ranging from smooth to slightly striated, with deep cuticular folds (Fig. 4.3.28.3. A–B), or densely striated with no cuticular folding. When present, striations are wavy, randomly orientated to radiating from cell centres, and continuous over intercellular boundaries (Fig. 4.3.28.3. C). Simple, unicellular trichomes with nodular surfaces may be present, concentrated on the main vein or sparsely distributed over the leaf surface (Fig. 4.3.28.3. B).

Cell shape is indistinguishable on the abaxial epidermal surface. The cuticle may be sparsely (Fig. 4.3.28.3. D–E) to densely striated (Fig. 4.3.28.3. F), with striations straight to slightly wavy, parallel and crossing intercellular boundaries. Simple, unicellular trichomes with nodular surfaces may be present, mainly concentrated on the main vein or sparsely distributed over the leaf surface (Fig. 4.3.28.3. E).

Leaves are escentially hypostomatic (Fig. 4.3.28.3. D–F), but a few stomata may occur abaxially next to the main vein (Fig. 4.3.28.3. B). Stomata on the abaxial surface are numerous, randomly orientated and level with the surrounding epidermal cells. Stomata are paracytic and cuticle covering subsidiary cells may be smooth to striated, striations radiating from the stomatal pore. Guard cells are broadly elliptic and covered by broad stomatal ledges (Fig. 4.3.28.3. D–F).

Seed micromorphology

The upper seed surface is covered by longitudinal ridges and sparsely arranged protuberances that are formed by raised, contorted epidermal cells (Fig. 4.3.28.4. A–B). Epidermal cells between the protuberances are more or less isodiametric and tetra- to hexagonal. Periclinal walls are convex to partially concave, while anticlinal walls are straight and slightly to deeply sunken. The cells are covered by a coarsely granular cuticle (Fig. 4.3.28.4. C–E).

Abaxially the seed has a narrow central ridge and slightly thickened margins (Fig. 4.3.28.5. A). Protuberances, consisting of contorted epidermal cells, are distributed over the surface between the seed margins and the central ridge (Fig. 4.3.28.5. B). Cells between protuberances are isodiametric and tetra- to hexagonal. Periclinal walls may be tabular while anticlinal walls are straight and level with the epidermal surface near the central ridge (Fig. 4.3.28.5. C, E). Near the seed margin periclinal walls range from convex to partially concave while anticlinal walls are straing and slightly sunken (Fig. 4.3.28.5. D).

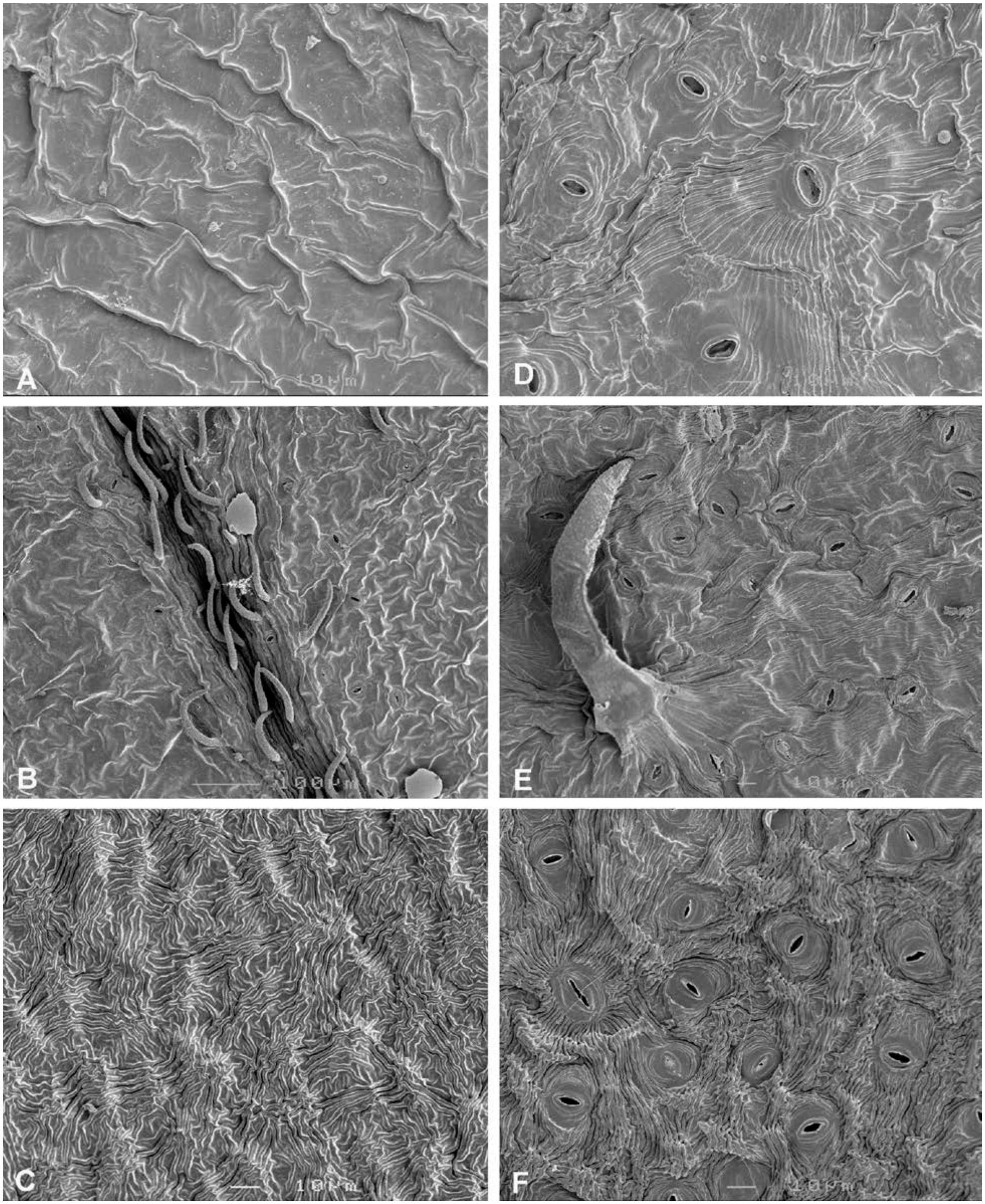


Fig. 4.3.28.3. *Cryptolepis thulinii* leaf epidermal surfaces: (A) adaxial epidermal surface with cuticular folds, (B) adaxial epidermal cells, cuticular folds, trichomes along the main vein, a few stomata next to main vein, (C) adaxial epidermal cells with striated cuticle, (D) abaxial epidermis with slightly striated cuticle and stomata, (E) abaxial epidermis with slightly striated cuticle, stomata and trichome, (F) abaxial epidermis with densely striated cuticle and stomata. Magnification: A, C, D, F = x650; B = x150; E = x400. Specimens: (A, D) *Gillett et al. 25286* (EA); (B, E) *Thulin & Warfa 4712* (UPS); (C, F) *Thulin & Warfa 5287* (UPS).

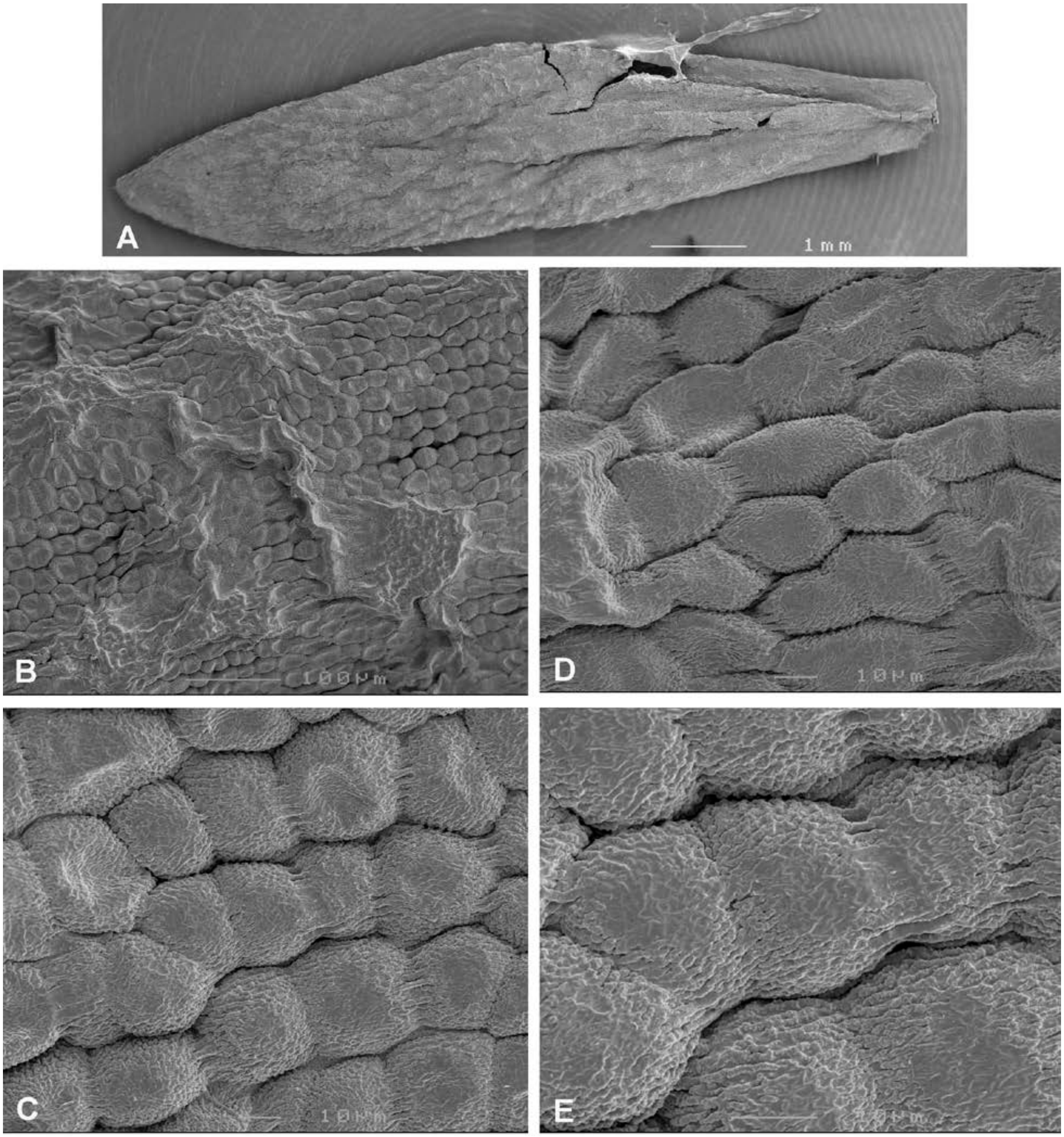


Fig. 4.3.28.4. *Cryptolepis thulinii* seed surface*,* (A) adaxial view of seed, (B) adaxial seed surface with sparsely arranged protuberances, (C, D) cells tetra- to hexagonal with convex periclinal walls and slightly to deeply sunken anticlinal walls, (E) cells covered by a granular cuticle. Magnification: A = x20, B = x220, C–D = x900, E = x1800. Specimen: (A–F) *Gillett et al. 25286* (EA).

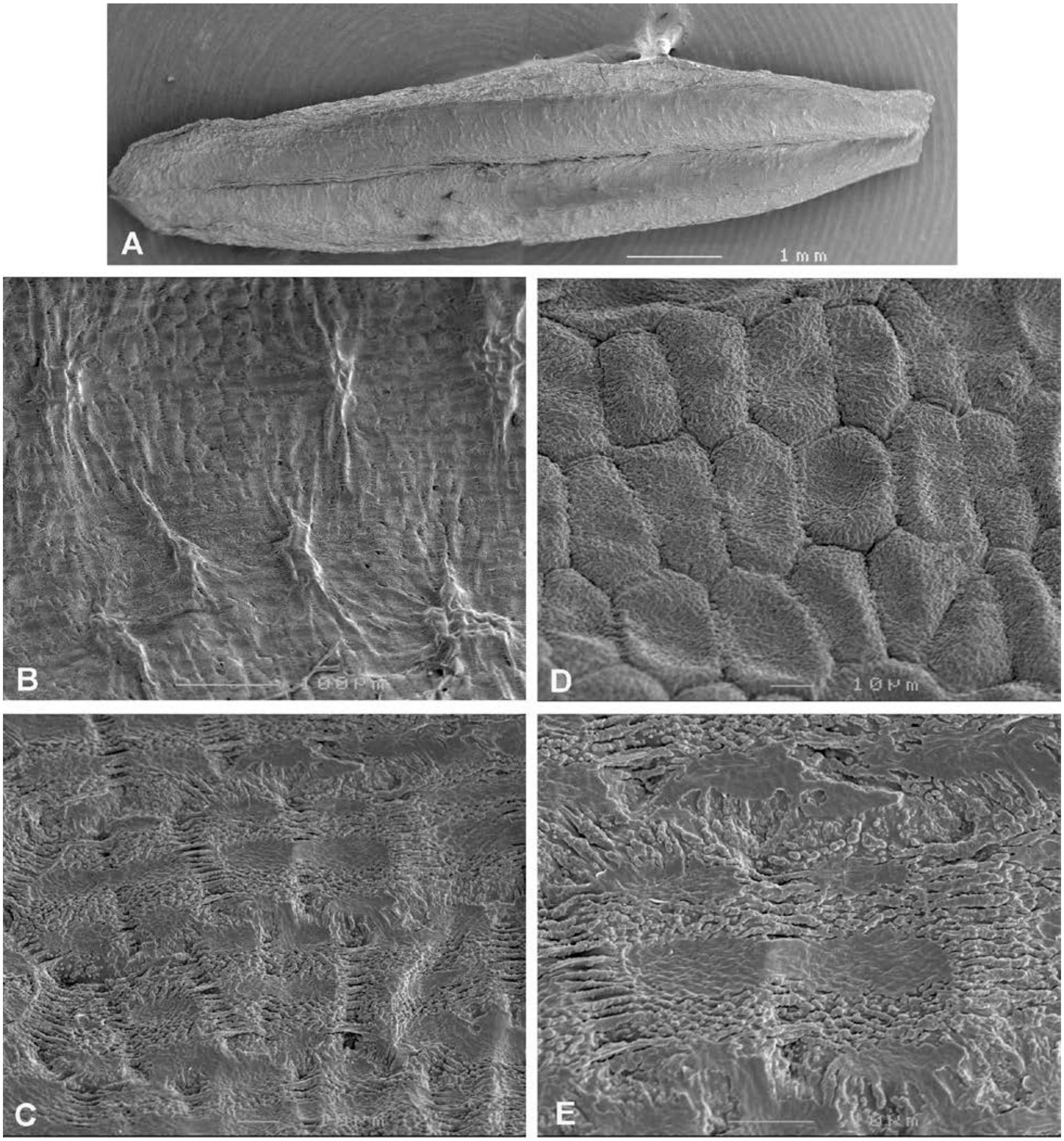


Fig. 4.3.28.5. *Cryptolepis thulinii* seed surface: (A) abaxial view of seed, (B) abaxial surface between central ridge and seed margin with protuberances, (C) cells near central ridge with tabular periclinal walls, (D) cells near seed margin with convex to partially concave periclinal walls, (E) cells covered by granular cuticle. Magnification: A = x20; B = x220; C–D = x900; E = x1800. Specimen: (A–E) *Gillett et al. 25286* (EA).

4.3.29 ***Cryptolepis villosa*** L.Joubert *sp. nov.*

Cryptolepis villosa is a slender climber. The leaves are lanceolate to oblong-lanceolate, medium sized to large, herbaceous with attenuate apices. The abaxial leaf surface is villous and covered by globular micropapillae while the adaxial leaf surfaces and margins are also characteristically villous. Inflorescences bear acicular bracts which are longer than 2.5 mm. Buds are oblong with attenuate apices and glabrous corolla tubes, which are shorter than the corolla lobes*.* *S*epals are narrowly lanceolate, ± 4 mm long*.*

Type: Source of Nahomba River, Selous Game Reserve, Tanzania, 10-02-1978, *Vollesen, K. 4920* (K!, holo.; K!, iso.).[Notes 1 & 2]

A slender climber, with white latex, up to 3 m high. *Stems* woody, slender, twining, up to 3 mm diameter; young stems light brown, smooth, puberulent to puberulous; older stems brown to dark purplish-brown, slightly verrucose, bark peeling, glabrous or puberulent to puberulous; interpetiolar ridges absent, colleters present. *Leaves* opposite, axils puberulent, petiolate; petiole green, puberulous, grooved, 2 mm long; blade lanceolate to oblong-lanceolate, 28–65 x 13–17 mm, herbaceous, dark to bright green, villous adaxially, pale green, villous and papillate abaxially; margin plane, villous; apex attenuate, puberulous to villous, not recurved; base rounded to truncate; venation eucamptodromous, inconspicuous, 6–8 secondary veins on either side of main vein, intersecondary venation present, tertiary veins random reticulate, areole development incomplete, veinlets absent. *Inflorescences* cymose, lax, few-flowered, slender, villous, each cyme consists of 1–2 monochasia, primary peduncle 8–13 mm long, secondary peduncle, when present 5 mm long, pedicels 13–18 mm long; bracts opposite, sparsely arranged, acicular, 2.5–3 mm long, margins puberulent. *Buds* slender, 12–14 mm long, oblong, apices attenuate, full turn helically twisted. *Sepals* pale green, narrowly lanceolate, ± 4 x 0.8 mm, attenuate, puberulous, margin puberulous, colleters ovate, apices dentate. *Corolla* creamy-yellow, 13–16 mm long; tube campanulate, 3–4 mm long, glabrous outside and inside; lobes spreading, linear, 10–12 x 1 mm, apices acute to round. *Corona* single; primary corona inserted ± 1.5 mm from corolla tube base, included, lobes inconspicuous, sub-clavate, ± 0.5 mm long, glabrous, apices obtuse, connivent over gynostegium, spongy coronal feet prominent, extending to staminal insertion point. *Stamens* inserted ± 0.5 mm from corolla tube base; anthers triangular, apiculate, glabrous, ± 0.5 mm long, filaments ± 0.2 mm long. *Nectaries* prominent, inserted ± 0.5 mm from corolla tube base. *Ovaries* ± 0.5 x 0.8 mm; style ± 0.2 mm long, style-head broadly pyramidal, acute, ± 0.3 x 0.7 mm. *Follicles* unknown. *Seeds* unknown. (Fig. 4.3.29.1.)

Diagnostic characteristics

Cryptolepis villosa is a slender climber. The leaves are lanceolate to oblong-lanceolate, medium sized to large, 28–65 x 13–17 mm, herbaceous with attenuate apices. This species is vegetatively very similar to *C. eburnea* and *C. microphylla,* with all three species possessing similar growth form, leaf shape and globular micromicropapillae on the abaxial leaf surface. *Cryptolepis villosa* is distinguished from *C. eburnea* by its oblong buds with attenuate apices and glabrous corolla tubes, which are shorter than the corolla lobes, as opposed to dumb-bell shaped buds, salver-shaped corollas, with corolla tubes longer than the corolla lobes and puberulent outer corolla surfaces in *C. eburnea. Cryptolepis villosa* is distinguished from *C. microphylla* by its villous adaxial and abaxial leaf surfaces and margins, acicular bracts longer than 2.5 mm and sepals narrowly lanceolate, ± 4 mm long, as opposed to glabrous to sparsely puberulent adaxial leaf surfaces, triangular bracts, shorter than 1 mm and sepals triangular to broadly ovate, less than 1 mm long in *C. microphylla.*

Distribution and habitat

Cryptolepis villosa is endemic to Tanzania (Fig. 4.3.28.2.). Little is known about the habitat of this species. It has been found in lowland forest and thicket at altitudes ranging from 250–650 m. Associated species include *Manilkara sulcata* Dubard*, Brachylaena* sp. and *Pteleopsis* sp. The single flowering specimen was collected in February.

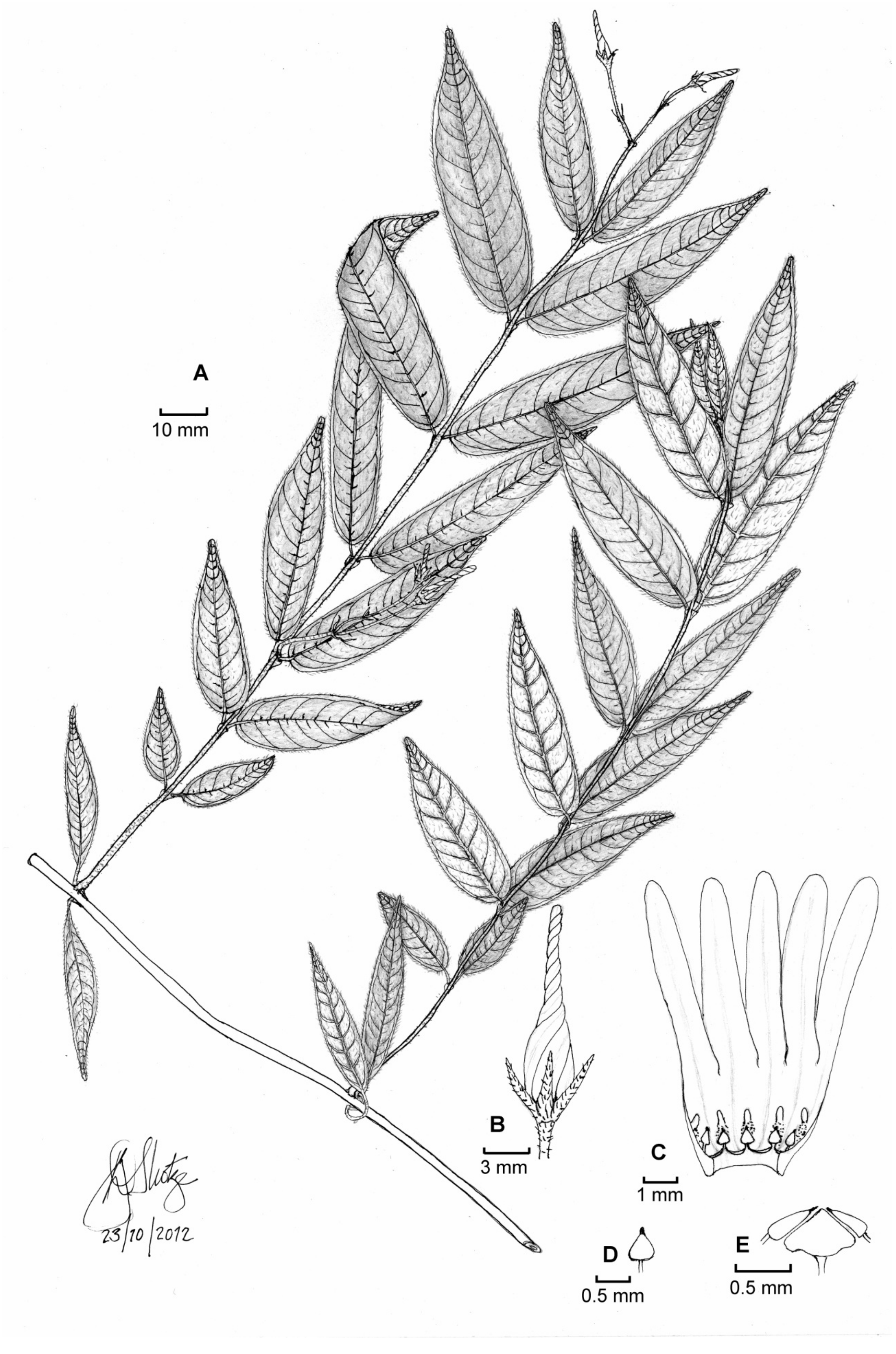
Notes

1. The specific epithet is derived from the villous leaves, a feature unique within *Cryptolepis.*

2. In the latest volume of the Flora of Tropical East Africa (Goyder et al., 2012), dealing with the Apocynaceae (subfamilies Periplocoideae and Asclepiadoideae) Venter (2012) wrongly depicts *Cryptolepis villosa* as *Cryptolepis microphylla.*

Representative specimens

— 4º46' S, 39º07' E: Kilulu Hill, 26-07-2001, *Luke, W.R.Q. , Chidzinga, S. 7546* (K).



23/10/2012

Fig. 4.3.29.1. Illustration of *Cryptolepis villosa*: (A) stem with leaves and inflorescences, (B) external view of bud, (C) corolla opened, showing sub-clavate primary corona lobes and stamens, (D) stamen with triangular anther, (E) gynostegium with connivent anthers. Specimens: (A) *Luke & Chidzinga 7546* (K)*, Vollesen 4920* (K)*,* (B–E) *Vollesen 4920* (K).

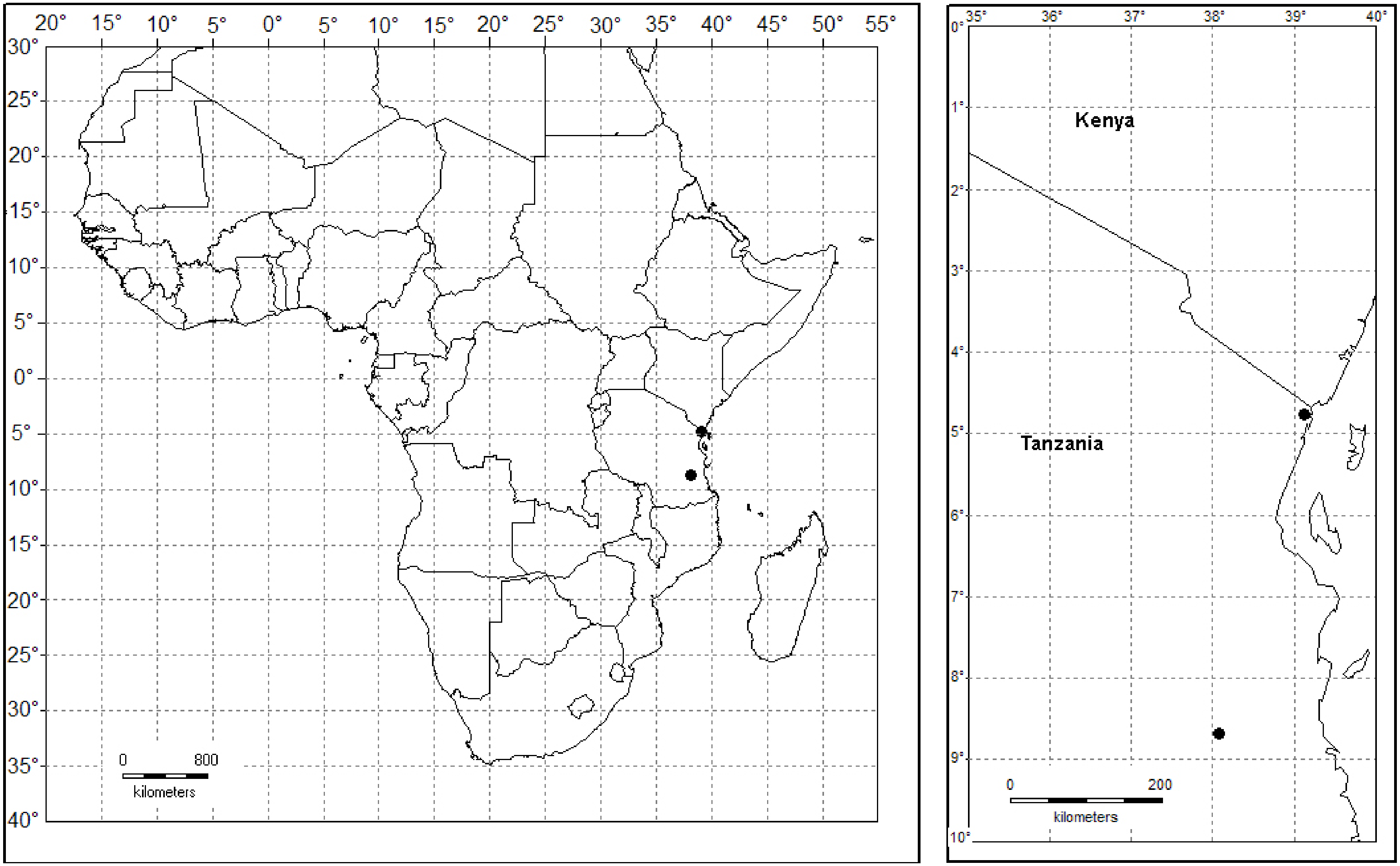


Fig. 4.3.29.2. Known distribution of *Cryptolepis villosa.*

Leaf micromorphology

The adaxial surface is densely villous with long (250–400 µm) simple, unicellular trichomes (Fig. 4.3.29.3. A). Adaxially epidermal cell shape is variable. Periclinal walls are tabular while anticlinal walls are prominently undulate and slightly sunken. The cuticle is heavily striated, these being parallel, randomly orientated and restricted to individual cells (Fig. 4.3.29.3. B–C).

The abaxial surface is densely villous with long (500–700 µm) simple, unicellular trichomes (Fig. 4.3.29.3. D). Cell shape on the abaxial epidermal surface is not visible due to the presence of globular, striate micropapillae, connected by radiating cuticular ridges (Fig. 4.3.29.3. E–F). The periclinal wall of each epidermal cell protrudes to form a single papilla.

Leaves are hypostomatic with stomata, randomly orientated and level with the surrounding epidermal cells (Fig. 4.3.29.3. E). Stomata are paracytic and subsidiary cells are covered by a striated cuticle, striations being perpendicular to guard cells and stomatal pore. Guard cells are narrowly elliptic and covered by a broad stomatal ledge (Fig. 4.3.29.3. F).

Seed micromorphology

Seeds unknown.

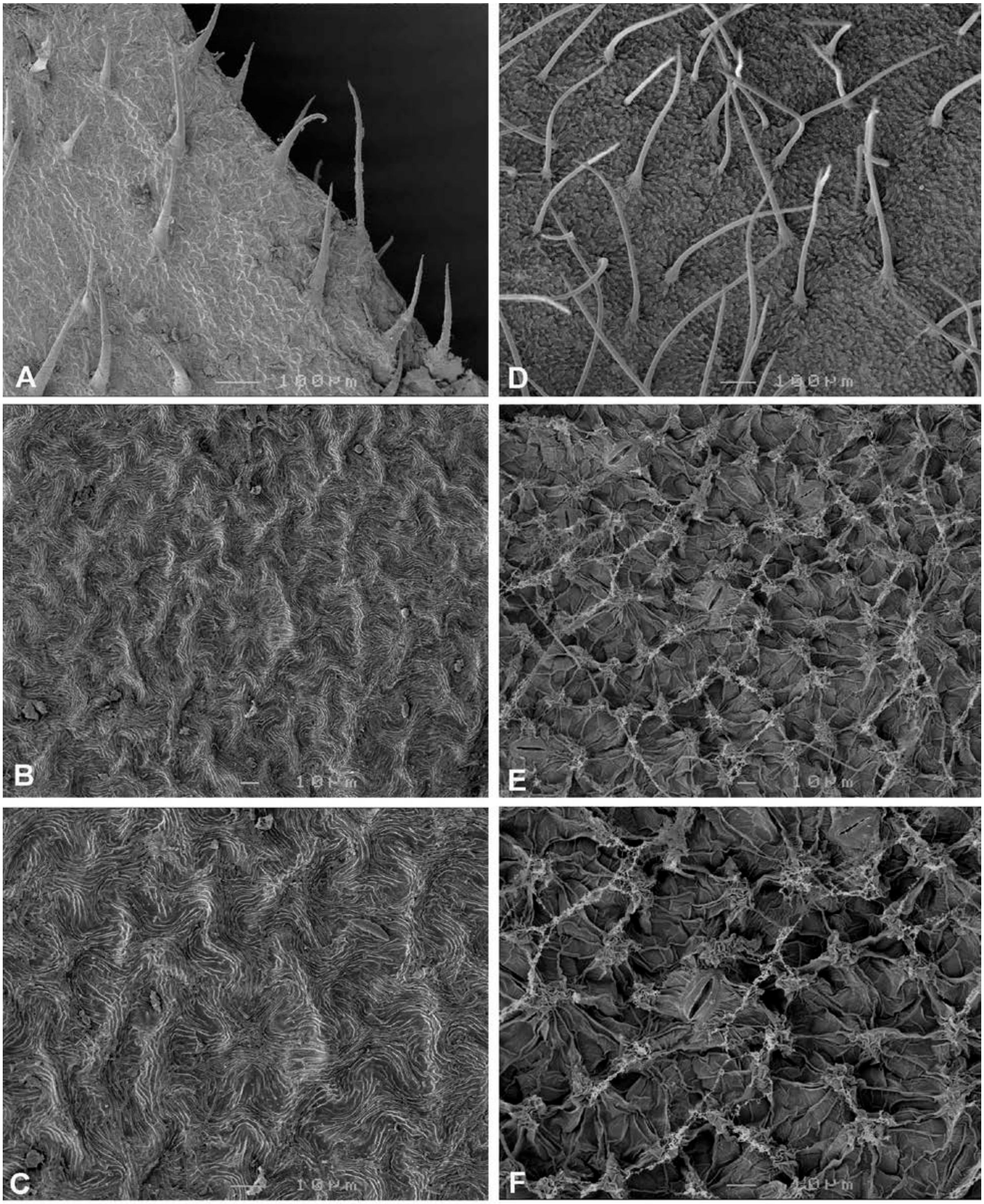


Fig. 4.3.29.3. *Cryptolepis villosa* leaf epidermal surfaces: (A) adaxial epidermis with dense trichomes, (B–C) adaxial epidermal cells with tabular periclinal walls, undulate, slightly sunken anticlinal walls and densely striated cuticle, (D) abaxial epidermis with dense trichomes, (E–F) abaxial epidermis with globular striate micropapillae and stomata. Magnification: A = x100; B, E = x400; C, F = x650; D = x80. Specimen: (A–F) *Vollesen 4720* (K).

4.3.30 ***Cryptolepis volubilis*** (Balf.f.) Schwartz, Mitteilungen aus dem Institut für Allgemeine Botanik in Hamburg 10: 187 (1939). Basionym: *Ectadiopsis volubilis* Balf.f., Proceedings of the Royal Society of Edinburgh 12: 78 (1884), 163 (1888); K.Schum.: 219 (1895b).

Types: Socotra, *Balfour, I.B. 259* (E-scan!, lecto., here designated; BM!, K!, OXF, isolecto.), *696* (E-scan!, BM!, K!, OXF, syn.); Socotra Wadi Keregnigiti, *Schweinfurth 472* (E-scan!, P!, syn.); Socotra, Wadi Kischen, *Schweinfurth 667* (K!, syn.).

= *C. decidua* subsp. ***volubilis*** (Balf.f.) Bullock, Kew Bulletin 9: 361(1954).

Type: Homotypic synonym.

A shrub, with white latex, up to 4 m high. *Stems* woody, twining, slender, up to 3.5 mm diameter; young stems light brown, smooth to slightly verrucose, glabrous; older stems blackish- to greyish-brown, smooth to slightly verrucose, glabrous; brachyblasts occasional; interpetiolar ridges absent, colleters inconspicuous or absent. *Leaves* opposite or fascicled on brachyblasts, axils villous, petiolate to sub-sessile; petiole green, slightly puberulous, shallowly grooved, 0.5–1(–2) mm long; blade linear, narrowly elliptic, elliptic, obovate, oblong or oblong-obovate, 20–55 x 2–10 mm, coriaceous, glabrous, bright green; margin plane; apex attenuate to cuspidate, rarely obtuse to retuse, glabrous, not recurved; base cuneate; venation brochidodromous, 5–7 secondary veins on either side of main vein, indistinct adaxially, visible abaxially, intersecondary venation absent, tertiary veins random reticulate, areole development imperfect. *Inflorescences* cymose, compact, few-flowered, each cyme consists of 1–3 dichasia, each ending in 1–2 monochasia, primary peduncle 2–5 mm long, secondary peduncles contracted, ± 0.5 mm long, pedicels 0.5–1 mm long; bracts opposite, sparsely arranged, slightly puberulent, inconspicuous, triangular, ± 0.3 mm long, margins fimbriate. *Buds* slender, ± 0.3 mm long, ovoid, apices acute to acuminate, half turn helically twisted. *Sepals* light green, lanceolate to triangular, ± 0.8 x 0.5–0.7 mm, puberulous, apices acute, margins fimbriate, colleters absent. *Corolla* white to cream, ± 4 mm long; tube campanulate, ± 1 mm long, glabrous outside and inside; lobes spreading, lanceolate, ± 3 x 0.7 mm, apices attenuate. *Corona* single; primary corona inserted ± 0.8 mm from corolla tube base, slightly exserted, lobes clavate, fleshy, 0.2–0.8 mm long, glabrous, apices acute, connivent over gynostegium. *Stamens* inserted 0.5–0.8 mm from corolla tube base; anthers hastate, attenuate, glabrous, 0.5–0.7 mm long, filaments ± 0.2 mm long. *Nectaries* conspicuous, inserted 0.5–0.8 mm from corolla tube base. *Ovaries* 0.2–0.3 x 0.5–0.7 mm; style ± 0.1 mm long, style-head broadly pyramidal, acute, ± 0.2 x 0.4–0.5 mm. *Translators* unknown. *Follicles* erect, divaricate at ± 135°, broadly ovoid, 37–44 x 11–17 mm, dark brown; apices acute, bases obtuse. *Seeds* elliptic, 7–8 x 3–3.5 mm, dark brown, slightly warty; coma white to yellowish-white, ± 14 mm long. (Fig. 4.3.30.1.)

Diagnostic characteristics

Cryptolepis volubilis is a shrub, up to 4 m high, with twining branches, growing on Socotra. The leaves are linear, narrowly elliptic, elliptic, obovate, oblong or oblong-obovate, medium-sized, 20–55 x 2–10 mm, coriaceous with attenuate to cuspidate, rarely obtuse to retuse, apices. The combination of twining stems, leaf shape and texture distinguishes this species from all other *Cryptolepis* species on Socotra. This species may be similar to some specimens of *C. oblongifolia*, which may also have twining stems and coriaceous, lanceolate to narrowly lanceolate or linear leaves. *Cryptolepis volubilis* is distinguished from *C. oblongifolia* by its imperfect areole development, few-flowered inflorescences, corolla ± 4 mm long, with the corolla tube up to 1 mm long and a single corona. By contrast, *C. oblongifolia* has well-developed areoles, usually many-flowered inflorescences, corolla 4–12 mm long, with a corolla tube 1.5 mm or longer and a double corona.

Distribution and habitat

Cryptolepis volubilis is endemic to the island Socotra (Fig. 4.3.30.2.). It occurs on steep rocky slopes and gravelly mountain ridges, commonly associated with granite at altitudes from 30–823 m. *Cryptolepis volubilis* is associated with succulent scrub dominated by *Buxus hildebrandtii* Baill., *Carphalea obovata* (Balf.f.) Verdc., *Searsia thyrsiflora* (Balf.f.) Moffett with emergent *Sterculia africana* (Lour.) Fiori; it may also be associated with *Jatropha unicostata* Balf.f., *Zizyphus* sp. and *Tichocalyx* sp. Flowering occurs from January to May.

Vernacular name

Socotra: Ekkehin (Balfour, 1888).

Representative specimens

— **12º19'57'' N, 54º00'26'' E:** Nogad Plain, Mouth of Wadi Irih (River), 06-02-1990, *Miller, A.G., Bazara'a, M., Guarino, L. & Kassim, N. M.10308* (K).

— **12º36'38'' N, 54º03'52'' E:** 7 km SE of Hadiboh, Wadi Deneghan (River), [Wadi Dininghen], 19-02-1989, *Miller, A.G., Guarino, L., Obadi, N., Hassan, M. & Mohammed, N. M.8243* (K, UPS).

— **12º38'12'' N, 53º30'39'' E:** Qaysoh [Qashio], South of Qalansiyah, 30-01-1990, *Miller, A.G., Bazara'a, M., Garino, L. & Kassim, N. M.10172* (UPS).

— **12º38'43'' N, 53º29'11'' E:** Qallansiya [Qalansiyah], Jebel Ma'alih (Mountain), 27-03-1967, *Smith, A.R.* & *Lavranos, J. 171* (EA, WAG).

— **12º39' N, 54º05' E:** Hadibu [Hadiboh], 7 km E of Hadibu along road to Mumi, 20-01-1994, *Thulin, M.* & *Gifri, A.N. 8629* (K, UPS).

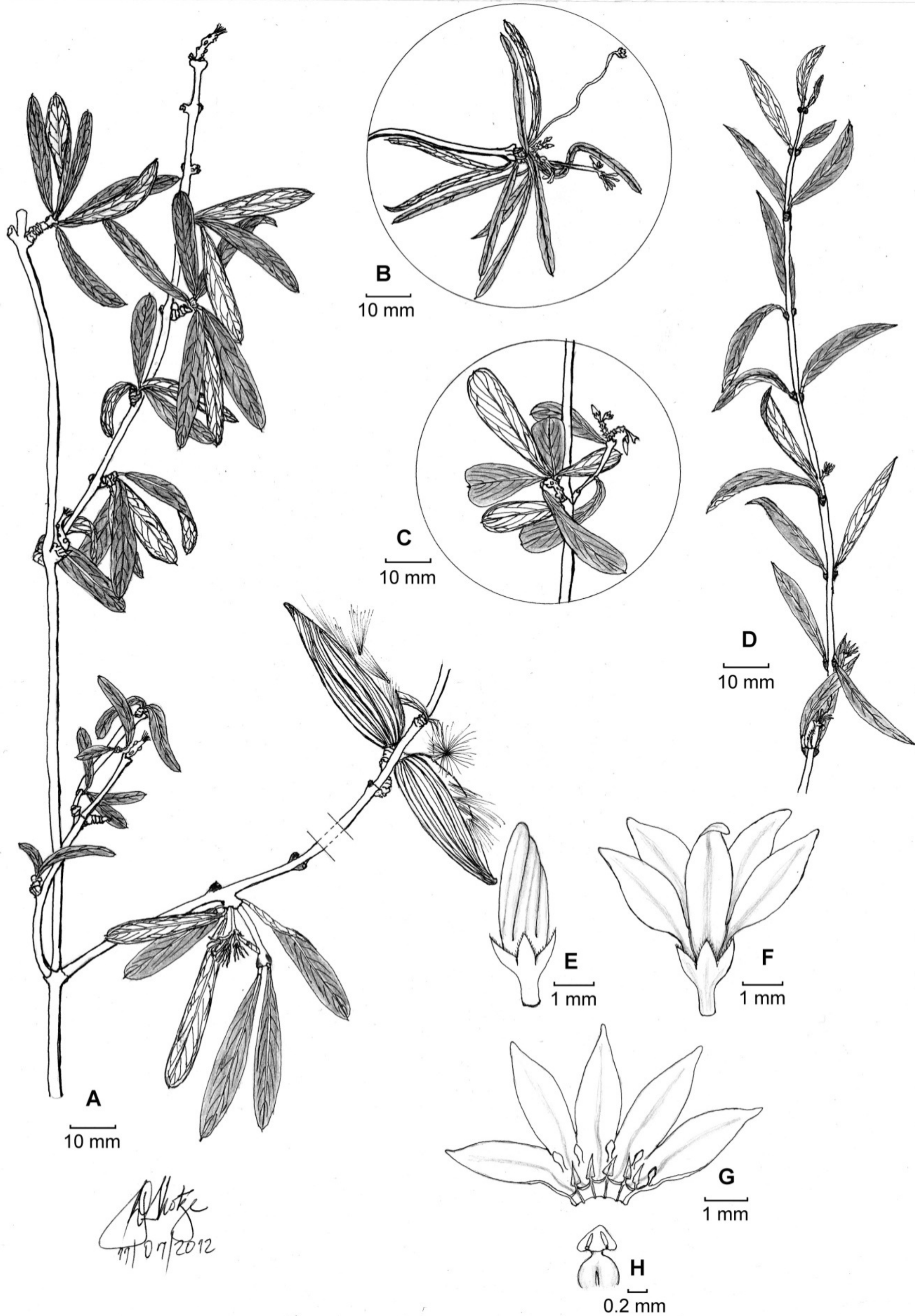


Fig. 4.3.30.1. Illustration of *Cryptolepis volubilis*: (A) stem with elliptic leaves, inflorescence and paired follicles, (B) stem with linear leaves, (C) stem with obovate leaves and an inflorescence, (D) stem with narrowly elliptic leaves, (E) external view of bud, (F) external view of mature flower, (G) corolla opened showing clavate primary corona lobes and narrowly hastate anthers, (H) pistil of semi-inferior apocarpous ovaries, style and style-head with translators. (A) *Balfour s.n.* (K); (B, G) *Smith & Lavranos* (WAG); (C) *Miller et al. M.10308* (K); (D–F, H) *Thulin & Gifri 8629* (K).

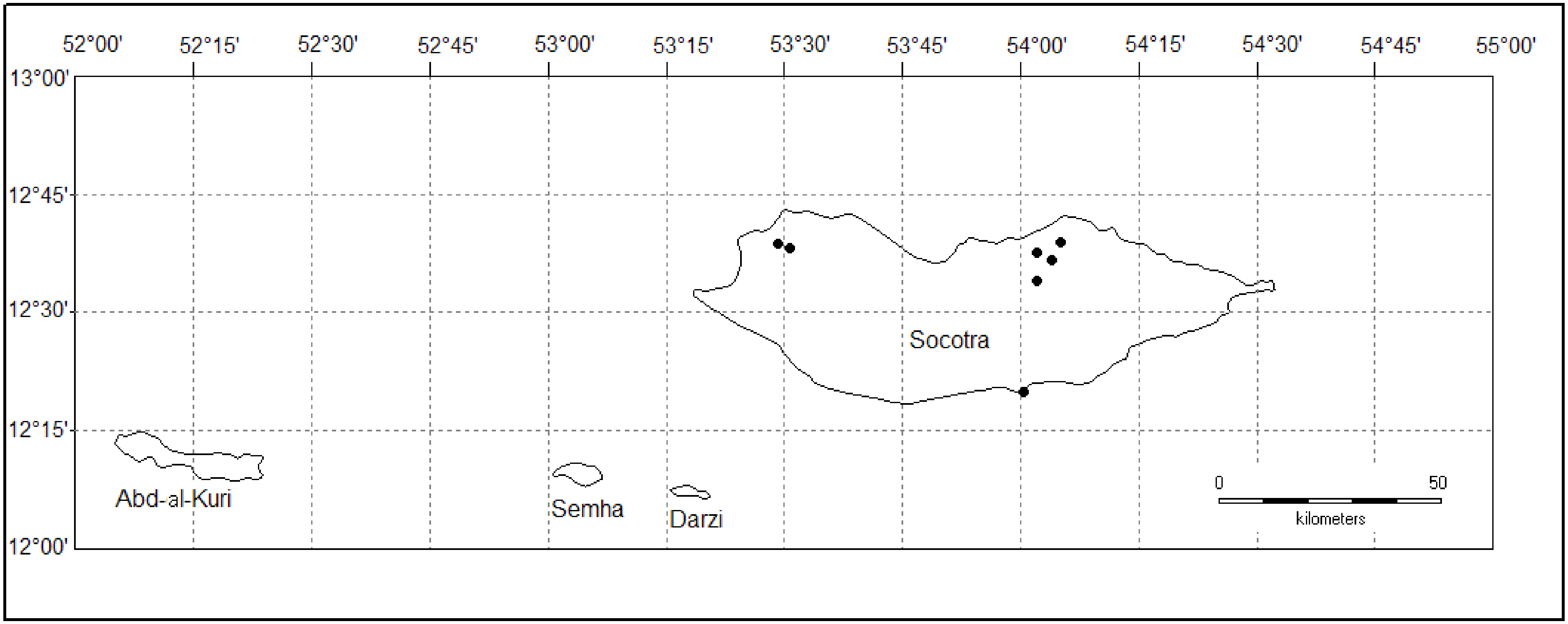


Fig. 4.3.30.2. Known distribution of *Cryptolepis volubilis*.

Leaf micromorphology

Adaxial epidermal cells are elongate, rarely isodiametric and tetra- to pentagonal. Periclinal walls are tabular and anticlinal walls are straight and level with the epidermal surface (Fig. 4.3.30.3. A–C). The cuticle is heavily striated, with parallel striations continuous over intercellular boundaries (Fig. 4.3.30.3. A, C). Occasionally striations are less dense but distinct, randomly orientated, and continuous over intercellular boundaries (Fig. 4.3.30.3. B).

Abaxial epidermal cells may be tetra- to hexagonal with periclinal walls which are slightly convex while anticlinal wall boundaries are slightly sunken (Fig. 4.3.30.3. E–F). In other specimens the cell shape and anticlinal walls are indistinct and periclinal walls are raised to form simple globular micropapillae (Fig. 4.3.30.3. D). All cuticular patterning is obscured by a dense covering of wax platelets (Fig. 4.3.30.3. D–F).

Leaves are hypostomatic with stomata randomly orientated, slightly sunken or level with surrounding epidermal cells. Stomata are paracytic with subsidiary cells densely covered by wax platelets. Guard cells are narrowly elliptic and covered by a broad stomatal ledge. (Fig. 4.3.30.3. D–F)

Seed micromorphology

The adaxial seed surface is rough with cells clustered into longitudinal ridges running down the centre and radiating towards the margins of the seed (Fig. 4.3.30.4. A). Ridges consist of contorted epidermal cells (Fig. 4.3.30.4. B, D). Cells between the ridges are loosely packed, isodiametric with concave periclinal walls and straight to slightly curved and deeply sunken anticlinal walls (Fig. 4.3.30.4. C, E). The cuticle is coarsely granular (Fig. 4.3.30.4. C, E).

The abaxial seed surface is characterized by ridges radiating laterally from the narrow, central ridge (Fig. 4.3.30.5. A). On the ridges cell shape is indistinct, but faint cuticular striations often occur on the ridges (Fig. 4.3.30.5. B, D, E). In between ridges cells are isodiametric and tetra- to pentagonal. Cells near the margin have convex periclinal walls (Fig. 4.3.30.5. C) while cells near the central ridge have concave periclinal walls (Fig. 4.3.30.5. E). The cuticle is coarsely granular (Fig. 4.3.30.5. C).

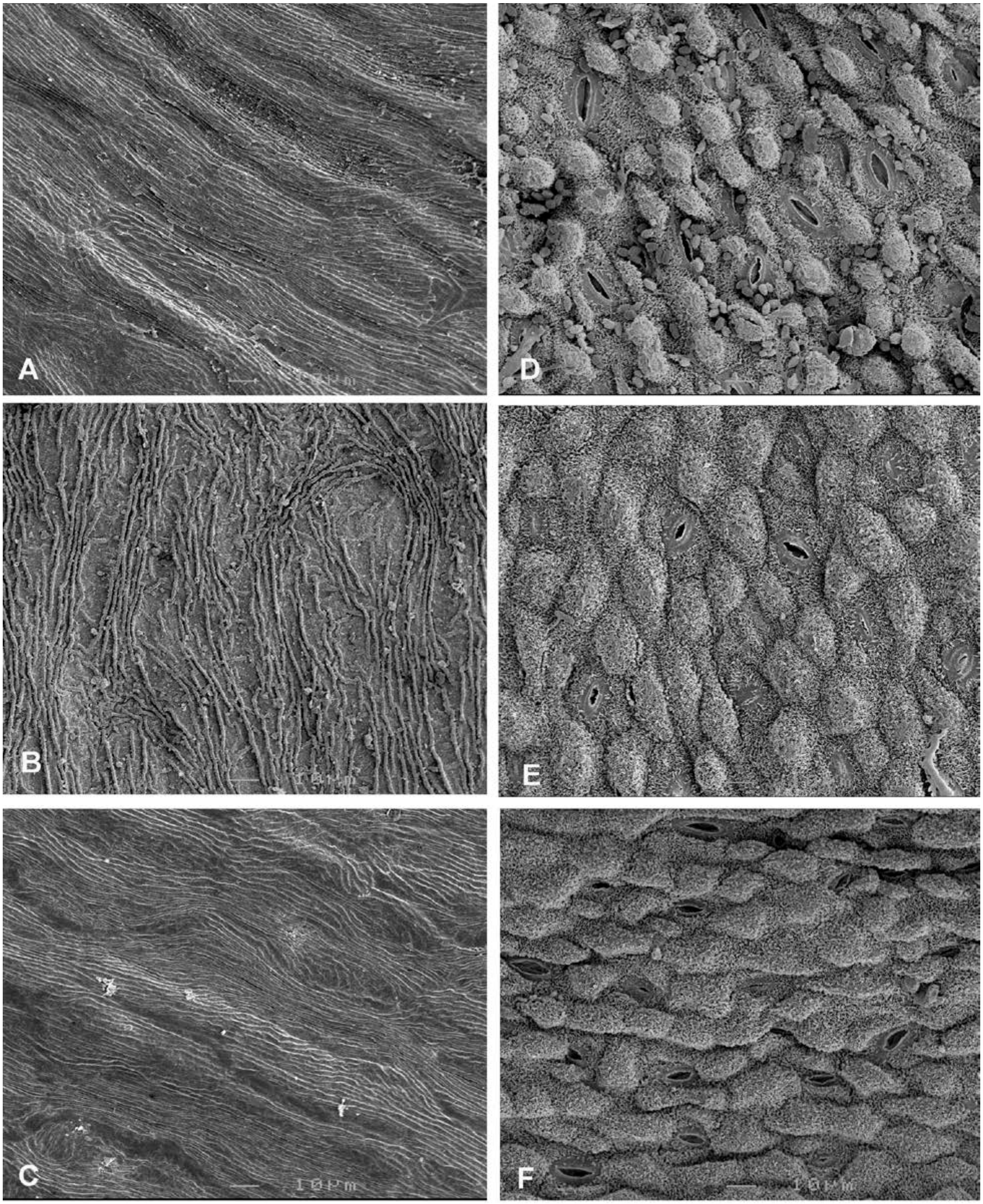


Fig. 4.3.30.3. *Cryptolepis volubilis* leaf epidermal surfaces: (A, C) adaxial epidermal cells with tabular periclinal walls and densely striate cuticle, (B) adaxial epidermal cells with tabular periclinal walls and sparsely striated cuticle, (D) abaxial epidermis with globular micropapillae, stomata and wax platelets, (E–F) abaxial epidermis with convex periclinal walls, stomata and wax platelets. Magnification: A–F = x650. Specimens: (A, D) *Balfour s.n.* (K); (B, E) *Miller et al. M.8243* (UPS); (C, F) *Smith & Lavranos 171* (EA).

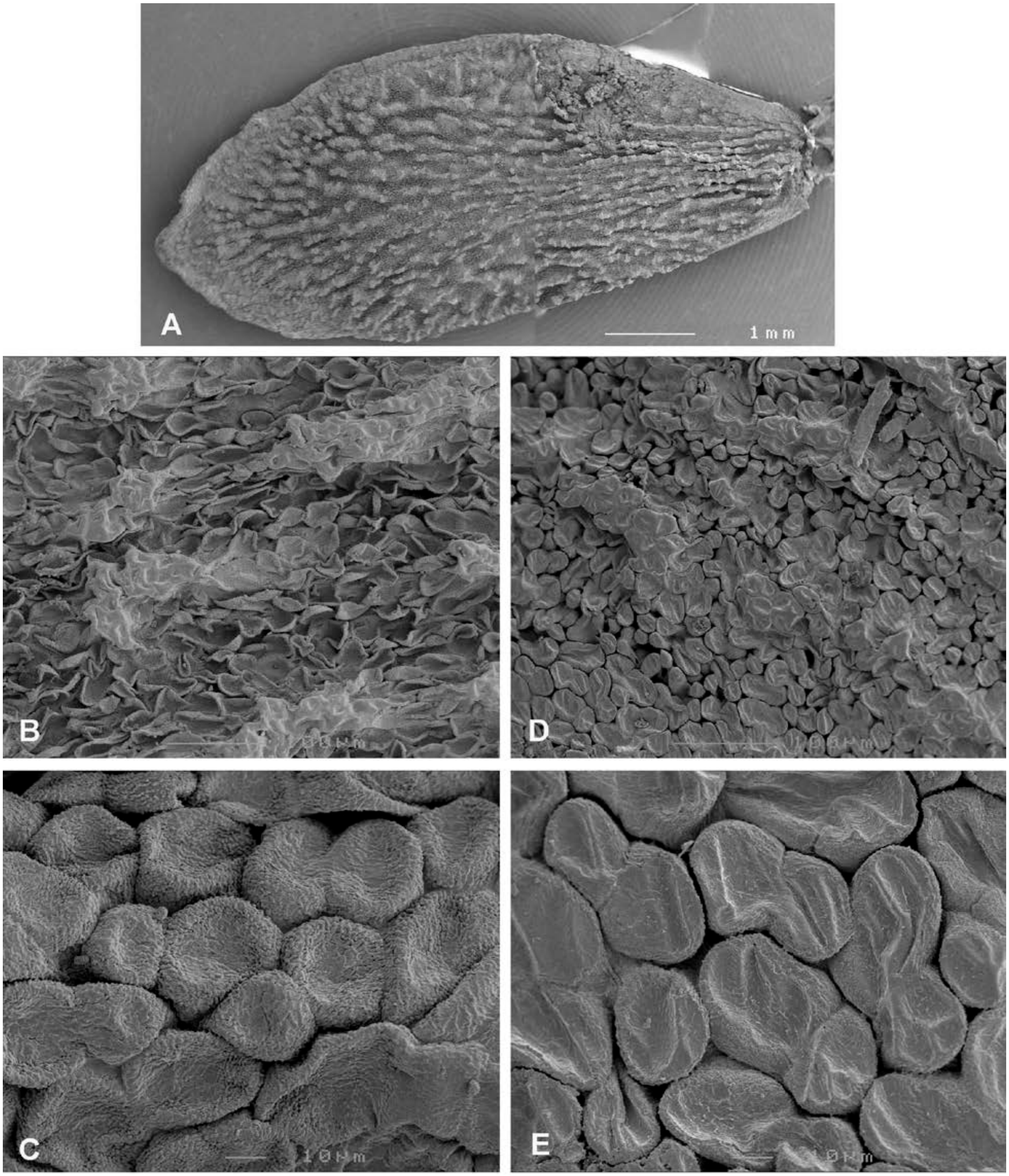


Fig. 4.3.30.4. *Cryptolepis volubilis* seed surface: (A) adaxial view of seed, (B, D) adaxial seed surface with longitudinal ridges of contorted epidermal cells, (C, E) cells tetra- to hexagonal with convex periclinal walls, deeply sunken anticlinal walls and granular cuticle. Magnification: A = x20; B, D = x220; C, E = x900. Specimens: (A–C) *Miller et al. M.8243* (UPS); (D–E) *Balfour s.n.* (K).

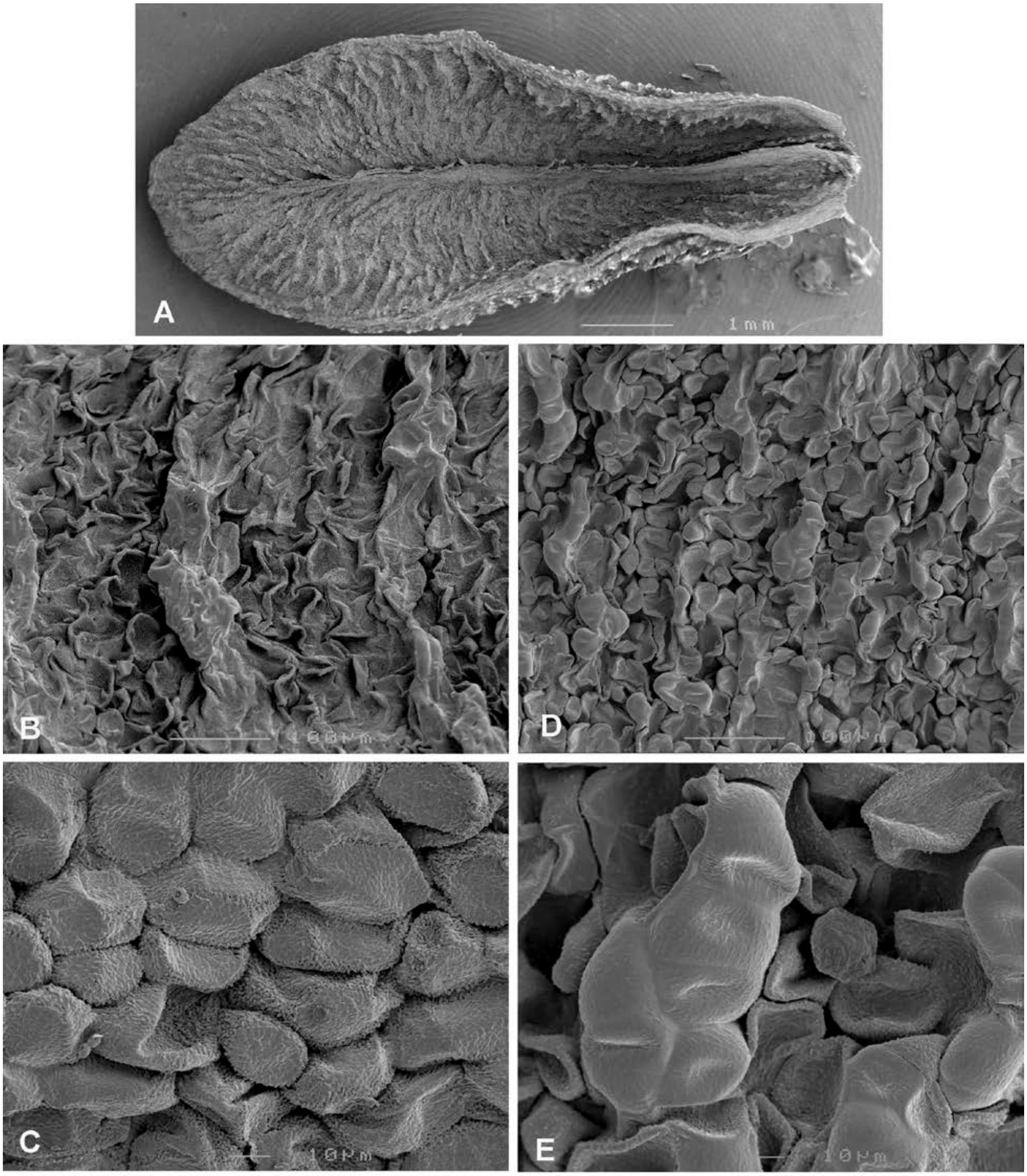


Fig. 4.3.30.5. *Cryptolepis volubilis* seed surface: (A) abaxial view of seed, (B, D) abaxial surface between central ridge and seed margin with radiating ridges of deformed cells, (C) cells with convex periclinal walls and granular cuticle, (E) cells forming ridges covered with finely striated cuticle. Magnification: A = x20; B, D = x220; C, E = x900. Specimens: (A–C) *Miller et al. M.8243* (UPS); (D–E) *Balfour s.n.* (K).

4.3.31 ***Cryptolepis yemenensis*** Venter & R.L.Verh., Botanical Journal of the Linnean Society 131: 419 (1999).

Type: Yemen, Shabwa Governate, 5 km S of Habban, along Lawdar-Al-Mukalla road, *Boulos, Rowaished, Gifri, Saeed & Hussein 16899* (K!, holo.; BM!, E, KTUH, iso.).

A shrub, with white latex, up to 1.5 m high. *Stems* woody, erect, branching, slender, stem diameter unknown; young stems light brown, smooth, rarely slightly verrucose, glabrous; older stems greyish-brown, smooth, glabrous; brachyblasts often present; interpetiolar ridges glabrous, inconspicuous on young stems and absent on older branches; colleters inconspicuous or absent. *Leaves* opposite or fascicled on brachyblasts, axils puberulous, sessile to sub-sessile; petiole green, glabrous, 0.5 mm long; blade oblong, 10–20 x 2–3.5 mm, semi-succulent, light green, glabrous; margin plane; apex obtuse, rarely acute, mucronate, glabrous, not recurved; base obtuse; main vein slightly sunken on upper leaf surface, prominent on lower leaf surface, higher order venation not visible. *Inflorescences* cymose, compact, few-flowered, each cyme consists of 1 dichasium or 1–2 monochasia, primary peduncle 1–2 mm long, secondary peduncles absent or 1 mm long, pedicels 0.5–1 mm long; bracts opposite, densely packed, glabrous, triangular, ± 0.7 mm long, margins fimbriate. *Buds* slender, ± 3 mm long, ovoid, apices obtuse, slightly turned. *Sepals* light green, ovate, ± 1 x 0.5 mm, apices acute, occasionally mucronate, margins fimbriate, colleters conical, translucent, inconspicuous. *Corolla* greenish-white, 4–5.5 mm long; tube campanulate, ± 2 mm long, glabrous outside and inside; lobes spreading, oblong, 2–3.5 x 0.9 mm, apices obtuse. *Corona* double; primary corona inserted ± 1 mm from corolla tube base, included, lobes clavate, fleshy, ± 0.4 mm long, glabrous, apices acute, connivent over gynostegium; secondary corona pockets prominent at corolla lobe sinuses. *Stamens* inserted ± 0.6 mm from corolla tube base; anthers hastate, attenuate, glabrous, ± 0.6 mm long, filaments ± 0.1 mm long. *Nectaries* conspicuous, inserted ± 0.6 mm from corolla tube base. *Ovaries* ± 0.2 x 0.5 mm; style ± 0.1 mm long, style-head broadly pyramidal, acute, ± 0.3 x 0.4 mm. *Translators* narrowly elliptic, ± 0.3 mm long, apices acute. *Follicles* erect, single to paired, when paired divaricate at ± 90°, narrowly ovoid, 25–38 x 4–6 mm, dark brown, apices attenuate, bases cuneate. *Seeds* narrowly elliptic, 9 x 2.5 mm, reddish-brown, smooth to slightly ridged; coma white to yellowish-white, ± 12 mm long. (Fig. 4.3.31.1.)

Diagnostic characteristics

Cryptolepis yemenensis is a shrub, up to 1.5 m high. The leaves are oblong, small, 10–20 x 2–3.5 mm and semi-succulent. This species is distinguished from other species with similar growth form and semi-succulent leaves by a combination of flowers in compact, few-flowered inflorescences and clavate, not filiform, primary corona lobes. *Cryptolepis yemenensis* is most similar to *C. nugaalensis, C. somaliensis* and *C. stefaninii*, which all have flowers in inflorescences and clavate corona lobes. *Cryptolepis stefaninii* is easily distinguished in this group, having larger leaves than the other three species, with leaf sizes 25–47 x 3–7 mm and corona lobes reddish with bilobed apices. *Cryptolepis nugaalensis* is distinguished from *C. somaliensis* and *C. yemenensis* by larger flowers, corolla longer than 9 mm and corolla lobes linear, longer than 7 mm and glabrous anthers. By contrast *C. somaliensis* and *C. yemenensis* both have corollas shorter than 6 mm, corolla lobes narrowly triangular, narrowly ovate or oblong, shorter than 4 mm. *Cryptolepis yemenensis* is distinguished from *C. somaliensis* by corona lobes up to 0.4 mm long and glabrous anthers as opposed to corona lobes 1 mm long and villous anthers of *C. somaliensis*.

Distribution and habitat

Cryptolepis yemenensis is endemic to Yemen (Fig. 4.3.31.2.). It grows among calcareous boulders in wadis and outcrops at altitudes from 900–1050 m. Associated species include a *Commiphora* sp. and *Anisotes* sp. Flowering occurs throughout the year.

Representative specimens

— 13º36'32" N, 45º49'06" E: Yemen, Abyan, between Shaqra and Lodar, 17-10-1962, *Popov, G. P34/10* (BM).

— 14º50'47" N, 48º26'33" E: Yemen, Hadramaut, 64 km S of Jahi Pass, along Jol West Road, 16-08-1949, *Guichard, K.M. KG/HAD 15* (BM).

— 14º56'24" N, 48º25'36" E: Yemen, Hadramaut, Djol Plateau, 17-04-1939, *Wissman, H.V. 1378* (BM).

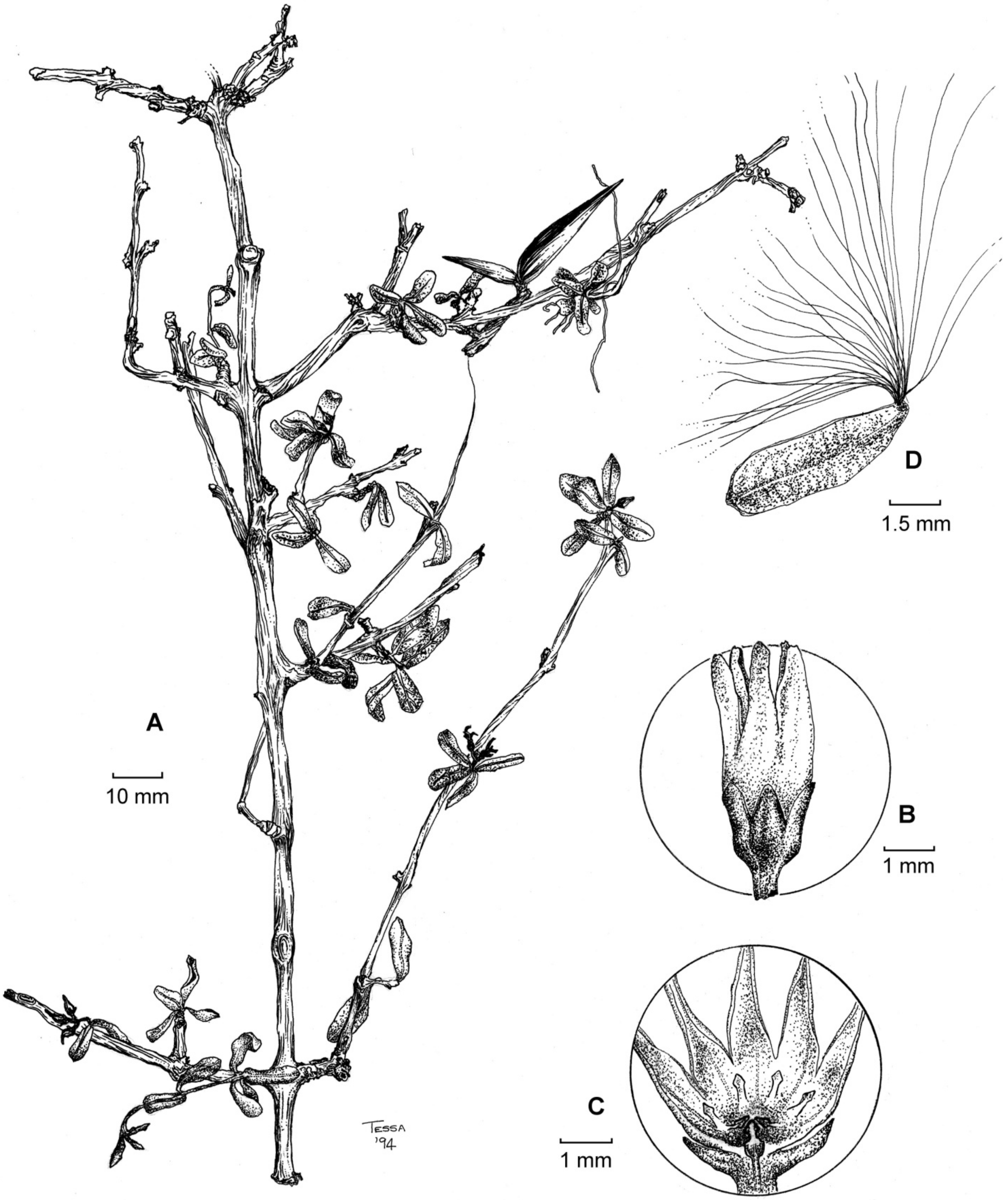


Fig. 4.3.31.1. Illustration of *Cryptolepis yemenensis*: (A) stem with leaves, inflorescences and paired follicles; (B) external view of flower; (C) flower opened showing gynoecium, stamens and primary corona lobes; (D) seed with coma of hairs. Specimen: (A–D) *Boulos et al. 16899* (K). Reproduced with permission of the Botanical Journal of the Linnean Society.

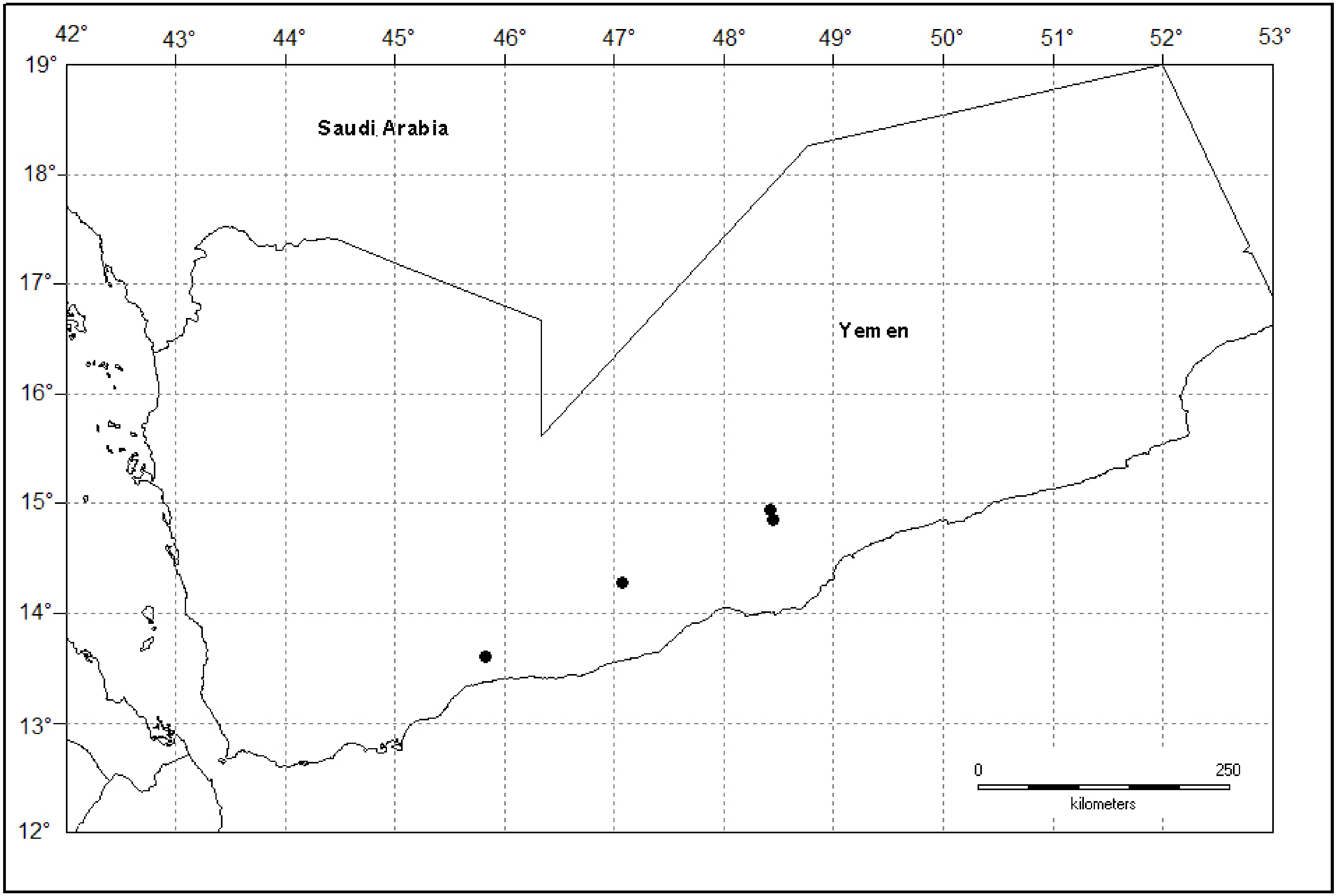


Fig. 4.3.31.2. Known distribution of *Cryptolepis yemenensis*.

Leaf micromorphology

The adaxial and abaxial epidermal surfaces are similar. Cells are more or less isodiametric and tetra- to hexagonal. The periclinal walls are tabular to slightly convex while the anticlinal walls are straight and level with the epidermal surface to slightly sunken (Fig. 4.3.31.3. A–F). The cuticle may be slightly (Fig. 4.3.31.3. B–C, E–F) or heavily striated (Fig. 4.3.3.1.3. A, D) with straight to slightly wavy, parallel striations, continuous over intercellular boundaries.

Leaves are amphistomatic with stomata randomly orientated and level with surrounding epidermal cells. The number of stomata on the adaxial and abaxial epideris is similar. Stomata are paracytic with subsidiary cells covered by a slightly to heavily striated cuticle and striations perpendicular, or rarely parallel to the guard cells and stomatal pore, from the stomatal pore. Guard cells are narrowly elliptic and covered by a broad stomatal ledge. (Fig. 4.3.31.3. A–F)

Seed micromorphology

The adaxial seed coat surface shows longitudinal ridges consisting of protuberances of contorted epidermal cells (Fig 4.3.31.4. A–C). Cells between protuberances are isodiametric and ovate. Periclinal walls are concave while anticlinal walls are curved and deeply sunken. The cuticle is coarsely granular (Fig. 4.3.31.4. D–E).

Abaxially the seed has a narrow central ridge (Fig. 4.3.31.5. A). The surface between the central ridge and seed margins is sparsely covered by inconspicuous protuberances. Protuberances consist of contorted epidermal cells (Fig. 4.3.31.5. B–C). Cells between the protuberances are variously shaped, usually isodiametric or slightly elongate and tetra- to pentagonal. Periclinal walls are convex to partially concave while anticlinal walls are sunken. The cells are covered by a coarse granular cuticle. (Fig. 4.3.31.5. D–E)

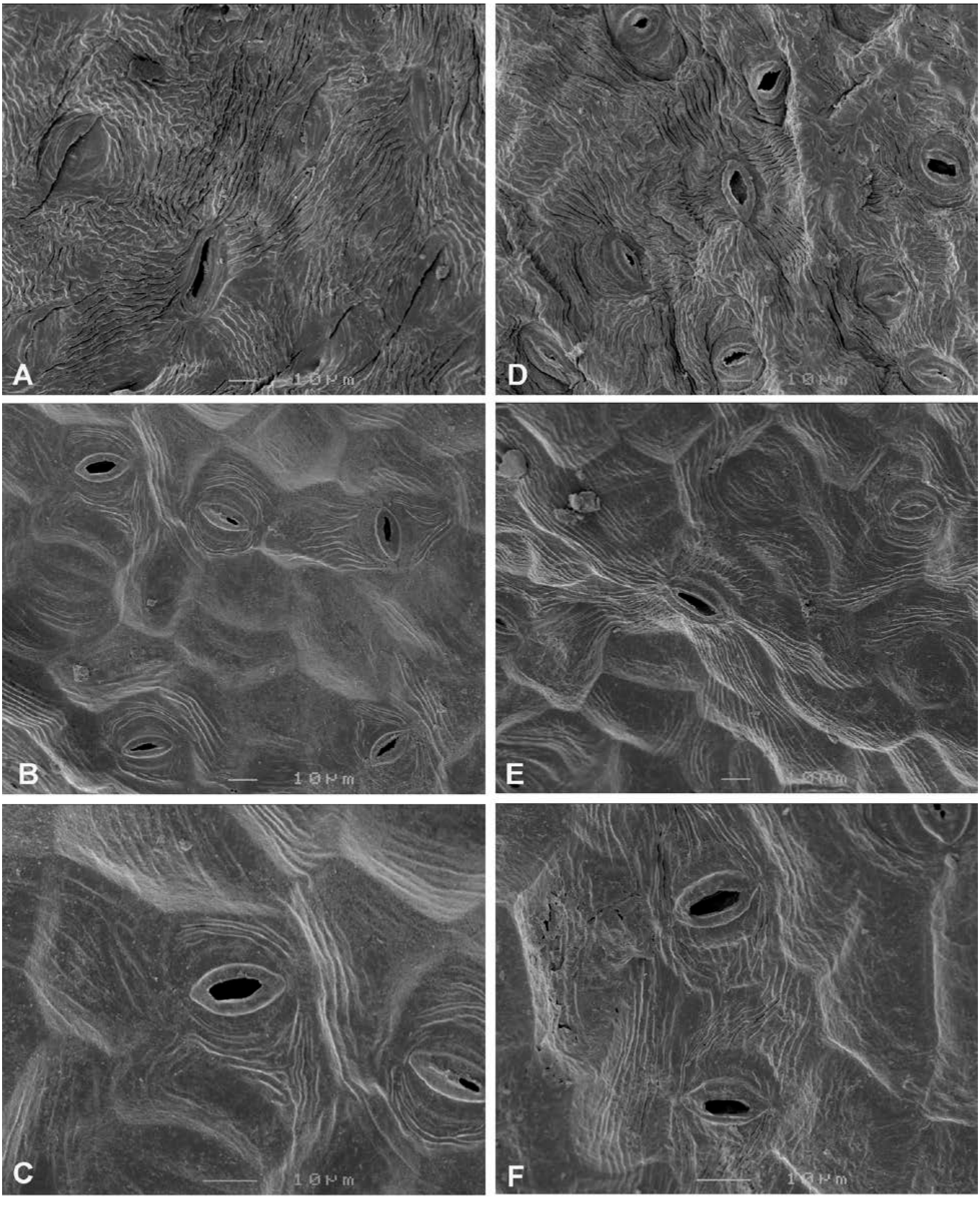


Fig. 4.3.31.3. *Cryptolepis yemenensis* leaf epidermal surfaces: (A) adaxial epidermal cells with tabular periclinal walls, densely striated cuticle and stomata, (B–C) adaxial epidermal cells with slightly convex periclinal walls, slightly striated cuticle and stomata, (D) abaxial epidermis with tabular periclinal walls, densely slightly striated cuticle and stomata, (E–F) abaxial epidermis with slightly convex to tabular periclinal walls, slightly striated cuticle and stomata. Magnification: A–B, D–E = x650; C, F = x1200. Specimens: (A, D) *Wissman 3178* (BM); (B–C, E–F) *Popov P34/10* (BM).

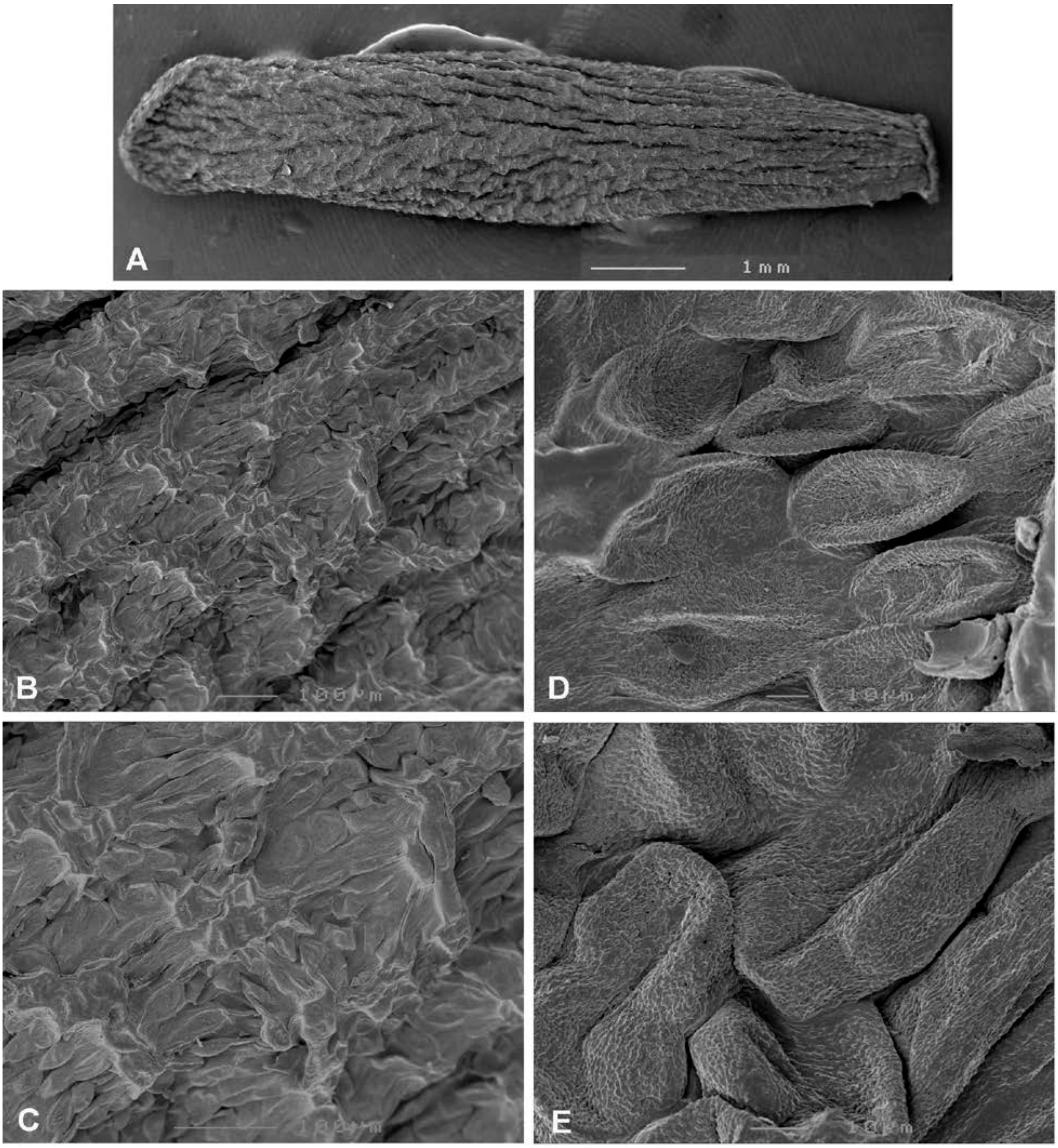


Fig. 4.3.31.4. *Cryptolepis yemenensis* seed surface: (A) adaxial view of seed, (B–C) adaxial seed surface with ridges formed by protuberances of contorted epidermal cells, (D–E) cells ovate with convex periclinal walls, deeply sunken anticlinal walls and granular cuticle. Magnification: A = x20; B = x120; C = x220; D = x900; E = x1200. Specimen: (A–E) *Popov P34/10* (BM).

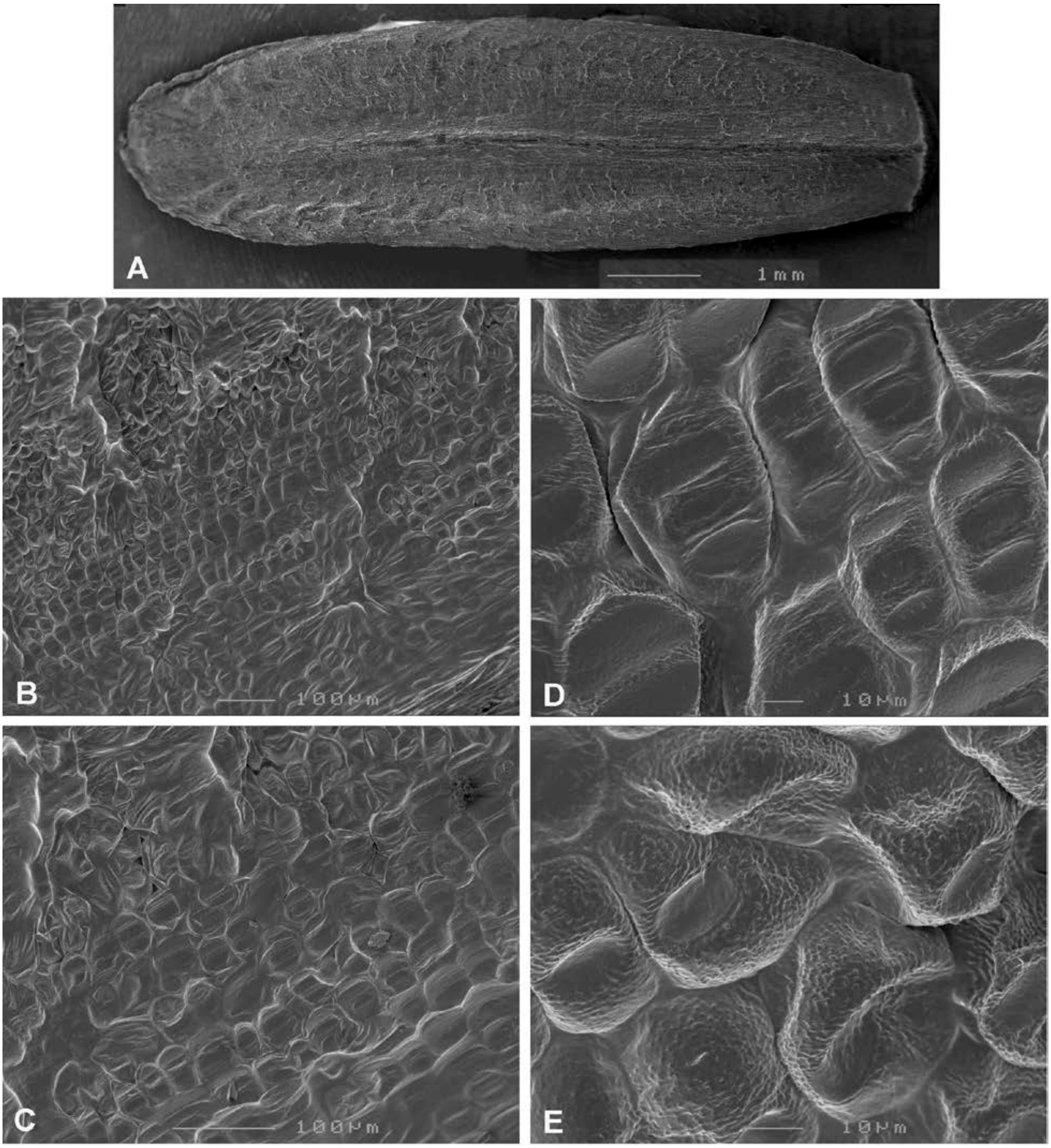


Fig. 4.3.31.5. *Cryptolepis yemenensis* seed surface: (A) abaxial view of seed, (B–C) abaxial surface between central ridge and seed margin with inconspicuous protuberances, (D–E) cells with convex to partially concave periclinal walls and granular cuticle. Magnification: A = x20; B = x120; C = x220; D = x900; E = x1200. Specimen: (A–E) *Popov P34/10* (BM).

4.4 IMPERFECTLY KNOWN SPECIES

Cryptolobus Meisn. in Steud. Nomenclator Botanicus seu synonymia plantarum universalis, 2(1): 450 (1840) (non *Cryptolobus* Spreng.) *nom. nud.*

Cryptolepis barteri K.Schum. *nom. nud.* in Engler & Prantl, Die Natürlichen Pflanzenfamilien 4(2): 219 (1895b); Hutch. & J.M.Dalz.: 53 (1931).

Cryptolepis laxa Baill., Bulletin Mensuel de la Societé Linnéenne de Paris 2(101): 804 (84 by error) (1889); N.E.Br.: 252 (1902).
Type: Tropical Africa, *Brazza 126* (not found).
Note: Brown (1902–04) placed this species under imperfeclty known species since the type specimen designated by Baillon (1889) could not be located and the description is insufficient for accurate identification of this species.

Cryptolepis longiflora Regel, Catalogus Plantarum quae in Horto Aksakoviano: 43 (1860) *nom. nud.*

Ectadiopsis brevifolia Balf.f. in Proceedings of the Royal Society of Edinburgh 12: 78 (1884), 164 (1888).
Type: Socotra, *Balfour 583*; Socotra, *Balfour 615* (not found).
Note: The type specimens of this species could not be located and the status of the species could therefore not be verified.

Ectadiopsis buettneri K.Schum. in Engl. & Prantl, Die Natürlichen Pflanzenfamilien, 4(2): 219 (1895b); N.E.Br.: 252 (1902); T.Durand & H.Durand: 356 (1909); Bullock: 269 (1955).
Type: Democratic Republic of the Congo, Kinshasa (Leopoldville), *Buettner 1885* (not found).
Note: In the original publication of *E. buettneri*, Schumann (1891) refers to a specimen collected at Leopoldville in the Democratic Republic of the Congo, but does not indicate a collector or number. Durand and Durand (1909) refer to a specimen collected by R. Buettner in 1885. Buettner's collection is probably housed at BR, but this specimen could not be located. Both Brown (1902) and Bullock (1955) cite *E. buettneri* as an imperfectly known species.

4.5 List of *Cryptolepis* species names published in Index Kewensis or the International Plant Names Index and newly described species

Names printed in bold are accepted names.

C. africana (Bullock) Venter & R.L.Verh.
C. albicans Jum. & H.Perrier = *Pentopetia albicans* (Jum. & H.Perrier) Klack.
C. angolensis Welw. = *C. oblongifolia* (Meisn.) Schltr.
C. apiculata K.Schum.
C. arbuscula (Radcl.-Sm.) Venter
C. arenicola Schltr. ex Dinter = *C. oblongifolia* (Meisn.) Schltr.
C. balansae Baill. = *C. dubia* (Burm.f.) M.R.Almeida
C. barteri K.Schum. = imperfectly known species
C. baumii N.E.Br. = *C. oblongifolia* (Meisn.) Schltr.
C. baumii Schltr. = *C. oblongifolia* (Meisn.) Schltr.
C. bifida (Blume) P.I.Forst. = *Phyllanthera bifida* Blume
C. bifida L.Joubert & Venter = *C. ibayana* L.Joubert & Venter
C. brazzaei Baill. = *C. oblongifolia* (Meisn.) Schltr.
C. buxifolia Chiov. = *C. oblongifolia* (Meisn.) Schltr.
C. buchananii Roem. & Schult. = *C. dubia* (Burm.f.) M.R.Almeida
C. capensis Schltr.
C. cryptolepioides (Schltr.) Bullock
C. debeerstii De Wild. = *C. oblongifolia* (Meisn.) Schltr.
C. decidua (Planch. ex Hook.f. & Benth.) N.E.Br.
C. decidua subsp. *decidua* = *C. decidua* (Planch. ex Hook.f. & Benth.) N.E.Br.
C. decidua subsp. *volubilis* (Balf.f.) Bullock = *C. volubilis* (Balf.f.) Schwartz
C. delagoensis Schltr.
C. dubia (Burm.f.) M.R.Almeida
C. eburnea (Pichon) Venter
C. edithae (Hance) Benth. = *C. sinensis* (Lour.) Merr.
C. elegans Wall. ex G.Don = *C. sinensis* (Lour.) Merr.
C. elliotii Schltr. = *C. oblongifolia* (Meisn.) Schltr.
C. filiformis Wall. = *Atherandra javensis* (Blume) Costantin
C. gillettii Hutch. & E.A.Bruce
C. gossweileri S.Moore & M.Moore
C. grandiflora Wight
C. grandidieri Baill. = *Pentopetia cotoneaster* Decne.

C. grayi P.I.Forst. = *Phyllanthera grayi* (P.I.Forst.) Venter

C. grevei Baill. = *Pentopetia grevei* (Baill.) Venter

C. hensii N.E.Br. = *C. oblongifolia* (Meisn.) Schltr.

C. hypoglauca K.Schum.

C. ibayana L.Joubert & Venter

C. intricata (Balf.f.) Venter

C. javanica (Blume) Blume = *C. sinensis* (Lour.) Merr.

C. lancifolia P.I.Forst = *Phyllanthera lancifolia* (P.I.Forst.) Venter

C. laurentii De Wild. = *C. microphylla* Baill.

C. laxa Baill. = imperfectly known species

C. laxiflora Blume = *C. sinensis* (Lour.) Merr.

C. linearis N.E.Br. = *C. oblongifolia* (Meisn.) Schltr.

C. longiflora Reg. *nom. nud.* = imperfectly known species

C. macrophylla (Radcl.-Sm.) Venter

C. microphylla Baill.

C. migiurtina Chiov.

C. monteiroae Oliv. = *Stomatostemma monteiroae* (Oliv.) N.E.Br.

C. multinervosa P.I.Forst. = *Phyllanthera multinervosa* (P.I.Forst.) Venter

C. myrtifolia (Baill.) Schltr. = *C. oblongifolia* (Meisn.) Schltr.

C. newii (Benth.) P.I.Forst. = *Sacleuxia newii* Benth.

C. nigritana (Benth.) N.E.Br. = *C. oblongifolia* (Meisn.) Schltr.

C. nugaalensis Venter & Thulin

C. nymanii (K.Schum.) P.I.Forst. = *Phyllanthera nymanii* (K.Schum.) Venter

C. oblongifolia (Meisn.) Schltr.

C. obtusa K.Schum. = *C. obtusa* N.E.Br.

C. obtusa N.E.Br.

C. orbicularis Chiov.

C. papillata P.I.Forst. = *Phyllanthera papillata* (P.I.Forst.) Venter

C. pauciflora (Roxb.) Wight = *C. sinensis* (Lour.) Merr.

C. pendulina (Venter & D.V.Field) P.I.Forst. = *Stomatostemma pendulina* Venter & D.V.Field

C. perakensis (King & Gamble) P.I.Forst. = *Phyllanthera perakensis* King & Gamble

C. producta N.E.Br. = *C. oblongifolia* (Meisn.) Schltr.

C. purpureus (N.E.Br.) P.I.Forst. = *Batesanthus purpureus* N.E.Br.

C. reticulata (Roxb.) Wall. = *C. dubia* (Burm.f.) M.R.Almeida

C. reticulata (Roxb.) K.Schum. = *C. dubia* (Burm.f.) M.R.Almeida

C. ruspolii Chiov. = imperfectly known species

C. sanguinolenta (Lindl.) Schltr.

C. scandens (K.Schum.) Schltr. = *C. oblongifolia* (Meisn.) Schltr.

C. sinensis (Lour.) Merr.

C. sinensis subsp. *africana* Bullock = *C. africana* (Bullock) Venter & R.L.Verh.

C. sinensis (Lour.) Merr. var *ciliata* (Costantin) P.H.Hô = *C. sinensis* (Lour.) Merr.

C. sizenandii Rolfe = *C. oblongifolia* (Meisn.) Schltr.

C. socotrana (Balf.f.) Venter

C. somaliensis Venter & Thulin

C. stefaninii Chiov.

C. suffruticosa (K.Schum.) N.E.Br. = *C. oblongifolia* (Meisn.) Schltr.

C. thulinii L.Joubert

C. transvaalensis Schltr. = *C. cryptolepioides* (Schltr.) Bullock

C. triangularis N.E.Br. = *C. sanguinolenta* (Lindl.) Schltr.

C. tuberosa (E.A.Bruce) P.I.Forst. = *Sacleuxia tuberosa* (E.A.Bruce) Bullock

C. villosa L.Joubert

C. volubilis (Balf.f.) Schwartz

C. welwitschii (Baill.) Schltr. = *C. oblongifolia* (Meisn.) Schltr.

C. welwitschii var. *luteola* Hiern = *C. oblongifolia* (Meisn.) Schltr.

C. wightiana Wall. = *C. grandiflora* Wight

C. yemenensis Venter & R.L.Verh.

CHAPTER 5

PHYLOGENETIC AND BIOGEOGRAPHIC RELATIONSHIPS IN *CRYPTOLEPIS*

5.1 Introduction

The Periplocoideae consists of about 34 genera, with about 190 species (Venter and Verhoeven, 2001, Ionta, 2009; Venter, 2009). The subfamily is distributed in the Old World in Africa, the Arabian Peninsula (including Socotra), SE Asia, Australia, Europe and Madagascar. Most species are woody climbers which grow in tropical rainforest, tropical seasonal forest and tropical woodland (Venter and Verhoeven, 2001). Two genera, *Epistemma* D.V.Field and *Sarcorrhiza* Bullock, are epiphytic or lithophytic and grow in tropical forests (Venter and Verhoeven, 1997). A few genera include species which grow in semi-arid regions or in locally arid habitats such as shallow soils on periodically dry rocky outcrops. These species are usually erect or straggling, slender, few-stemmed shrubs, occasionally arising from a tuberous rootstock. Some genera, such as *Raphionacme,* are geophytic herbs or climbers arising from a subterranean tuber (Venter, 2009a). A small number of species occupy the macchia surrounding the Mediterranean, but the Periplocoideae are absent from similar vegetation of the Cape Floral Kingdom in South Africa (Bruyns, 2000; Venter and Verhoeven, 2001). Only two species from the subfamily regularly form trees. These are *Cryptolepis arbuscula*, which reaches a height of 4 m, and *C. macrophylla*, which ranges from a shrub to a small tree of 3 m tall. Both are endemic to Socotra.

Cryptolepis, in addition to being the second largest genus in the Periplocoideae, is also the most widely distributed. The genus is found throughout sub-Saharan Africa, in the Arabian Peninsula where it is known from southern Yemen and on the islands of Socotra and Abd al Kuri of the Socotran Archipelago. It also occurs in Asia from Pakistan and India eastwards to China, Indonesia and the Philippines.

The Periplocoideae are characterized by complex flowers exhibiting corolline coronas of highly variable shape and position, a high degree of synorganization between the androecium and gynoecium to form a gynostegium, pollen arranged in tetrads which are occasionally agglutinated into pollinia and spoon-shaped translators onto which the pollen tetrads or pollinia are shed at anthesis (Venter and

Verhoeven, 2001). The combination of these characters results in a highly specialized pollination mechanism, specifically adapted for animal pollination (Venter and Verhoeven, 2001). The specialized pollination mechanism of the Periplocoideae was believed to be an intermediate stage between that of the Apocynoideae and the milkweeds (Secamonoideae and Asclepiadoideae) (Endress, 2001; Kunze, 1993). However, recent molecular phylogenetic investigations have suggested that the presence of pollen tetrads or pollinia and spoon-shaped translators in Periplocoideae and the pollinia and clip-like translators in the milkweeds may be the result of parallel or convergent evolution (Livshultz, 2010; Livshultz et al., 2007, 2011).

Climate changes, particularly aridification and temperature changes were proposed as a possible driving force behind the evolution of the specialized pollination mechanism found in the milkweeds, associated with a habitat shift from tropical rainforest to dry forest (Livshultz et al., 2011). The presence of a similar, possibly homoplasious, specialized pollination mechanism in the Periplocoideae is most likely the result of environmental pressures similar to those which led to the evolution of the advanced pollination mechanism of the milkweeds (Livshultz et al., 2011). This possibility is supported by Macfalane's hypothesis of an African origin of both Periplocoideae and milkweeds and the overrepresentation of Periplocoideae in the drier habitats of Africa as opposed to more mesic habitats (Lens et al, 2009; Livshultz et al., 2011; Venter and Verhoeven, 1997).

The biogeographic pattern of Africa is closely correlated with climatic variation and current distribution of taxa has been particularly influenced by climatic changes during the Cenozoic Era (65 Ma–present) (Van Zinderen Bakker and Mercer, 1986; Meadows, 1996). Since fossil pollen of *Tacazzea* has been reported from the Oligocene (34–24 Ma) and lower Miocene (25–5 Ma) in Cameroon and *Periploca* pollen has been found in Miocene deposits from Eurasia (Muller, 1981), it is likely that the Periplocoideae had already diversified to some extent by 23.5 Ma and would therefore have been subjected and influenced by climatic fluctuations during the late Cenozoic (Neogene). Though Ionta and Judd (2007) made no attempt to date their Periplocoideae phylogeny, it shows that the clade containing *Cryptolepis* and *Parquetina* diverged from the grooved translator clade relatively early. Since *Tacazzea* (included in the grooved translator clade) pollen was found in deposits from the Oligocene and lower Miocene (Muller, 1981), the *Cryptolepis*-*Parquetina* clade was presumably already in existence by this period. The study of the biogeography and evolutionary history of *Cryptolepis* should therefore take late Cenozoic climate changes into account.

Historically the circumscription of genera within the Periplocoideae was based mainly on floral features. The depth of the corolla tube, the degree of exposure of the gynostegium and the relative positions of stamens and corona lobes in the tube have been regarded as taxonomically important (Brown, 1902, 1907). These characters were used by Venter and Verhoeven (1997) to divide the Periplocoideae into three tribes, but these were not supported in a cladistic analysis of morphological characters (Venter and Verhoeven, 2001). More recently it has been found that, in the Apocynaceae, floral features show a high degree of homoplasy, making an assessment of phylogenetic relationships difficult using these features (Endress and Bruyns, 2000; Klackenberg, 1999; Meve and Liede, 2004; Venter, 2009b). Since tribes which were defined by these floral characters are not monophyletic, the monophyly of genera defined by the same characters is questionable.

In the first broad survey of the Periplocoideae using molecular techniques, Ionta and Judd (2007) included 45 species from 29 genera. Since most genera in the Periplocoideae are mono- or ditypic, they achieved at least an assessment of relationships within and among these smaller genera. Several of the clades identified by Ionta and Judd (2007) are unsupported by morphological synapomorphies, though they found that a major grouping within the Periplocoideae was characterised by a deep, longitudinal groove along the spoon-shaped translator and that the phenomenon of pollen gathered into pollinia had evolved several times within the subfamily, all within this ‘grooved translator clade’. Some clades also reflect geographical affinities, such as the Asian pollinial clade and the Malagasy clade (Ionta and Judd, 2007).

Species sampling in Ionta and Judd's (2007) phylogenetic investigation of the Periplocoideae was too low to indicate whether the three largest genera, *Raphionacme* (37 spp.), *Cryptolepis* (31 spp.) and *Pentopetia* (22 spp.), are monophyletic or to assess the relationships between their species. Nevertheless, they showed that *Phyllanthera grayi* (P.I.Fors.) Venter, initially included in *Cryptolepis* (Forster, 1990), was not part of *Cryptolepis*, but was sister to the rest of the subfamily and that the five species sampled from *Cryptolepis* formed a clade that is sister to the two species of *Parquetina*.

Venter and Verhoeven (1997, 2001) placed the genera *Curroria, Ectadiopsis, Leposma, Mangenotia, Mitolepis* and *Socotranthus* in synonymy under *Cryptolepis. Cryptolepis* is characterized by a well defined, campanulate corolla tube, which includes the gynostegium. The corona arises half way up the corolla tube and stamens are inserted at the base of the corolla tube (Venter and Verhoeven, 1997). The corona lobes are not fused to the staminal filaments and prominent spongy pads connect the bases of the corona lobes to the stamen bases (Venter and Verhoeven, 1997). With the value of floral features in the circumscription of genera in the Periplocoideae being questioned, a re-evaluation of the monophyly of *Cryptolepis* and its defining features are required.

The aim of this chapter is to:

(1) assess the monophyly of *Cryptolepis*,

(2) investigate the relationships among the species of *Cryptolepis*,

(3) assess these relationships in the context of their biogeography and

(4) recircumscribe *Cryptolepis* if necessary.

5.2 Results

5.2.1 Phylogeny

The consensus tree obtained from Bayesian Inference (BI) analysis of the ITS dataset is shown in Fig. 5.1. The tree shows good resolution with high Posterior Probability (PP) support values. The consensus tree obtained by BI analysis of the chloroplast dataset alone (*trnD-T* and *trnT-F*) is shown in Fig. 5.2. This tree is poorly resolved with much lower support values than in the ITS analysis. However, none of the clades found in the ITS phylogeny are contradicted by the chloroplast phylogeny. Analysis of the total data by BI resulted in a well resolved consensus tree with moderate to high PP-values (Fig. 5.3.).

Consensus trees from analyses of the three datasets with Maximum Parsimony (MP) do not contradict those obtained through BI, but showed lower resolution and lower support values than the BI analyses. Jackknife support values for clades in the MP analyses are plotted onto the BI trees for the respective datasets (Figs. 5.1.–5.3.). Statistical results of the parsimony analyses are shown in Table 5.1.

Table 5.1. Statistics for the markers used and for parsimony analyses conducted.

	Combined cpDNA	**ITS**	**Total DNA (combined cpDNA+ ITS)**
Number of taxa included	73	85	88
Number of missing sequences	35 *trnD–trnT* 17 *trnT–trnF*	3	0
Aligned length	2745	759	4018
Parsimony informative characters	254 (10%)	372 (52%)	626 (19%)
Number of informative gaps	42	23	65
Length of best tree with gaps	443	1748	2216
Number of trees retained	884	1024	830
Consistency Index (CI)	0.606	0.386	0.437
Retention Index (RI)	0.8051	0.748	0.764

5.2.1.1 Analysis of ITS data

The Periplocoideae is strongly supported (PP 1.00; JK 100) as monophyletic, with *Phyllanthera grayi,* from Asia and *Petopentia natalensis* (Schtr.) Bullock from Southern Africa supported (PP 1.00; JK 100 and PP 1.00; JK 92 respectively) as successive sisters to the remaining periplocoids. In the BI analysis the rest of the Periplocoideae is further subdivided into a poorly supported (PP 0.78) *Periploca-Ectadium* clade which is sister to a pair of clades: a supported (PP 1.00) clade formed by the *Cryptolepis-Parquetina* clade (PP1.00; JK 73) with *Camptocarpus* and a poorly supported (PP 0.82) clade consisting mainly of Asian species. Within the latter clade BI and MP analyses reveal strong support for the grooved translator clade (PP 1.00; JK 82) of Ionta and Judd (2007). A weakly supported Asian pollinial clade (PP 0.92) is nested within the grooved translator clade as in Ionta and Judd (2007). (Fig. 5.1.).

Cryptolepis is paraphyletic, with *C. stefaninii* sister to a well supported clade consisting of the main *Cryptolepis* clade and *Parquetina* (PP 0.99; JK 72). *Parquetina* forms a well supported clade (PP 1.00; JK 100), which is sister to a well supported (PP 1.00; JK 99) main *Cryptolepis* clade. The main *Cryptolepis* clade is subdivided into two sister clades, A and B. Clade A is well supported (PP 1.00; JK 84) and consists of the Asian species *C. dubia* and all the species from the Mandeb Circle (the Horn of Africa, southern Arabian Peninsula and the Socotran Archipelago) (Newton, 1980) included in the analysis, except *C. stefaninii* (PP 0.87; JK 62). Clade B consists of sub-Saharan African species and has support in BI (PP 0.98) but not in MP analysis. (Fig. 5.1.).

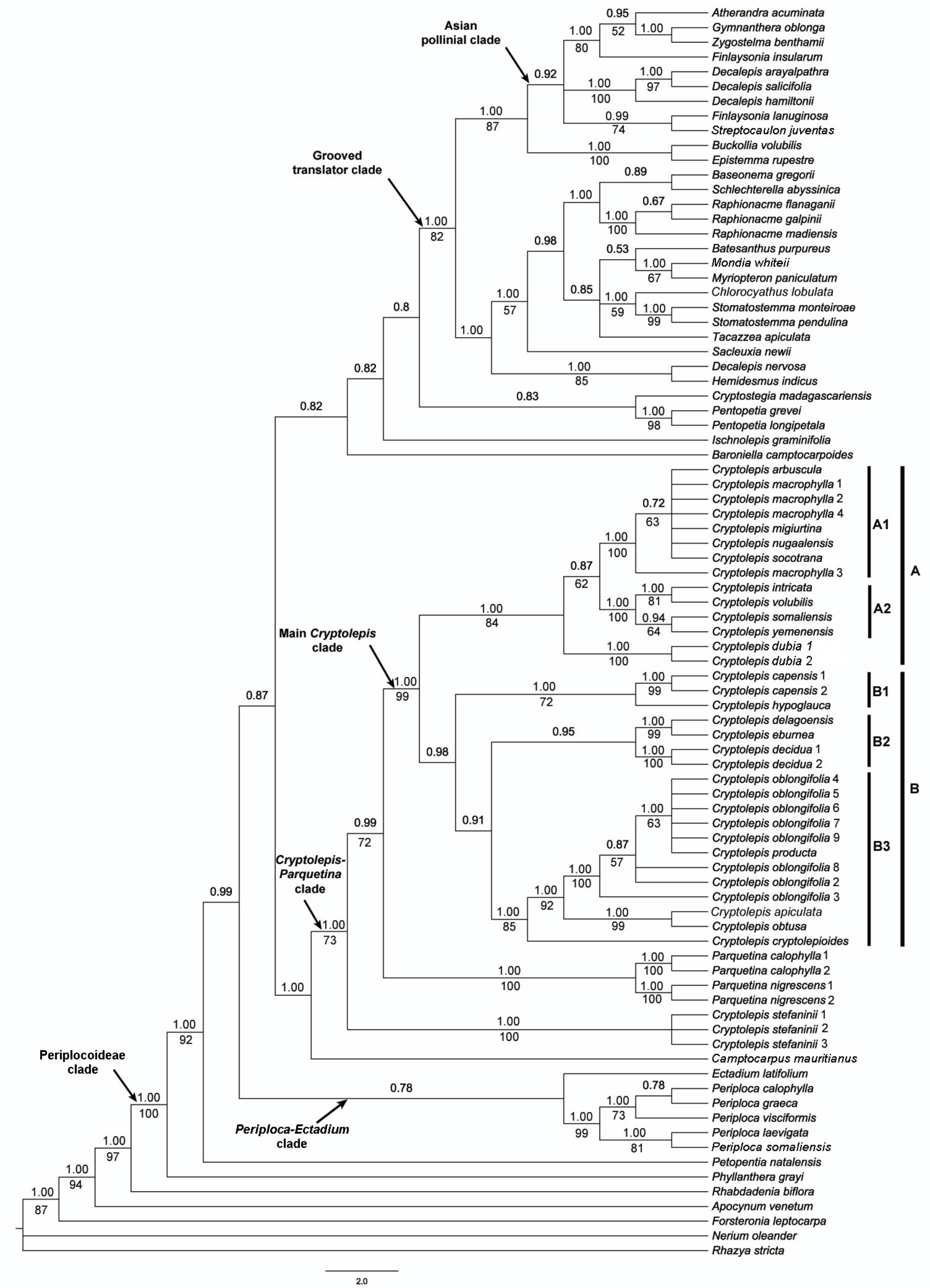


Fig. 5.1. Relationships in Periplocoideae from consensus of 15001 trees from Bayesian analysis of ITS data. Numbers above branches indicate Posterior Probabilities. Numbers below branches indicate Jackknife support percentages for the same clades. Where Jackknife support percentages are not given branches collapse in Maximum Parsimony analysis.

5.2.1.2 Analysis of cpDNA data

Here the same main *Cryptolepis* clade appears as in the ITS analysis with support of PP 1.00 and JK 51. It is sister to an unsupported clade formed by the rest of the Periplocoideae (PP 0.86) including the species of *Parquetina* and *C. stefaninii*. This remainder of the Periplocoideae is unresolved, forming a polytomy of nine minor groups among which are the Asian pollinial clade (PP 0.84) and the Malagasy clade (PP 1.00) of Ionta and Judd (2007). The grooved translator clade of Ionta and Judd (2007) does not appear. (Fig. 5.2.).

The main *Cryptolepis* clade shows the same topology as in the ITS analysis. Clade A, consisting of the Mandeb Circle species (except *C. stefaninii*) and here including *C. sanguinolenta* from sub-Saharan Africa, is sister to *C. dubia* with good support in BI analysis (PP 0.99), but unsupported in MP analysis. Clade B, now also including *C. sinensis* from Asia, is moderately supported by BI analysis (PP 0.91) and displays the same topology with three sub-clades as was found in the ITS analysis. (Fig. 5.2.).

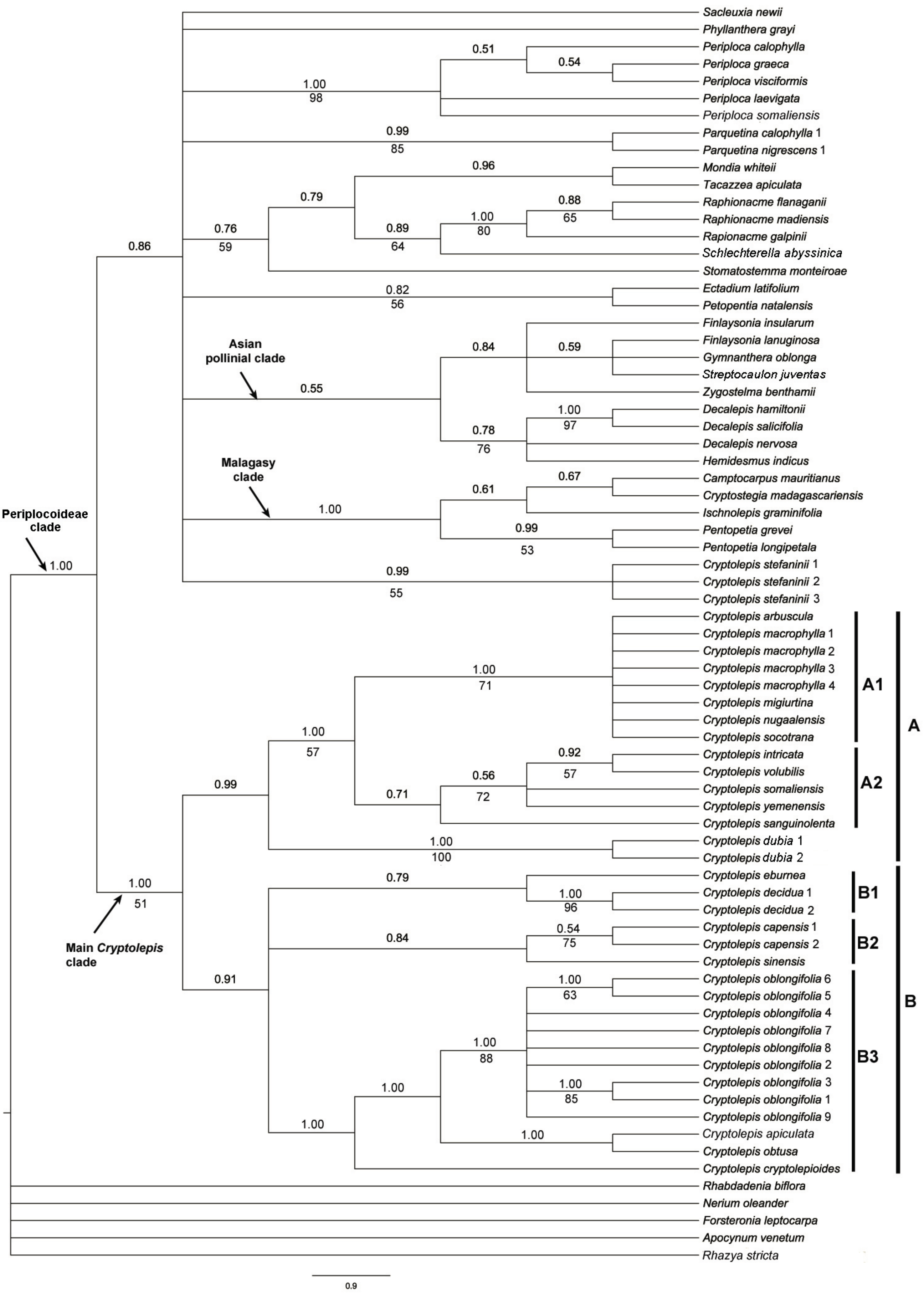


Fig. 5.2. Relationships in Periplocoideae from consensus of 15001 trees from Bayesian analysis of combined cpDNA data. Numbers above branches indicate Posterior Probabilities. Numbers below branches indicate Jackknife support percentages for the same clades. Where Jackknife support percentages are omitted branches collapse in Maximum Parsimony analysis.

5.2.1.3 Analysis of combined cpDNA and ITS data

The combined data analysis in Fig. 5.3. shows similar clades to those identified by Ionta and Judd (2007) but with different (though not always supported) relationships to one another. As was found by Ionta and Judd (2007) *Phyllanthera grayi, Petopentia natalensis* and the *Ectadium-Periploca* clade (PP 0.95) are successive, early diverging lineages, with the rest of the Periplocoideae falling into two major groups.

The first of these groups, though unsupported, consists of the grooved translator clade, the Malagasy clade and *Baroniella camptocarpoides* Costatin & Gallaud. The relationships of taxa in this clade correspond closely to that found by Ionta and Judd (2007) with the grooved translator clade being well supported (PP 1.00; JK 77) and the Asian pollinial clade (PP 0.87) essentially unsupported but nested within the grooved translator clade. The only difference between these results and those reported by Ionta and Judd (2007) is that the Malagasy clade is now sister to the grooved translator clade in Fig. 5.3.

The second group consists of the *Cryptolepis-Parquetina* clade (PP 1.00; JK 62) (Fig. 5.4.). In this clade *Cryptolepis*, as currently circumscribed, is paraphyletic since *Parquetina* (PP 1.00; JK 60) is nested within *Cryptolepis.* All the *Cryptolepis* species, except *C. stefaninii,* form a well supported monophyletic group (PP 1.00; JK 77), the main *Cryptolepis* clade, and these results support the decision by Venter and Verhoeven (1997, 2001) to place the genera *Curroria, Ectadiopsis, Mangenotia, Mitolepis* and *Socotranthus* in synonymy under *Cryptolepis*. *Cryptolepis* species which were previously included in the above mentioned genera are shown in bold in Fig. 5.4.

All *Cryptolepis* species apart from *C. stefaninii* fall into one of two sister clades, clades A (PP 1.00; JK 71) and B (PP 1.00). Both clades show a disjunct distribution between sub-Saharan Africa and Asia (Fig. 5.5.–5.6.). Clade A consists of all the species from the Mandeb Circle and *C. sanguinolenta* from sub-Saharan Africa, being sister to *Cryptolepis dubia* from SE Asia (Fig. 5.5.). This suggests a possible long distance dispersal event in clade A from north-east Africa or the Arabian Peninsula to south-east Asia.

Clade A is further subdivided into two sister clades, the first of which (sub-clade A1) is well supported (PP 1.00; JK 98) and consists of *C. arbuscula, C. macrophylla* and *C. socotrana* from Socotra, as well as *C. migiurtina* and *C. nugaalensis* which are both endemic to Somalia. Sub-clade A2 is moderately supported (PP 0.79; JK 92) and consists of *C. intricata* and *C. volubilis* from Socotra, *C. somaliensis* from Somalia and *C. yemenensis* from the southern parts of Yemen. The position of *C. sanguinolenta* within this clade is unsupported. The existence of two well supported sub-clades suggests that, within the Mandeb Circle, at least two separate dispersal events occurred between Somalia and Socotra. There is also an indication of a single dispersal event either between Somalia and Yemen or between Socotra and Yemen. Sub-clade A1 shows low molecular variation, indicating that this diversification may have been very recent.

The second *Cryptolepis* clade (clade B) contains all the species from sub-Saharan Africa, except *C. sanguinolenta* (Fig. 5.6.). Within clade B three sub-clades can be identified. Firstly there is sub-clade B1, with moderate support (PP 0.85; JK 62) and a distribution as shown in Fig. 5.6.(A). This sub-clade consists of *C. capensis* from Southern Africa, which is sister to *C. hypoglauca,* from Tropical East Africa and isolated populations in Central Africa. *Cryptolepis sinensis* from southern Asia is tentatively placed in sub-clade B1.

Sub-clade B2, with weak support (PP 0.84), consists of *C. eburnea* from West Tropical Africa, *C. delagoensis* from the eastern parts of Southern Africa and *C. decidua* from the arid north-western parts of Southern Afica. Species from this sub-clade occupy disjunct geographical ranges as shown in Fig. 5.6.(B). Sub-clade B3 is strongly supported (PP = 1 00, JK = 83) and contains four species, *C. cryptolepioides* from the eastern parts of Southern Africa, *C. oblongifolia,* which grows throughout the tropical and sub-tropical parts of sub-Saharan Africa, *C. apiculata*, which is restricted to the eastern parts of Tropical East Africa and the north-eastern parts of Southern Africa and *C. obtusa,* which is widely distributed in the eastern parts of Southern and Central Africa as well as the southern parts of Tropical East Africa. This is the only sub-clade in clade B where the species occur sympatrically (Fig. 5.6.(C)). The specimen representing *C. producta* is nested within the well supported *C. oblongifolia* clade (PP 1.00; JK 87), supporting its synonymy with the latter species.

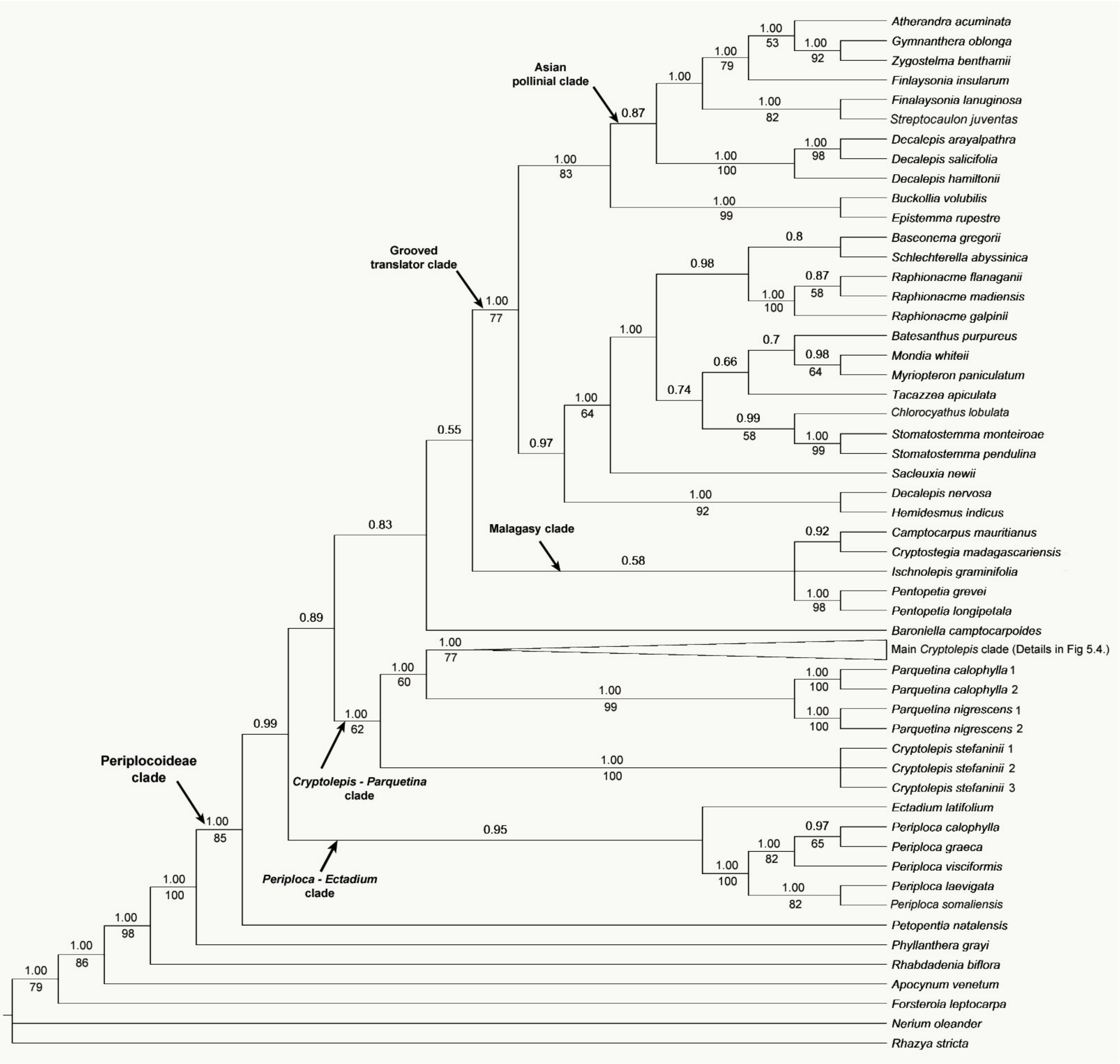


Fig. 5.3. Relationships in Periplocoideae from consensus of 15001 trees from Bayesian analysis of total DNA data. Numbers above branches indicate Posterior Probabilities. Numbers below branches indicate Jackknife support percentages for the same clades. Where Jackknife support percentages are omitted branches collapse in Maximum Parsimony analysis.

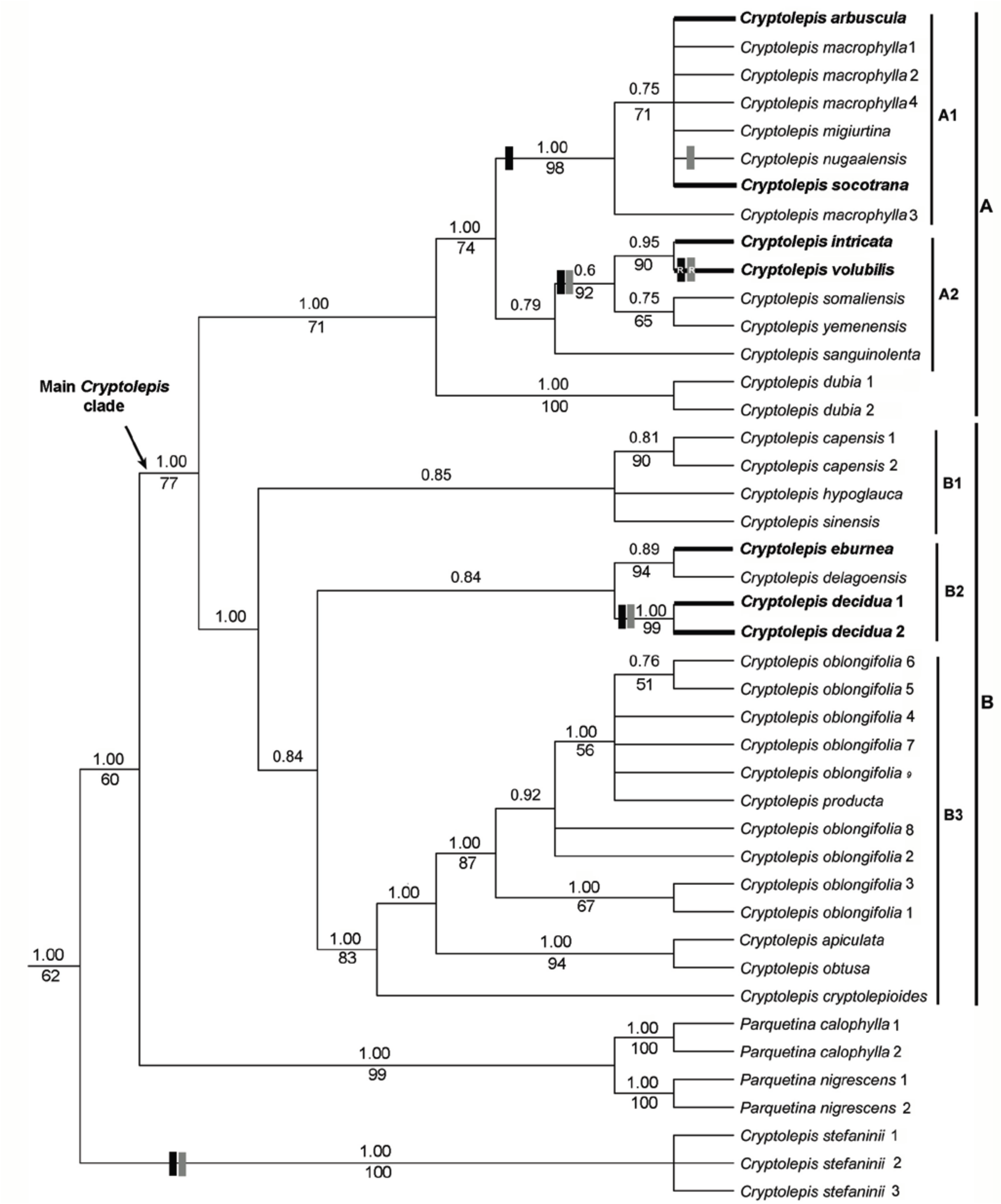


Fig. 5.4. Relationships in *Cryptolepis* from consensus of 15001 trees from Bayesian analysis of total DNA data. Numbers above branches indicate Posterior Probabilities. Numbers below branches indicate Jackknife support percentages for the same clades. Where Jackknife support percentages are omitted branches collapse in Maximum Parsimony analysis. Black bars indicate synapomorphies of a self-supporting growth form associated with an arid habitat. Grey bars indicate synapomorphies of semi-succulent leaves. Bars marked with "R" indicate reversals. Species names and branches in bold indicate genera synonymized with *Cryptolepis* by Venter and Verhoeven (1997, 2001).

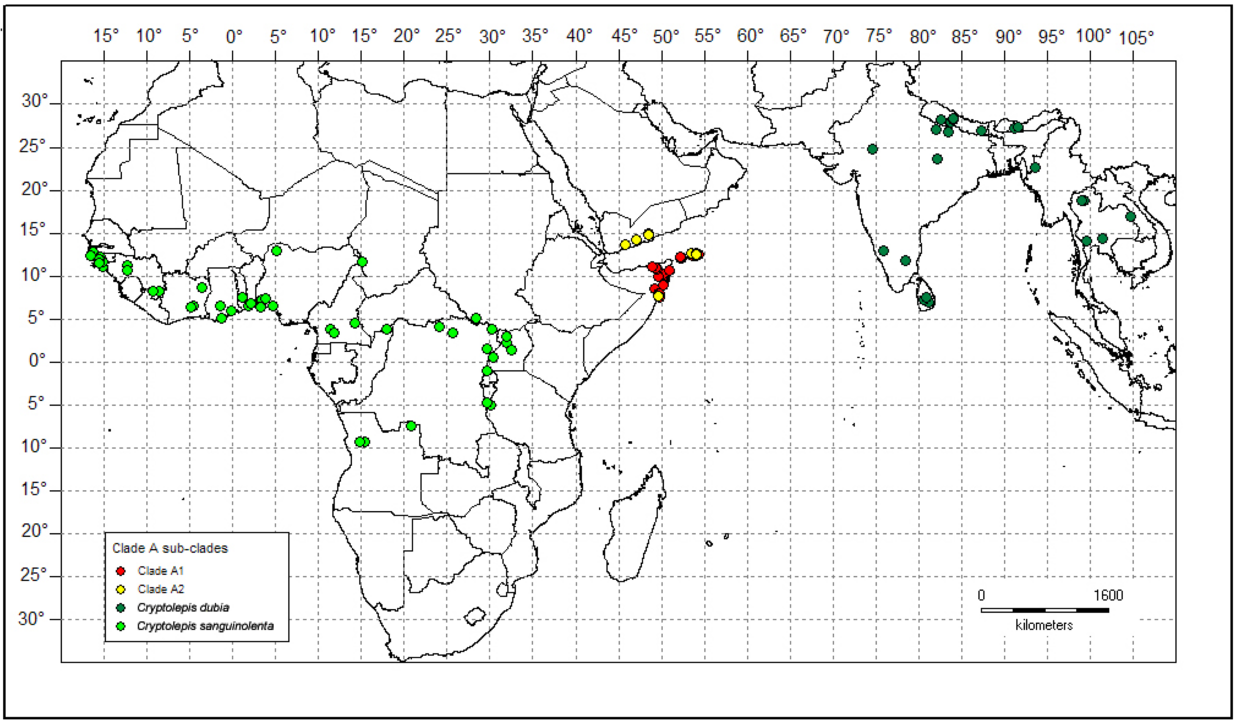


Fig. 5.5. Distribution of *Cryptolepis* species in clade A.

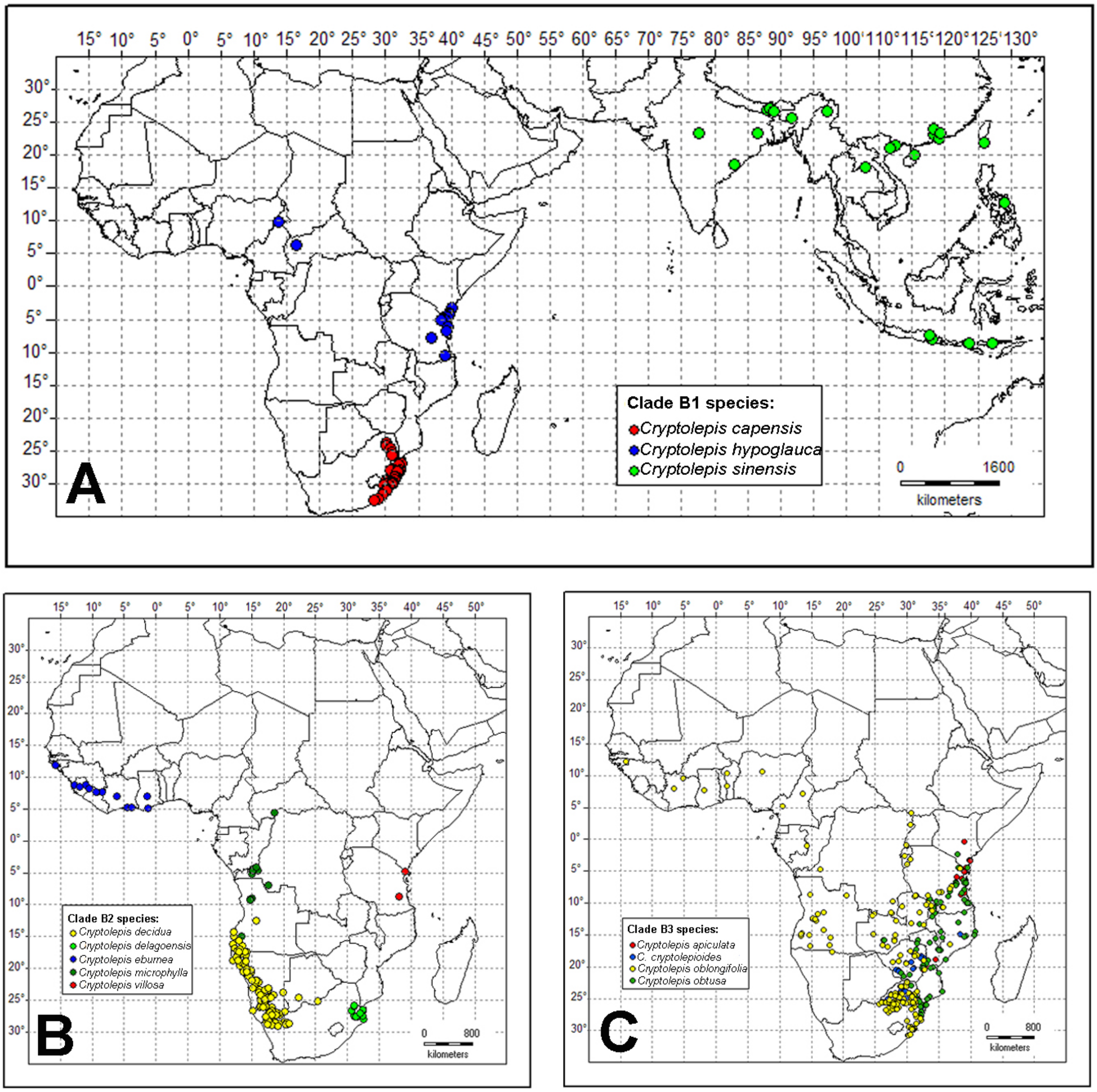


Fig. 5.6. Distribution of *Cryptolepis* species comprising the three sub-clades of clade B: (A) clade B1, (B) clade B2, (C) clade B3.

5.2.2 Morphological overview

5.2.2.1 Growth form and its adaptive value to drought and fire

The most parsimonious distribution of an erect, self-supporting growth form and semi-succulent leaves, associated with an arid or semi-arid habitat, is mapped onto the phylogeny in Fig. 5.4. This phylogeny suggests that such adaptations to arid conditions evolved independently at least four times in *Cryptolepis,* once in clade A1, clade A2, *C. decidua* and *C. stefaninii*. One reversal to a climbing growth form and coriaceous leaves occurred in *C. volubilis* which also grows in arid conditions on Socotra*. Cryptolepis oblongifolia* has a woody underground stem and is usually a dwarf-shrub. However, the branches may become twining when growing close to a support plant or are prostrate in older plants growing in open habitat without support and this species is consequently not regarded as having a true self-supporting growth form.

Collectors notes as well as personal observation suggest that *Cryptolepis oblongifolia* is adapted to growing in areas which are regularly exposed to fire or heavy grazing (*Breteler 11990* (WAG), *White 3644* (K), *Bester 9229* (PRE), *Richards 2063* (K), *Bester 9002* (PRE), *Bester 9013* (PRE), *Harder and Bingham 2542* (WAG)). Along the escarpment of the Blyde River Canyon in Mpumalanga (South Africa) *C. oblongifolia* (*Joubert 26, 48, 49, 51* (BLFU)) and *C. cryptolepioides* (*Joubert 27, 45, 46, 47* (BLFU)) have been observed growing in close proximity to each other. *Cryptolepis cryptolepioides* was restricted to the sandstone cliffs and boulders along the escarpment where it was well protected from fire. *Cryptolepis oblongifolia,* by contrast, was restricted to the neighboring grassland where fires regularly occur. The woody underground stem of this species would enable it to survive and coppice after fire or heavy grazing. Such fire tolerance may have been the main driving force behind its divergence from closely related species such as *C. apiculata, C. cryptolepioides* and *C. obtusa* of clade B3 (Fig. 5.4.).

A comparison of vegetative and floral morphology with the phylogenetic topology of *C. oblongifolia* did not yield any consistent trend and leaf shape, floral characters and molecular sequence data vary independently of one another (Fig. 5.4.). *Cryptolepis oblongifolia* is therefore regarded as a widespread, highly variable species which cannot be divided into well supported subspecies or varieties.

5.2.2.2 Comparison of *Cryptolepis stefaninii, Parquetina* and the main *Cryptolepis* clade

Morphological differences between *Cryptolepis stefaninii,* the main *Cryptolepis* clade and *Parquetina* are summarised in Table 5.2.

The vegetative morphology of *C. stefaninii* is very similar to that of other *Cryptolepis* species growing in arid habitats in the Mandeb Circle and Namib Desert. However, this species differs from all other *Cryptolepis* species in epidermal micromorphology, since it has guard cells covered by a prominently striated, raised cuticle, which obscures the stomatal ledge and pore (Fig. 3.4. D). In other *Cryptolepis* species the guard cells may be prominent, but they never enclose the stomatal ledge and pore (Fig. 3.4. A–C). *Cryptolepis stefaninii* exhibits floral morphology that is typical of the traditional circumscription of *Cryptolepis.*

Most vegetative characters of *Parquetina* are very similar to those of lianescent *Cryptolepis* species growing in forests, except for the characteristic blackening of cut parts of *Parquetina* plants. The micromorphology of *Parquetina* leaves does not show any clear distinction from *Cryptolepis*. Both *Parquetina* species have hypostomatic leaves with a slightly striated upper epidermis and stomata on the lower epidermis covered by broad to narrow stomatal ledges, as in *Cryptolepis* (Fig. 5.7. A–D). In *P. calophylla* the lower epidermis is covered by globular micropapillae, similar to those found in *C. dubia,* which is vegetatively very similar to *P. calophylla* (Fig. 5.7. B). In *P. nigrescens* the cells of the lower epidermis are not clearly visible and the periclinal cell walls have a distinct honeycomb appearance (Fig. 5.7. D).

In *P. calophylla* the campanulate corolla, with gynostegium enclosed in the corolla tube, corona arising half way up the corolla tube and stamens arising directly below the corona lobes, is typical of that found in *Cryptolepis,* except for the fact that the corona is fused to the filament base. *Parquetina nigrescens* is similiar to *P. calophylla* in that the bases of its corona lobes are fused to the filaments. In *Cryptolepis* such fusion of corona lobes and stamens was previously unknown but this investigation has shown that fusion between the stamens and corona lobes does occur in *C. arbuscula.* In *C. socotrana* hooded, bilobed corona lobes are inserted directly behind the insertion point of the stamens, not higher up in the corolla tube as in most other *Cryptolepis* species. These two species are nested in the main *Cryptolepis* clade (Fig. 3.4.) and the close association of their stamens and corona lobes suggests that distance between stamens and corona lobes may be of little value in distinguishing periplocoid genera.

In *P. nigrescens* the primary difference in floral morphology from that of *P. calophylla* and *Cryptolepis,* is due to a single character, the reflexed corolla tube, which causes the gynostegium to be exposed and the corona lobes to be positioned at the corolla tube mouth. If the positions of the various parts relative to the corolla tube are examined, it is clear that the gynostegium is positioned about half way up the corolla tube, the corona lobes arise half way up the corolla tube and the stamens directly below them. A reflexed corolla tube is also found in *Baseonema* and *Batesanthus*, which are both unrelated to each other and to *P. nigrescens* (Fig. 3.3.). Our results show that the reflexed corolla tube and characters associated with this feature, such as an exposed gynostegium and corolla lobes exserted from the corolla tube mouth, are of little taxonomic value in circumscribing genera in the Periplocoideae and should not be valued too highly in *Cryptolepis*.

Table 5.2. Morphological comparison between the main *Cryptolepis* clade, *C. stefaninii* and *Parquetina.*

	Main *Cryptolepis* clade	***Cryptolepis stefaninii***	***Parquetina***
Growth form	Climbers, shrubs or trees.	Shrub	Climbers
Leaf and flower colour after being cut.	No blackening of plant organs after being cut.	No blackening of plant organs after being cut.	All parts turning black when cut.
Leaf micro-morphology	Stomatal pore and ledge exposed. Occasionally with micropapillae on abaxial epidermis.	Guard cell cuticle raised and obscuring stomatal pore and ledge. Micropapillae absent.	Stomatal pore and ledge exposed. Micropapillae on abaxial epidermis of *P. calophylla.*
Corolla shape	Campanulate, rarely salverform or urceolate.	Campanulate	Campanulate or rotate.
Corolla reflexed or spreading	Spreading	Spreading	Reflexed in *P. nigrescens* but spreading in *P. calophylla.*
Fusion of corona lobe bases to stamens	*C. arbuscula* and *C. socotrana* with corona lobe bases fused to stamens. Corona lobes and stamens free in all other species.	Corona lobes and stamens free.	Corona lobes and stamens fused.

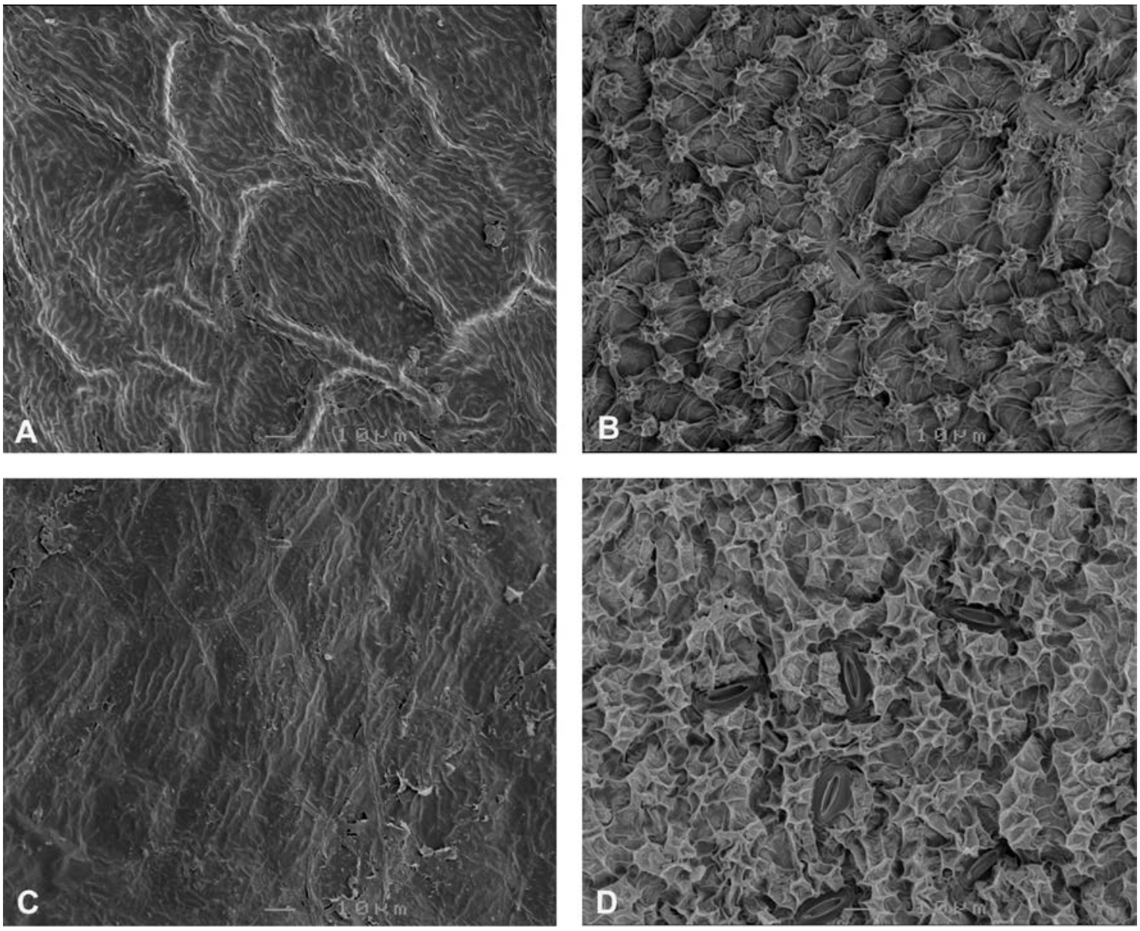


Fig. 5.7. *Parquetina* leaf epidermal surfaces: (A) adaxial epidermis of *P. calophylla* with slightly striated cuticle, (B) abaxial epidermis of *P. calophylla* with micropapillae and stomata covered by broad stomatal ledges, (C) adaxial epidermis of *P. nigrescens* with a slightly striated cuticle, (D) abaxial epidermis of *P. nigrescens* with a honeycomb appearance and stomata covered by narrow stomatal ledges. Magnification: A–D = x600. Specimens: (A–B) *Essau 1711* (WAG); (C–D) *Weiringa 4056* (WAG).

5.2.3 Biogeography

The species diversity for *Cryptolepis* is shown in Fig. 5.8. *Cryptolepis* is poorly represented in southern Asia, with only three species growing in that region, *C. dubia, C. grandiflora* and *C. sinensis*. The other 28 species are restricted to Africa and the southern parts of Yemen. *Cryptolepis* is absent from the southern and central parts of South Arica and the greatest part of the Kalahari Gap (Jürgens, 1997) with its deep sandy soil extending from South Africa, through the central parts of Botswana and eastern Namibia. The genus is also absent from the Mediterranean region and Sahara as far south as the Sahel (White, 1983). Though *Cryptolepis* is well represented by seven species in Somalia, the genus appears to be absent from the rest of the Somalia-Masai Regional Centre of Endemism which stretches from Eritrea, through Sudan and Kenya into Tanzania (White, 1983). The diversity map also shows absence of *Cryptolepis* from the Congolian rainforest, lowland rainforest and swamp forest (White, 1983) of the central parts of The Democratic Republic of the Congo, The Republic of the Congo, Gabon and Equatorial Guinea.

The drainage systems of sub-Saharan Africa can be roughly divided into an eastern section and a western section by a watershed extending along the eastern section of the East African Rift system, form northern Ethiopia southward to the west of Lake Malawi (Grove, 1978; Summerfield, 1996). In Southern Africa this division is continued resulting in a nearly continuous division of Africa into an eastern section stretching from the Mandeb Circle in the north through Tropical East Africa to the eastern parts of Southern Africa and a much larger western section (Fig. 5.9.).

Despite the discrepancy in land surface area of the two sections the distribution of *Cryptolepis* species shows a strong bias towards the eastern section of Africa. Four centers of diversity were found for *Cryptolepis* (Fig. 5.8.), occurring from the Mandeb Circle, along the eastern African coastline to the eastern half of Southern Africa. Nearly two thirds (23) of all *Cryptolepis* species grow within this eastern section of Africa and Yemen, with only three of these species also found in the western section of Africa. Two of the species, *C. hypoglauca* and *C. obtusa,* are mainly distributed through Tropical East and Southern Africa with only marginal populations in Central Africa. One species, *C. oblongifolia,* is widely distributed over the whole of sub-Saharan Africa. By contrast the western section of Africa is relatively depauperate in *Cryptolepis* species, having only eight species of which five are restricted to this section.

The first two centers of diversity in the eastern section of Africa are found in the Mandeb Circle, one in Socotra and the other in Somalia. The Mandeb Circle has a total of thirteen *Cryptolepis* species, all of which are endemic. A single species is endemic to Yemen. The Socotran centre of diversity consists of five species, all of which are endemic to the island archipelago. In Somalia there are seven species which are all endemic to this country. These species are, however, not sympatric in a single large centre of endemism, but are spread out along the northern and eastern coastline of Somalia, resulting in a relatively small centre of diversity where the distribution ranges of four species overlap.

The third centre of diversity lies in Tropical East Africa, east of the Eastern Arc Mountains. Tropical East Africa has eight *Cryptolepis* species, with *C. sanguinolenta* restricted to the deciduous forest at the western extremity of this region and not forming part of the East African centre of diversity. Of the other seven species three are endemic and six of the species' distribution ranges overlap at the Eastern Arc Mountains to form a relatively pronounced centre of diversity. Five of these species all grow in coastal-, lowland- or riverine forest. *Cryptolepis ibayana* grows in montane forest at higher altitudes, while *C. oblongifolia* grows in woodland or savannah. The Southern African centre of diversity covers the largest surface area, stretching from the eastern tropical to sub-tropical parts of the region, and includes six species, three of which are endemic to this region.

Central Africa has seven species, two of which, *C. gossweileri* and *C. microphylla,* are endemic to the region. Of the other five species three have only marginal distribution in Central Africa. *Cryptolepis hypoglauca* and *C. obtusa* are more widely distributed in Tropical East Africa and Southern Africa and reach the western extremity of their respective ranges in Central Africa. *Cryptolepis decidua* is near endemic to the Namib Desert and western arid Kalahari. *Cryptolepis sanguinolenta* grows in West Tropical Africa, the northern parts of Central Africa and the western extremities of East Africa. Only three species grow in West Tropical Africa of which only *C. eburnea* is endemic to this region. The other two species are *C. sanguinolenta* and *C. oblongifolia.*

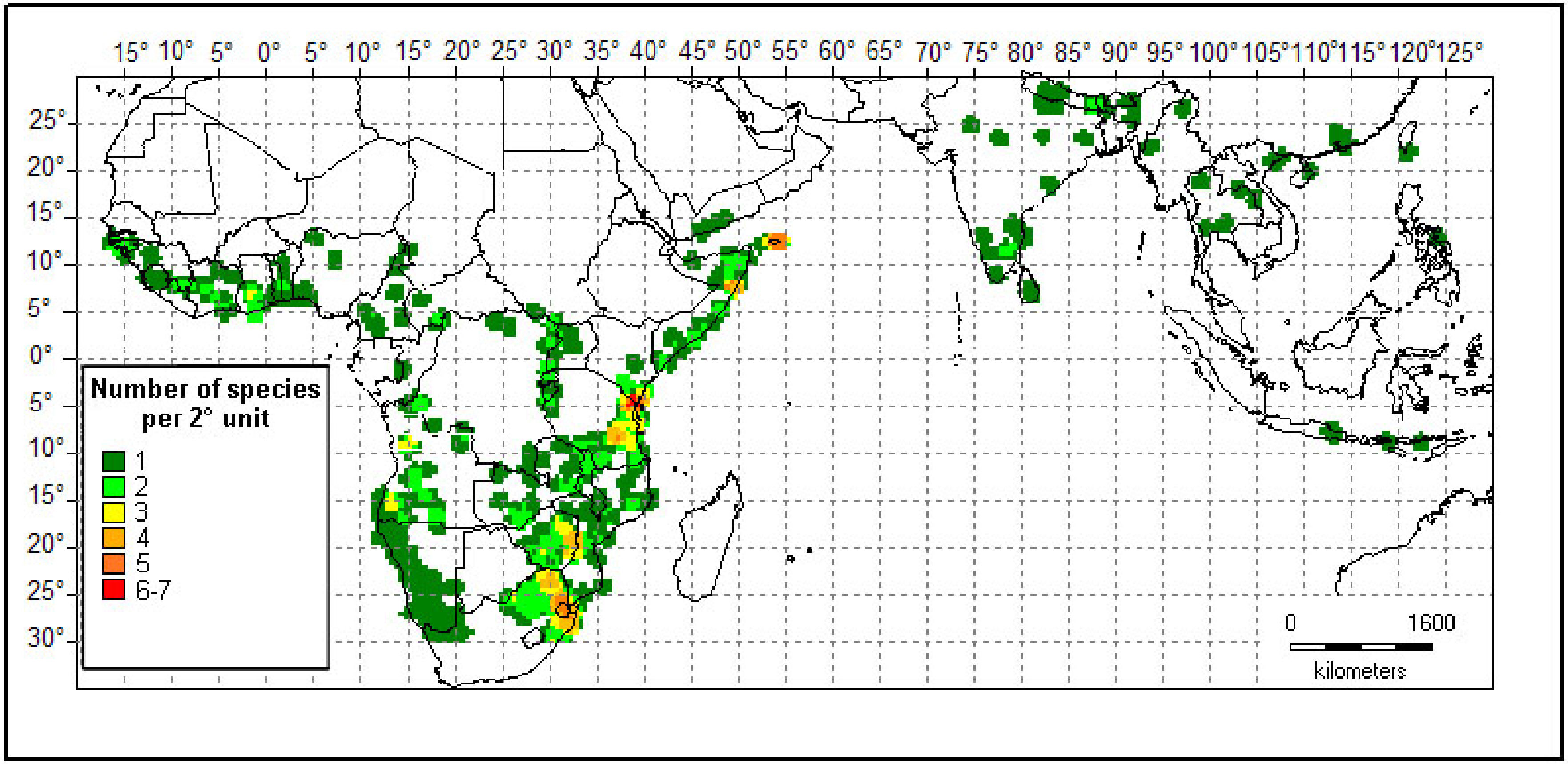


Fig. 5.8. Species diversity map of *Cryptolepis* based on circular neighborhood analysis using cell size of 30' and map units set at 2°.

Fig. 5.9. Drainage systems of the African mainland with an extensive westward drainage system and a smaller eastward drainage system, dividing the continent into two sections. (Adapted from Summerfield (1996)).

5.3 Discussion

5.3.1 Classification of *Cryptolepis* and *Parquetina*

With the wider sampling of *Cryptolepis* in this analysis, it was found that *C. stefaninii* does not show close affinity to the main *Cryptolepis* clade. In addition this species does not form a clade with the other species (clade A, Fig. 5.4.), which occupy the same geographical area in Somalia. However, morphological characters support the inclusion of this species in *Cryptolepis* and only stomatal characters clearly differentiate it from other *Cryptolepis* species*.*

The two *Parquetina* species have had a chequered history. Bullock (1961) included both in the single species *Parquetina nigrescens* but Venter and Verhoeven (1996) resurrected them as two species in the separate genera *Omphalogonus* Baill. and *Periploca* on account of the rotate flower in the latter and the more campanulate tube in the former. After Ionta and Judd (2007) found that the two species, *Omphalogonus calophyllus* Baill. and *Periploca nigrescens* Afzel., are sisters, Venter (2009b) placed both of them in *Parquetina*.

Parquetina is characterized by the manner in which whole specimens turn black when cut, a character unique within the Periplocoideae. Vegetatively the two *Parquetina* species are virtually indistinguishable, though micromorphological characters of the leaf epidermis effectively distinguish them. Florally *Parquetina calophylla* is characterized by a shallowly campanulate corolla tube with the corolla surface papillose, a characteristic also found in *Phyllanthera* (Venter and Verhoeven, 2001). The corona lobe is divided into outer apical segment which is subulate to rounded and an inner apical segment which is hood-shaped. The flowers of this species were reported to have an offensive odor and are possibly fly-pollinated (Venter and Verhoeven, 1996). In *Parquetina nigrescens* the corolla tube is reflexed from the middle. The corona lobes are linear to filiform, mostly terminally cross-shaped with apical segments tortuous (Venter and Verhoeven, 1996). The corona lobe bases are fused to the staminal filaments in both species, a characteristic previously used to separate *Parquetina* from *Cryptolepis* (Venter and Verhoeven, 2001).

Venter and Verhoeven (1996, 1997) showed that coronal structure, size and colour are not taxonomically useful for circumscribing genera and postulated that the position of the corona in the corolla tube is of importance. Our results show that the distance between the point of stamen insertion on the corolla tube and the corona lobes is variable in *Cryptolepis,* and is probably not a good character for differentiating genera in the Periplocoideae. However, the placement of corona lobes either at the corolla lobe sinuses or at any point on the corolla tube, in combination with additional reproductive and vegetative characters, are of value in generic circumscription.

Since no substantial morphological support can be found for separating *C. stefaninii* from *Cryptolepis* and since *Parquetina* is differentiated from *Cryptolepis* by only one character which is quite conspicuous but of dubious value, it is proposed that the genus *Parquetina* should be placed in synonymy under *Cryptolepis* as was supported by the ITS and combined data phylogenetic analyses.

5.3.2 The influence of glacial and interglacial climate change on biogeography and phylogenetic relationships

The climate, and consequently the biogeography, of Africa was influenced by a number of forces during the Cenozoic. Geological forces, such as continental drift, caused a change in the equatorial position and led to a migration of vegetation types associated with latitudinal climate zones (Van Zinderen Bakker and Mercer, 1986). By the mid Miocene (16–10 Ma) rifting and lifting of the continental plate started in East Africa but according to Andrews and Van Couvering (1975) this had not progressed far enough to limit the eastward movement of moist monsoonal circulation from the Atlantic ocean. They contend that lowland evergreen forest would have extended from the west coast to the east coast of Africa during this period, but Axelrod and Raven (1978), Bonnefille (1984) and Kortlandt (1983) propose different models which suggest that East Africa experienced aridification and that mosaics of arid adapted forest and woodland-savanna had become established.

Tectonic uplift and tilting along the East Africa Rift increased during the Late Pliocene (3.5–1.8 Ma) and had a more pronounced effect on precipitation. In Southern Africa similar tectonic uplift also influenced atmospheric circulation and climate, with high precipitation mainly restricted to the low-lying areas to the east of the escarpment. Such geological factors were, however, gradual in nature and caused long term changes (Van Zinderen Bakker and Mercer, 1986)

Glaciation events and interglacial periods had a much more pronounced and wide-spread influence on the climate of Africa during the Cenozoic. Several glacial and interglacial periods were caused by expansion or recession of either Antarctic or Arctic glaciers. During glacial periods the general climate of Africa became drier and colder, while interglacial periods were marked by warmer, more mesic conditions (Van Zinderen Bakker and Mercer, 1986). Axelrod and Raven (1978) describe the historical phytogeography of Africa's vegetation during the Cenozoic and propose that the tropical rainforest expanded and that all vegetation types migrated to higher latitudes during warmer, moist interglacial periods. Tropical forests may also have extended into higher latitudes of Arabia, connecting the tropical flora of Africa and southern Asia (Davis et al., 2004). The two separate dispersal events of *Cryptolepis* between Africa and southern Asia, as shown in clade A (Fig. 5.5) and B (Fig. 5.6a), may have occurred during these periods when tropical forest covered extensive areas or, alternatively, are the result of chance long distance dispersal. During the cold, dry glacial periods vegetation zones migrated closer to the equator and tropical rainforests shrunk considerably while arid adapted vegetation types expanded in south-western, north-west and north-east Africa (Van Zinderen Bakker and Mercer, 1986).

Lomolino et al. (2006) describe three possible responses of terrestrial organisms to such shifts in habitat. Those organisms which are mobile, may migrate with the shifting climate to occupy new geographical areas. Such shifts could bring the organisms into contact with new soil types or topographic conditions which could result in speciation. Less mobile species may remain in the same area and adapt to the new climatic conditions while those species which are unable to migrate with their optimal habitat and are unable to adapt to the changed conditions eventually become extinct (Lomolino et al., 2006). Such extinctions would have been a particular threat to species of communities which could not shift effectively with the shifting climate such as tropical rainforest and arid and semi-arid adapted communities. In addition, not all members of a community react in the same way to shifts in climatic zones (Lomolino et al., 2006) and as a result symbiotic species such as plants and their pollinators may have been separated during glacial or interglacial species range shifts.

All members of the Periplocoideae would have been able to migrate with shifting climatic zones since these taxa all possess seeds with a coma of hair or rarely a marginal ring of hair which are adapted for anemochoric dispersal. Vicariance due to climatic shifts may have played a significant role in speciation in this subfamily. Disassociation between plants and pollinators would have aggravated the mate-finding Alee effect (low fitness at low population densities due to difficulty of locating appropriate mates (Gascoigne et al., 2009)). According to Livshultz et al. (2011) this may have been the primary driving force behind the specialized pollination mechanism found in the milkweeds and Periplocoideae.

During glacial periods the Benguela Current shifted northward as far as Cape Lopez (Gabon) and had a significant aridifying effect which stretched far inland as suggested by consecutive layers of Kalahari sand which extend into the Congo Basin (Van Zinderen Bakker, 1975; Goudie, 1996). The tropical rainforest became severely fragmented and was virtually eliminated but for a few isolated refugia along the equator (Mayr and O'Hare, 1986; Van Zinderen Bakker, 1975). Goudie (1996) cites several sources of evidence which suggest that the tropical rainforests of West Tropical Africa were also nearly eliminated during the last glacial maximum (20 000–15 000 BP). This elimination of the tropical rainforest has been proposed as the cause of the relatively poor diversity of African tropical forests as compared to those of Malayia and South America (Flenley, 1979).

Hamilton (1976) proposed the presence of refugia in the tropical rainforest of South America as the reason for isolated patches of high diversity and endemism within those forests. Various authors have since shown that forest patches persisted in West Cameroon during periods of glacial aridification and general disappearance of lowland tropical rainforest in Africa (Maley, 1991; Giresse et al., 1994). Rainforest adapted species such as the two species of *Parquetina*, which diverged from the main *Cryptolepis* clade relatively early, may be relict species which survived in such rainforest refugia and were able to re-colonize large areas of Tropical West Africa, Central Africa and East Africa once more mesic conditions returned and the lowland rainforest expanded in interglacial periods.

In addition to the near elimination of tropical rainforests, extreme aridification along the west coast of Africa may also have resulted in the extinction of many taxa which were adapted to more mesic conditions in the savanna, dry forest and grassland-forest mosaic surrounding the tropical rainforest (Van Zinderen Bakker, 1975). Such pronounced aridification as a result of the influence of the cold Benguela Current, may be one of the reasons for the depauperate *Cryptolepis* diversity in the western section of Africa.

Cryptolepis eburnea is the only African *Cryptolepis* species growing in the areas designated as Guineo-Congolian Rainforest (White, 1983) where it is restricted to the coast in the Guinea part of this rainforest biome. The absence of this species from the Congolian Rainforest together with its derived position in the phylogeny (Fig. 5.4.) and its close association with dry forest species (*C. delagoensis*) and arid adapted species (*C. decidua*) suggest that *C. eburnea* is not a relict tropical rainforest species which survived fragmentation of the rainforest in refugia, but rather that this is a recently derived species which reverted to tropical rainforest from a drier forest habitat.

Initially the close association between *C. eburnea* from West Tropical Africa and *C. delagoensis* from Southern Africa seems unfounded. However, this association becomes more likely when considering two other species, *C. microphylla* and *C. villosa*, which are not included in this phylogenetic analysis but share several morphological characters with the former two species. *Cryptolepis microphylla* grows in the forested southern part of Central Africa, extending from Angola to Zambia and southern parts of The Democratic Republic of the Congo and is vegetatively virtually indistinguishable from *C. eburnea. Cryptolepis villosa* from Tropical East Africa is also vegetatively similar to *C. eburnea* and *C. microphylla* and is distinguished mainly by its densely villous leaves. These three species and *C. delagoensis* share globular micropapillae on the abaxial leaf epidermis and similar, sub-clavate primary corona lobes. The difference in distribution ranges and morphology of these species are possibly the result of vicariance during a succession of glacial and interglacial events.

Interglacial periods were marked by the expansion of tropical forest and all climatic zones were displaced to higher latitudes (Goudie, 1996). Arid habitats, which generally occupy marginal positions in the northern, north-eastern and south-western parts of Africa, would have been encroached upon by more mesic vegetation types, eliminating the arid-adapted taxa. These species could only survive in arid refugia and the Horn of Africa has served as such a refugium for arid relic elements during interglacial periods (Thulin, 1994).

Cryptolepis stefaninii is the earliest diverging lineage in the *Cryptolepis-Parquetina* clade and is the only species from the Mandeb Circle which is not included in clade A (Fig. 5.4.). The ancestor of *C. stefaninii* possibly diverged from the rest of the *Cryptolepis-Parquetina* clade and developed adaptations to an arid climate during one of the earliest glacial periods to which the clade was exposed. It is likely that the ancestors of *C. stefaninii* survived interglacial periods in the refugia of Somalia as suggested by Thulin (1994).

The other species (clade A) from the Mandeb Circle have similar adaptations to an arid climate but represent a more recent and rapid diversification which resulted in little molecular divergence (Fig. 5.4.). Low molecular variation has been documented in several closesly related plant groups which have radiated on islands (Knox and Palmer, 1995; Böhle et al., 1996; Kim et al., 1996; Panero et al., 1999; Moore et al., 2002; Mort et al., 2002; Layaye et al. 2005). Such taxa which have undergone rapid diversification may show significant morphological divergence while molecular variation of noncoding gene regions, such as ITS, *trnT–L, trnL–F* and *trnD–T,* remains low (Baldwin et al. 1998).

The Mandeb Circle was therefore colonized by *Cryptolepis* at least twice during consecutive glacial periods. Van Zinderen Bakker and Mercer (1986) proposed that alternating expansions and reductions in the surface area covered by certain vegetation types and communities of species during glacial and interglacial periods, would have lead to repeated colonization of an area by different groups of species adapted to the climatic conditions at the time, with subsequent isolation of such species when the climate changed. Thulin (1994) also proposed that the diversity of plant taxa in the Horn of Africa is the result of the survival of arid relict elements of successive colonization events, supporting the results of this study.

Many taxa show a disjunct distribution between the Horn of Africa and the Namib Desert and semi-arid parts of south-west Africa (Thulin, 1994). The only *Cryptolepis* species from the Namib Desert and surrounding sub-arid area, *C. decidua,* is morphologically very similar to many of the Mandeb Circle species. Figure 5.4. shows that this species is unrelated to the Mandeb Circle species and represents a fourth, independent evolution of a self-supporting growth form and semi-succulent leaves as adaptation to its arid habitat. The Namib Desert is believed to be very old and is one of the deserts with the highest species diversity and levels of endemism in the world (Van Zinderen Bakker, 1975). Two other periplocoid genera, *Ectadium* and *Raphionacme* are well represented in the Namib, but *Ectadium* is absent from the Mandeb Circle, while only one *Raphionacme* species grows in this region (Venter and Verhoeven, 1988; Venter et al., 1990a). It is therefore surprising that only one *Cryptolepis* species is found in the Namib while thirteen species are endemic to the Mandeb Circle.

5.3.3 Co-occurrence of refugia and centers of diversity

5.3.3.1 Socotra

The Socotra island archipelago is a local centre of endemism within the Somali-Masai Regional Centre of Endemism with 37% of its vascular plants being endemic (Miller and Morris, 2004). Socotra has a diversity of habitats ranging from coastal plains of alluvial soil and compacted gravel and coarse sand, an extensive limestone plateau with rolling hills and dissected by river valleys and the Haggier Mountains consisting of a complex of igneous and metamorphic Precambrian rocks with deep, fertile soil accumulating in valleys and on the gentler slopes (WWF and IUCN, 1994). The diversity of soil types and topography has resulted in a wide range of vegetation types on Socotra (Král and Pavliš, 2006).

Five *Cryptolepis* species are endemic to the island archipelago. *Cryptolepis arbuscula* (clade A1, Fig. 5.4.) is restricted to the Haggier Mountains, while the other four species are associated with limestone on the foothills and ravines surrounding the Haggier Mountains. *Cryptolepis intricata* and *C. volubilis* (both in clade A2, Fig. 5.4.) are widely distributed over the limestone plateau and *C. macrophylla* (clade A1, Fig. 5.4.) also grows on the hills of Abd-al-Kuri. *Cryptolepis socotrana* (clade A1, Fig. 5.4.) is associated with limestone cliffs along the coastal plains and may extend inland along wadi slopes. Diversification within the two clades of *Cryptolepis* (clade

A1 and A2, Fig. 5.4.) on the island archipelago may at least partially be due to adaptation to specific soil types and topography on the different parts of the island.

5.3.3.2 Somalia

The distribution of *Cryptolepis* endemics in Somalia correspond to the three areas of endemism described by Thulin (1994). The first centre of endemism is in the northern mountains and this area has the highest number of endemics (Thulin, 1994). The high levels of endemism in these mountains is explained by a highly diverse topography (altitudinal ranges from 0–2400 m), considerable variation in rainfall received (0–700 mm) and the presence of both limestone and gypsum substrates (Thulin, 1994). Three *Cryptolepis* species occupy different niches in the northern parts of Somalia. *Cryptolepis gillettii* is adapted to arid conditions at low altitudes near the coast in the western parts of the region. By contrast *C. migiurtina* (clade A1, Fig. 5.4.) occupies more mesic conditions in the mountains and is associated with limestone, as opposed to *C. stefaninii* which grows in roughly the same area, but is closely associated with gypsum.

The second Somalian centre of endemism is the Nugaal Region, which is an arid area extending for 250 km along the Wadi Nugaal. To the west are widespread deposits of gypsum and anhydrites while towards the coast limestone dominates the geology (WWF and IUCN, 1994). This centre of endemism corresponds to the centre of diversity shown in Fig. 5.8. *Cryptolepis stefaninii* occupies the western gypsum-covered sections of the wadi, whereas four species grow in the coastal section of the wadi. *Cryptolepis migiurtina* (clade A1, Fig. 5.4.) reaches the southern limit of its distribution range here, while *C. orbicularis* reaches the northern extremity of its distribution on the coastal dunes just to the south of the wadi mouth. *Cryptolepis nugaalensis* (clade A1, Fig. 5.4.) and *C. somaliensis* (clade A2, Fig. 5.4.) are known only from the limestone dominated eastern section of Wadi Nugaal.

The third centre of endemism in Somalia extends along the coast towards the south of the country. Here species-rich sand dunes are distributed at different distances from the coast, with intermittent limestone outcrops and a limestone plateau parallel to the coast (Thulin, 1994). *Cryptolepis orbicularis* is endemic to the coastal dunes, whereas *C. thulinii* occupies the limestone plateau.

5.3.3.3 Eastern Arc Mountains

The Eastern Arc Mountains (EAM) of Kenya and Tanzania consist of a mountain chain of crystalline Precambrian basement rock which underwent periodic uplift by faulting and exposed to weathering over millions of years (Burgess et al., 2007; Mumbi et al., 2008). These mountains have extremely high biodiversity and are especially rich in endemics as has been illustrated by Lovett (1988, 1998), Lovett et al. (2004), Myers (1988, 1990), Myers et al. (2000) and Mittermeier et al. (1998). The moist eastern and south-eastern mountain slopes are covered by continuous forest which extends into lower elevations and grades into the lowland coastal forests (Lovett et al., 2001; Burgess et al., 2007). The drier slopes towards the west and north-west are covered by deciduous woodland, while evergreen forest persists at higher elevations due to the influence of fog over these areas during the night (Burgess et al., 2007).

Two reasons for the high species diversity and endemism in the EAM have been proposed. The first hypothesis proposes that the EAM acted as moist forest refugia during arid glacial periods (Burgess et al., 2007; Diamond and Hamilton, 1980; Hamilton, 1982; Lovett, 1993; Mumbi et al., 2008). This hypothesis is supported by the presence of many ancient relict lineages which suggests that the forests have persisted for prolonged periods (Burgess et al., 1998). The ocean temperature along the east coast of Africa remained relatively warm in comparison to the cold Benguela Current along the west coast (Van Zinderen Bakker, 1975). Mumbi et al. (2008) presented the first palaeo-climatic data for the EAM which shows that this area was relatively stable in terms of temperature variation and rainfall during the last glacial period. They propose that the influence of the south-east trade winds, which brought moist air from the warm Indian Ocean, supported relatively high rainfall along the east coast and EAM during glacial periods (Mumbi et al., 2008). Pollen and macrofossil data have also shown that moist forests persisted in the EAM throughout the last glacial maximum (Mumbi et al., 2008). This refugium effect would explain the high diversity and endemism of *Cryptolepis* species in the riverine forest of the EAM as well as in the lowland and coastal forest to the east of the mountains.

The second hypothesis proposed for the high diversity of endemics in the EAM is the rapid, recent radiation of species to occupy different niches in the region as illustrated by Burgess et al. (2007). While local diversification in *Cryptolepis* species may have played a role in the current diversity of species, it is also possible that expansion of the moist forest vegetation into Southern Africa during interglacial periods may have led to the expansion of distribution ranges of *Cryptolepis* species, followed by speciation as the species came into contact with new environmental conditions and pollinators. These populations could have become isolated in refugia such as riverine forest in gullies along the coast and escarpment during drier glacial periods leading to vicariance. The Southern African species could also have migrated northwards, back to the more favorable conditions of the EAM during arid glacial periods, thereby enriching the flora of the region.

This pattern of speciation and distribution would explain the close association between *C. capensis* from Southern Africa and *C. hypoglauca* from Tropical East Africa and isolated populations of the latter species in the north-western parts of Central Africa. These two species are both large-leaved climbers growing in moist forest. In Southern Africa *C. capensis* is restricted to moist forest along rivers and in gullies along the eastern escarpment, supporting the hypothesis that it is derived from a group of moist forest species which migrated south during a mesic interglacial period and now survives in moist forest refugia in Southern Africa, while its sister species persisted in the refugia of Tropical East Africa and Cameroon.

Close affinities between some of the EAM taxa and species from the forests of Southern Asia have also been proposed as evidence for the old age and long persistence of forests in the EAM (Burgess et al., 2007). This is consistent with the phylogenetic affinity of *C. sinensis* from the tropical forests of Southern Asia with *C. hypoglauca* and *C. capensis* (Fig. 3.4.).

5.3.3.4 Southern Afican centers of endemism

The Southern African centre of *Cryptolepis* diversity overlaps several regional centres of endemism, the most important of which are the Chimanimani-Nyanga centre of endemism in Zimbabwe and Mozambique and the Barberton, Maputaland, Sekhukhuneland, Soutpansberg and Wolkberg centres of endemism in South Africa (Van Wyk and Smith, 2001).

The geology of the Chimanimani Mountains is dominated by metamorphosed quartzites, with shales and quarts shists found on the mountain plateau. The majority of the plant species which are endemic to the Chimanimani Mountains are closely associated with the nutrient poor soil derived from quartzites (Van Wyk and Smith, 2001). Wild (1964) postulated that the endemic flora of this centre of endemism is a remnant of an earlier, more widely dispersed flora and that the Chimanimani Mountains has served as a refuge for plant species which were once more widely distributed. The disjunct distribution of *Cryptolepis apiculata* in the Chimanimani- and Eastern Arc Mountains supports the hypothesis of an earlier, more widely distributed flora, which later became fragmented.

The Chimanimani-Nyanga centre of endemism has no endemic *Cryptolepis* species, but all the species of this region belong to Clade B3 (Fig. 5.4). Three of these species, *C. cryptolepioides, C. oblongifolia* and *C. obtusa* are widely distributed towards the north and south of the Chimanimani Mountains, which suggests that this centre of diversity serves as a corridor, connecting the *Cryptolepis* species of the South African centre of *Cryptolepis* species diversity with the Eastern Arc Mountain centre of endemism.

The Chimanimani-Nyanga centre of endemism has close floristic affinity with the coatal forests of South Africa, and several taxa shared with the Maputaland-Pondoland centre of endemism (Müller, 1999). This floristic link between the two centres of endemism is consistent with the large percentage of *Cryptolepis* species which are shared between the two regions.

The South African centre of *Cryptolepis* species diversity extends over at least five different centres of endemism as listed above, representing significant variation in rainfall, topography and soil types (Van Wyk and Smith, 2001). Two *Cryptolepis* species are endemic to this region. The first endemic species, *C. capensis* (Clade B1, Fig. 5.4), grows in moist forest along the eastern coats of KwaZulu-Natal and extends further inland in Mpumalanga and Limpopo where it is found in ravine forest. *Cryptolepis delagoeinsis* is restricted to the savannah and sand forest of the Maputaland and Barberton centres of endemism. Three species are shared with the Chimanimani centre of endemism, while two of these species also extend to the Eastern Arc Mountain centre of endemism.

5.3.4 Fire tolerance in *Cryptolepis oblongifolia*

Fire-adapted and grazing-resistant vegetation covers extensive areas of the modern vegetation of Africa and would have expanded to higher latitudes during interglacial periods, while replacing lowland rainforest during glacial periods (Axelrod and Raven, 1978). Alternating glacial and interglacial periods would therefore not have caused disappearance of the habitat of *C. oblongifolia,* but would rather have promoted range shifts in this species which possibly account for its current wide distribution over sub-Saharan Africa.

The extensive range of *C. oblongifolia* results in its being exposed to a variety of soil types and other habitat conditions as well as pollinators. As a consequence a variety of vegetative and floral forms have developed and some degree of molecular divergence has occurred among populations (Fig. 3.4.). Since the fire prone grassland, savanna and shrubland to which *C. oblongifolia* is adapted occupies widespread and continuous areas, the different populations of the species, even though being exposed to different environmental conditions and pollinators, were never reproductively isolated and as a consequence did not undergo speciation. The result is a widespread species exhibiting morphological and molecular variation and remaining distinct from similar species which are not fire adapted.

5.4 Conclusion

Though floral morphology has proven to be of value in delimiting *Cryptolepis* within the Periplocoideae, the phylogenetic position of *C. stefaninii* once again brings the circumscription of the genus into question. From our molecular and morphological evidence we propose that *Parquetina* is a synonym of *Cryptolepis* and that the circumscription of the genus should be adapted as follows:

Corolla lobes dextrorsely contorted in bud, usually longer than the corolla tube, but rarely slightly shorter than corolla tube. Corolla with a distinct upper corolla tube, usually campanulate, rarely urceolate, salver-form or reflexed, shorter than 25 mm. Corona single or double. Primary corona lobes inserted between the base and upper third of the upper corolla tube, but never at the corolla tube mouth. Secondary corona may be present as pockets in corolla lobe sinuses. Stamens inserted between the base and middle of the corolla tube and may be separated from the primary corona lobes by coronal pads or the staminal filaments may be fused to the bases of the primary corona lobes. Anthers glabrous or villous. Translators elliptic, broadly-elliptic or deltoid with a smooth adaxial surface.

There is little correlation between the morphology of *Cryptolepis* species and their phylogenetic relationships. Several characters such as the erect, self-supporting growth form, semi-succulent leaves and epidermal micropapillae, apparently evolved repeatedly within the group. Most morphological affinities therefore do not reflect evolutionary history and relationships in *Cryptolepis.*

The hotspot distribution of *Cryptolepis* species is associated with both arid and forest refugia in areas which have been described as local centres of endemism for a number of taxa. The phylogeny indicates that most of these hotspots were colonized repeatedly by different *Cryptolepis* groups. Two dispersal events between Africa and southern Asia are also suggested by the data analysis. Such dispersal events were either the result of chance long distance dispersal or due to vicariance resulting from climate changes of glacial and interglacial periods during the late Cenozoic. In addition to the influence of climate shifts, edaphic conditions and the distribution and influence of fire also had a significant influence on species diversity and distribution in *Cryptolepis.*

In order to reconstruct an accurate evolutionary history of *Cryptolepis* it will be necessary to include more *Cryptolepis* species, especially from the Eastern Arc Mountain centre of diversity and to construct a dated phylogeny in order to correlate speciation and dispersal events with known geological and climatic events.

CHAPTER 6
GENERAL DISCUSSION AND CONCLUSION

6.1 Evaluation of diagnostic characters for species and genus level classification

A large number of characters are of diagnostic value in the Periplocoideae (Venter and Verhoeven, 2001) and, in particular, in *Cryptolepis*. Though the majority of characters discussed in Chapter 3, including growth form, leaf shape, venation and size, inflorescence and floral structure, are of diagnostic value at species level, *Cryptolepis* species can only be differentiated by using a combination of these characters.

Leaf and seed coat micromorphology is of some value in aiding species identification within *Cryptolepis*, though these characters are distinctive enough for accurate species level identification in only a small number of *Cryptolepis* species. Examples of such distinctive characters are the finger-shaped papillae on the abaxial leaf epidermis of *C. intricata* (Fig. 4.3.15.3. D–F) and the narrow, sunken stomata and epidermis covered by wax platelets of *C. socotrana* (Fig. 4.3.25.3. A–F). In the majority of *Cryptolepis* species, leaf and seed micromorphological characters are only sufficiently variable to place a specimen within a group of species with similar micromorphology, thus serving to narrow down the number of species to be considered for identification. For accurate species identification, micromorphological characters should preferably be used in combination with diagnostically useful macromorphological characters.

Leaf micromorphological characters were reported to have diagnostic value at genus level in *Ectadium,* in which stomata are located in prominent stomatal crypts and grooves on the abaxial leaf epidermis (Venter et al., 1990a). Ionta (2009) also used leaf vestiture to distinguish *Stomatostemma* from *Finlaysonia.* Howerver, the micromorphology of leaf and seed coat surfaces have not been studied widely enough in the Periplocoideae to identify diagnostically useful micromorphological characters for the majority of genera. No micromorophological characters of diagnostic value could be identified for delimitation of *Cryptolepis.*

Pollen characters are of diagnostic value at higher taxonomic levels. Pollen characters are particularly useful at subfamily level, such as delimitation of the Apocynaceae subfamilies following Brown's (1810) essential characters. Pollen characters also have diagnostic value in a small number of genera such as *Raphionacme*, which has 8–16 pores per pollen tetrad as opposed to the usual 4–6 in most other periplocoid genera (Verhoeven and Venter, 1988), *Petopentia* which is characterised by linear to T-shaped tetrads (Verhoeven et al., 1989), and *Decalepis, Epistemma, Finlaysonia, Gymnanthera, Hemidesmus, Schlechterella* and *Streptocaulon* which have pollen tetrads agglutinated into pollinia (Verhoeven and Venter, 2001). Pollen tetrad size and structure are not of diagnostic value at species level in *Cryptolepis,* nor are these characters useful in distinguishing this genus from the majority of other periplocoid genera.

Translator characters have limited diagnostic value at species and generic level classification. The translators of *Taccazea* are variable enough to be of diagnostic value at species level (Venter et al., 1990b), while translator characteristics are used to differentiate the grooved translator clade from other periplocoid clades in the classification presented by Ionta and Judd (2007). In *Cryptolepis,* translators show little variability in shape and size, *C. decidua* being the exception with its distinct translator shape. In addition, the translators of *Cryptolepis* are extremely small (± 300–600 µm long) and are not readily observed in the field. Consequently, translators are not favoured as a diagnostic character in *Cryptolepis* and are used only in combination with more readily observable diagnostic characters for species level identification. The small size and smooth adaxial surface of *Cryptolepis* translators may be used to distinguish the genus from genera of the grooved translator clade of Ionta and Judd (2007).

Due to the wide range of morphological variation within and among periplocoid genera Ionta (2009) was unable to identify a single set of diagnostic characters which could be used consistently to distinguish all genera in the subfamily. Ionta (2009) did, however, identify a small number of synapomorphies for each genus, and these can be used as diagnostic characters. The disadvantage of these synapomorpies is that several genera are distinguished by only one or two characters. Ionta (2009) characterized *Cryptolepis* as follows: "...corollas twisted tightly in bud, alternipetalous corona lobes that arise between the stamens and the sinuses, and the gynostegium enclosed in the upper corolla tube." All these characters are also found in other periplocoid genera and *Cryptolepis* is defined more by the absence of any diagnostic character than by any distinct character unique to the genus. The circumscription proposed for *Cryptolepis* in Chapter 5, corresponds closely to Ionta's (2009) set of syapomorphies for the genus. However, the circumscription presented in Chapter 5 relies strongly on floral characters and less on vegetative characters and consequently *Parquetina* is here included in the generic concept of *Cryptolepis.*

6.2 Phylogenetic relationships and homoplasy in *Cryptolepis*

The Periplocoideae is morphologically highly variable in both vegetative and reproductive characters (Venter and Verhoeven, 1997, 2001; Ionta, 2009). Morphological variation in closely related taxa in the Periplocoideae makes interpretation of phylogenetic relationships, based on morphological characters alone, difficult. Consequently, phylogenetic analyses of datasets consisting of morphological characters alone usually result in poorly resolved phylogenies for this subfamily (Venter and Verhoeven, 2001; Ionta, 2009). In addition, several characters show a high degree of homoplasy within the Periplocoideae. One of the best studied examples of this homoplasy is the polyphyletic origin of pollinia in Asian and African Periplocoideae (Venter and Verhoeven, 1997, 2001; Ionta, 2009).

Cryptolepis is no exception regarding this high degree of morphological variation and homoplasy as an erect, self-supporting growth form and semi-succulent leaves evolved multiple times as adaptation to aridity. These characters evolved once in the Namib Desert and several times in the Mandeb Circle, which was colonised repeatedly by *Cryptolepis* during successive glacial periods. This evolutionary trend towards a shrub-like growth form in arid conditions corresponds to the evolutionary trend described for *Secamonoideae* on Madagascar (Lahaye et al., 2005). Several *Secamone* species growing in arid habitats on Magadascar have an erect, shrub-like growth form but are nested in different clades which mainly consist of lianescent species. Layahe et al. (2005) proposed two reasons for this evolutionary trend towards a shrub-like growth form in arid environments, the first being the reduced biotic competition experienced by plants in open environments and the second, the scarcity of support plants for the lianoid growth form.

Rauvolfioideae, the basal subfamily of the Apocynaceae, consists mainly of shrubs and trees while the four more derived subfamilies, the Apocynoideae, Periplocoideae, Secamonoideae and Asclepiadoideae are primarily lianescent (Lahaye et al., 2005). Reversals from lianoid habit to a fully self-supporting growth form are prevented by developmental constraints such as low wood density in older stems and retention of a narrow stem diameter (Rowe and Speck, 2004). Lahaye et al. (2005) proposed that shrub-like species of *Secamone* are derived from lianescent species through two developmental changes in their growth form. Firstly, the shrub-like growth form may be established as a result of a prolonged juvenile stage of typical lianescent growth. In lianas dense wood is produced during this juvenile stage to provide rigidity to young, essentially self-supporting, searching stems, while older stems become more compliant. Secondly, growth of apical meristems is aborted early in the development of stems, preventing the formation of long twining stems. A prolonged juvenile stage coupled with progenesis (early cessation of growth) of apical meristems are the essential developmental changes which allow the formation of a shrub-like growth form from lianoid ancestors in *Secamone* (Lahaye et al., 2005).

It is likely that a similar change in development has resulted in the shrub-like growth form of most of the *Cryptolepis* species which have adapted to arid habitats. This is supported by the regular deviation from the normal shrub-like growth form of *C. oblongifolia*, where stems may become procumbent in open habitats and twining stems often develop where this species grows close to support plants. The reversal from an erect, shrub-like growth form in the majority of species in clade A2 (Fig. 5.4) to a lianescent growth form in *C. volubilis* further supports this hypothesis. However, no detailed observations of developmental pattern and structure in growth form of the majority of shrub- or tree-like *Cryptolepis* species have been made and it is still unclear if these species have developed a prolonged juvenile stage and progenesis similar to that found in *Secamone.* It is clear that, though growth form is an important diagnostic character in *Cryptolepis,* this character should be interpreted carefully and used with caution in phylogenetic analysis since it exhibits a high degree of homoplasy within the genus.

Reproductive features also show some homoplasy connected with adaptation to arid habitats. Though inflorescences range from many- to few-flowered in *Cryptolepis* species from arid and mesic habitats, species in which inflorescences have been reduced to solitary flowers are unique to arid habitats. This extreme reduction of the inflorescence is found in *C. decidua* from the Namib Desert (clade B2, Fig. 5.4.), *C. gillettii* and *C. orbicularis* from Somalia and *C. arbuscula* (clade A1, Fig. 5.4.) and *C. intricata* (clade A2, Fig. 5.4.) from Socotra. While there is considerable variation in primary corona lobe shape in *Cryptolepis,* filiform corona lobes are only found in species with solitary flowers. All species with solitary flowers have filiform primary corona lobes, except *C. orbicularis,* which has narrowly clavate primary corona lobes. It is clear from the phylogeny presented in Fig. 5.4. that solitary flowers with filiform primary corona lobes arose independently at least three times in *Cryptolepis.* This suggests that, in arid environments, there is strong selection for these features. Though this selection is most likely connected to the pollinating agent, the exact nature of the selection pressure is yet to be determined. It is also unclear if solitary flowers and filiform corona lobes are linked characters or whether similar selective pressures resulted in independent parallel evolution of these two characters.

Though leaf and seed coat micromorphology are both diagnostically useful in differentiating *Cryptolepis* species groups, these characters are generally too variable to be used in classification within the genus. Even though Barthlott (1981) suggested that epidermal characteristics are not strongly influenced by environmental factors and, as a result, are reliable characters for taxonomic investigation, results from the present study indicate that leaf epidermal features should be used with caution in classification of *Cryptolepis* and related genera. One of the most distinct leaf micromorphological features of *Cryptolepis* are globular micropapillae on the abaxial leaf epidermis. Globular micropapillae are found in *Cryptolepis* species growing in tropical rainforest to dry sand-forest such as *C. dubia* (clade A, Fig. 5.4.), *C. delagoensis, C. eburnea* (both from clade B2, Fig. 5.4.), *C. microphylla* and *C. villosa.* Globular micropapillae are also found in *Parquetina calophylla* and it is unknown if similar structures are found in other periplocoid genera. Comparison of leaf micromorphological descriptions with Fig. 5.4. show that these micropapillae originated in three independent clades within the *Cryptolepis-Parquetina* clade and are consequently homoplasious.

The high incidence of homoplasy in the *Cryptolepis-Parquetina* clade suggests that both vegetative and reproductive characters in this clade show a high degree of plasticity. Morphological plasticity may have had value in pre-adapting the clade to range shifts and resultant changes in environmental conditions and pollinators during alternating glacial and interglacial periods. Consequently, morphological plasticity may be the main reason for the large size and wide distribution of this genus in a subfamily of mainly small genera with restricted distribution. This trend is repeated at species level in *C. oblongifolia,* which shows a high degree of intraspecific plasticity in vegetative and reproductive features. Intraspecific plasticity together with a high tolerance for disturbance has resulted in *C. oblongifolia* becoming the most widely distributed of all *Cryptolepis* species.

Morphological plasticity, which may have been one of the key elements in evolution and speciation within *Cryptolepis,* is also the main factor hampering phylogenetic classification and elucidation of the evolutionary history of the genus.

6.3 Nomenclature

A total of 81 species and four subspecies names were published for *Cryptolepis* by earlier taxonomists. A large number of these species were placed in synonymy by Bullock (1955) and Venter and Verhoeven (1997, 2001)*.* In addition, a number of species were transferred to other genera, while several new combinations were published in the genus (Venter and Verhoeven, 1997). This brought the total number of accepted names for *Cryptolepis* to 29 at the commencement of this study. During the course of this study three new species were identified and described, namely, *C. ibayana, C. thulinii* and *C. villosa.* Only one species, *C. producta,* was synonymised with *C. oblongifolia,* resulting in a total of 31 *Cryptolepis* species.

If the proposal to synonymize *Parquetina* with *Cryptolepis* based on phylogenetic analysis of ITS is accepted, the number of *Cryptolepis* species will rise to 33. However, since the cpDNA phylogeny did not support the monophyly of the *Cryptolepis-Parquetina* clade, it would be desirable to compare results from other independent gene regions to support such a classification in which *Parquetina* is synonymized with *Cryptolepis.*

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SUMMARY

Cryptolepis R.Br. (Apocynaceae, Periplocoideae) was taxonomically revised. Detailed descriptions of macro and micro-morphology, palynology, geographic distribution and ecological characteristics were presented. An identification key to the species was compiled and the nomenclature of all species was revised while all available type material was studied and lectotypes and neotypes were designated where necessary. Molecular phylogenetic analyses, based on the gene regions ITS, *trnD–T* and *trnT–F,* of representative species of 28 periplocoid genera and 22 *Cryptolepis* species were presented and the monophyly of *Cryptolepis* was evaluated.

Historically a total of 81 species names and four subspecies names were published for *Cryptolepis*. However, a large number of species names were later placed in synonymy or transferred to other genera, while several new combinations were published. This resulted in a total of 29 accepted *Cryptolepis* species at the commencement of this study. Three new species, *C. ibayana, C. thulinii* and *C. villosa,* resulted from this study and the latter two were described in this thesis. One species, *C. producta,* was synonymised with *C. oblongifolia. Cryptolepis,* therefore, comprises a total of 31 species at present.

In terms of species diversity, distribution and potential pharmaceutical and economic value, *Cryptolepis* is one of the most significant genera in the Periplocoideae. *Cryptolepis* grows throughout sub-Saharan Africa, the southern parts of Yemen, the island archipelago of Socotra, and southern Asia ranging from India to southern China, Taiwan, the Philippines and Indonesia. Most of the species grow in tropical forests or savannah, but 13 species are also adapted to arid environments.

The majority of *Cryptolepis* species are concentrated in four centres of diversity along the east coast of Africa and on Socotra. These hotspots are associated with both arid and forest refugia in areas which have been regarded as local centres of endemism for a number of other plant taxa. The phylogenetic analysis of *Cryptolepis* indicates that most of these hotspots were colonized repeatedly by different *Cryptolepis* groups. In addition to the influence of climate shifts, edaphic conditions and also fire had a significant influence on species diversity and distribution in *Cryptolepis.*

Macro and micro-morphological investigations indicated that numerous characters, including growth form, leaf shape and size, leaf epidermal characters, venation, inflorescence structure, floral structure and seed coat surface characters, are of diagnostic value at species level in *Cryptolepis.* However, the species can only be accurately identified by using a combination of these characters.

The molecular phylogenetic analyses revealed that *Cryptolepis* is paraphyletic and, in order to establish a monophyletic genus, it was proposed that the circumscription of the genus be broadened to include *Parquetina* as a synonym of *Cryptolepis.*

Several vegetative and reproductive characters showed a high degree of homoplasy, suggesting a high degree of morphological plasticity. This plasticity was also found at species level in *C. oblongifolia,* which showed significant variation in vegetative and reproductive features. This, together with a high tolerance for disturbance, has resulted in *C. oblongifolia* becoming the most widely distributed of all *Cryptolepis* species.

Keywords: Apocynaceae; Biogeography; *Cryptolepis;* Micromorphology; Nomenclature; Palynology; Periplocoideae; Phylogeny; Systematics; Taxonomy.

OPSOMMING

Cryptolepis R.Br. (Apocynaceae, Periplocoideae) is taksonomies hersien. Volledige beskrywings van die makro- en mikromorfologie, palinologie, geografiese verspreiding en ekologiese eienskappe is aangebied. 'n Uitkenningsleutel tot die spesies is opgestel, die nomenklatuur van al die spesies is hersien, terwyl alle beskikbare tipemateriaal bestudeer is en lekto- en neotipes is, waar nodig, aangewys. Molekulêre filogenetiese ontledings, gebaseer op die geenstreke ITS, *trnD–T* en *trnT–F,* van verteenwoordigende spesies van 28 periplokoide genusse en 22 *Cryptolepis* spesies is in die ondersoek ingesluit, en die monofilie van *Cryptolepis* is beoordeel.

Histories is 'n totaal van 81 spesies en vier subspesies name vir *Cryptolepis* gepubliseer. 'n Groot aantal van hierdie spesiesname is egter later in sinonomie geplaas of na ander genusse oorgeplaas, terwyl 'n aantal nuwe kombinasies gepubliseer is. Met die aanvang van die huidige studie was daar dus 'n totaal van 29 erkende spesies in *Cryptolepis.* 'n Verdere drie nuwe spesies, *C. ibayana, C. thulinii* en *C. villosa,* is die resultaat van hierdie studie, waarvan die laasgenoemde twee in hierdie proefskrif beskryf is. Een spesie, *C. producta,* is in sinonomie met *C. oblongifolia* geplaas. Gevolglik sluit *Cryptolepis* tans 'n totaal van 31 spesies in.

In terme van spesieverskeidenheid, verspreiding en potensiële farmaseutiese en ekonomiese belangrikheid is *Cryptolepis* een van die belangrikste genusse in die Periplocoideae. *Cryptolepis* kom dwarsdeur Afrika suid van die Sahara voor, maar ook in die suidelike deel van Jemen, in die Socotra eilandargipel en in suidelike Asië vanaf Indië tot suidelike Sjina, Taiwan, die Filippyne en Indonesië. Die spesies groei hoofsaaklik in tropiese woude of in savanna, maar 13 spesies word in droë omgewings aangetref.

Die meeste *Cryptolepis* spesies is in vier diversiteitsentrums langs die ooskus van Afrika en op Socotra gekonsentreer. Hierdie brandpunte word met beide droë- en woudtoevlugnisse geassosieer in gebiede wat beskou word as plaaslike sentrums van endemisme vir 'n aantal ander planttaksons. Die filogenetiese ontleding van *Cryptolepis* het getoon dat hierdie brandpunte ook herhaaldelik deur verskillende *Cryptolepis* spesiegroepe gekoloniseer is. Benewens die invloed van

klimaatsverskuiwings, het edafiese toestande en ook vuur spesiesdiversiteit en verspreiding in *Cryptolepis* duidelik beïnvloed.

Makro- en mikromorfologiese ondersoeke het aangetoon dat 'n verskeidenheid eienskappe insluitende groeivorm, blaarvorm, blaar epidermale eienskappe, tipe bearing, bou van bloeiwyses, blomstruktuur en eienskappe van die saadhuid diagnostiese waarde op spesievlak in *Cryptolepis* besit. Die spesies kan egter slegs noukeurig geïdentifiseer word deur 'n kombinering van eienskappe te gebruik.

Die molekulêre filogenetiese ontledings het aangetoon dat *Cryptolepis* parafileties is en ten einde 'n monofiletiese genus daar te stel, is voorgestel dat die omskrywing van *Cryptolepis* uitgebrei word deur insluiting van *Parquetina* as 'n sinoniem.

Sekere vegetatiewe en voortplantingskenmerke het 'n hoë mate van homoplasie getoon, en het op 'n hoë mate van morfologiese plastisiteit gedui. Dit is veral op spesievlak in *Cryptolepis oblongifolia* waargeneem. Hierdie plastisiteit, gekoppel met die hoë mate van verdraagsaamheid teenoor versteuring, het tot gevolg gehad dat *Cryptolepis oblongifolia* die wydste verspreiding in die genus het.

Sleutelwoorde: Apocynaceae; Biogeografie; *Cryptolepis*; Filogenie; Mikromorfologie; Nomenklatuur; Palinologie; Periplocoideae; Sistematiek; Taksonomie.

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APPENDIX 1

HERBARIUM SPECIMENS OF *CRYPTOLEPIS* SPECIES EXAMINED

Cryptolepis africana

Kenya:

— **3º54' S, 39º37' E:** Kilifi District, Kaya Ribe Forest, 02-09-1999, *Luke, W.R.Q., Mbinda, J. 5978* (K).

— **4º27'41" S, 39º23'50" E:** Kwale District, Buda Mafisini Forest, 8 miles [12.8 km] WSW of Gazi, 16-08-1953, *Drummond, R.B. , Hemsley, J.H. 3836* (K sheet 1, holo.; sheet 2, iso.).

Cryptolepis apiculata

Kenya:

— **3º18' S, 39º44' E:** Kilifi District, Mangea Hill (Sita), 24-03-1989, *Luke, W.R.Q. & Robertson 1784* (EA, K).

— **3º18'59" S, 39º58' E:** Mida, 1928, *Graham, R.M. 1526* (K, MO).

— **3º19'43" S, 39º52'35" E:** Arabuko Sokoke Forest, along the coast, 19-05-1984, *Simpson, B.L. 369* (EA).

— **4º30' S, 39º12' E:** Marengi Forest, 15-07-1987, *Luke, W.R.Q. & Robertson 589* (EA).

Mozambique:

— **18º55' S, 34º26' E:** Sofala District, Gorongosa [National Park], 15-04-1966, *Macedo, A. 179* (WAG).

Tanzania:

— **0º23' S, 38º57' E:** Tanga District, Pangani-Kange limestone, 15-06-1965, *Faulkner, H.G. 3559* (SRGH).

— **5º00'44" S, 39º03'48" E:** Tanga District, Amboni-Hügel, 1983, *Holst, C. 2564* (M, lecto., COI, K, isolecto.).

— **5º03'50" S, 39º04'12" E:** Tanga District, 1953, *Drummond, R.B.& Hemsley, J.H. 3517* (K).

— **5º05'43" S, 39º00'33" E:** Tanga District, between Pongwe and Maweni, 12-04-1965, *Faulkner, H.G. 4097* (K).

— **5º07' S, 39º02' E:** Tanga District, Kange Estate, 23-01-1952, *Faulkner, H.G. 940* (K).

— **5º56' S, 37º44' E:** Tanga District, Kange Forest, 17-09-1955, *Faulkner, H.G. 1742* (BM); Tanga District, Kange Forest, 19-09-1955, *Faulkner, H.G. 1743* (K).

— **6º09' S, 38º36' E:** Kisarawe District, Coastal Region, Kazimzumbwi Forest, on the Pugu Hills, S of Kisarawe, 02-1991, *Frontier-Tanzania, Coastal Forest Research Programme 1864* (MO).

— **6º59' S, 39º17' E:** 10 miles [16 km] S of Dar es Salaam, 20-04-1968, *Harris, B.J. 1624* (EA).

— **8º00' S, 36º44'03" E:** Ifakara District, Nyanganje [Nanganji] Forest Reserve, 04-1960, *Haerdi, F. 487/0* (K).

— **8º21' S, 38º56' E:** Coast Region, Rufiji District, northern edge of Matumbi Highlands, 19-02-1990, *Frontier-Tanzania , Coastal Forest Research Programme 889A* (K).

— **8º40' S, 38º25' E:** Selous Game Reserve, Malemba, 10-06-1971, *Lundanga, R.I. 1329* (EA).

Zimbabwe:

— **18º56' S, 32º39' E:** Mutare [Umtali] District, waterfall south of Drumfad, 02-11-1952, *Chase, N.C. 4696* (BM).

— **18º58' S, 32º42' E:** Mutare [Umtali] District, commonage, 21-06-1947, *Chase, N.C. 565* (SRGH); Mutare [Umtali] District, SW of Cross Hill, Commonage, 18-08-1953, *Chase, N.C. 5056* (BM); Mutare [Umtali] District, commonage, 18-08-1953, *Chase, N.C. 44095* (K); Mutare [Umtali] District, commonage near Cross Hill., 21-01-1954, *Chase, N.C. 5185* (BM, LISC); Mutare [Umtali] District, commonage, 21-01-1954, *Chase, N.C. 46027* (MO); Mutare [Umtali] District, commonage, 01-02-1957, *Chase, N.C. 6311* (COI, LISC, SRGH); Mutare [Umtali] District, South of municipal gravel quarry, commonage, 13-02-1958, *Chase, N.C. 6817* (LISC).

— **19º06'25" S, 32º49'51" E:** Mutare [Umtali] District, Burma Valley, Vumba [Botanical Reserve], on Steyns Farm, 04-12-1961, *Wild, H.& Chase, N.C. 5555* (K, MO, SRGH).

— **20º00' S, 33º01' E:** Melsetter [Chimanimani] District, Haroni/Makudupini Forest, 04-12-1964, *Wild, H. , Goldsmith, B.& Muller, J. 6631* (MO, SRGH).

— **20º29'24" S, 32º33'35" E:** Chipinge District, Tanganda River Valley, right bank [of Tanganda River], 100 yards [31 m] E of bridge over river, entrance to "New Year's Gift" Tea Estate and riverine fringe on left bank of Tanganda River Road to "New year's Gift" Tea Estate, 17-05-1962, *Chase, N.C. 7730* (K, SRGH).

Cryptolepis arbuscula

Socotra:

— **12º34' N, 54º07' E:** Eastern Hagghier Mountains, below Jebel Jaaf, 06-02-1992, *Miller, A.G. & Nyberg M. 11349* (E).

— **12º34'38" N, 54º05'50" E:** Hagghier Mountains, S of Adho Dimello Pass (Adho-di-Melhoh Pass), 12-02-1990, *Miller, A.G., Bazara'a, M., Guarino, L. & Kassim, N. M.10463A* (E).

— **12º34'42" N, 54º02'53" E:** Haggier Mountains, N of Adho Dimello Pass, *Damar, E. Soq., Alexander, D., Talib, N.M.A., Sulaiman, A.S., Affrar, A.I.A. & Boggs, R. M.18016* (E).

— **12º35' N, 54º17' E:** Hammaderoh Mountain, 07-04-1967, *Smith, A.R. & Lavranos, J. 308* (K, holo.).

— **12º36' N, 53º57' E:** Jebel Rughid Plateau, 30-01-1992, *Miller, A.G. & Nyberg M.11209* (E).

— **12º36'50" N, 54º00'50" E:** Muqadrihon Pass, 10 km SW of Hadiboh, towards Reiged Plateau, 20-01-1990, *Miller, A.G., Bazara'a, M., Guarino, L. & Kassim, N. M.10101B* (E).

— **Coordinates unknown:** Segal, 20-03-1953, *Popov, G. GP/So/283* (BM); Adla, 22-03-1953, *Popov, G. GP/So/270* (BM).

Cryptolepis capensis

South Africa:

— **23º40' S, 30º06' E:** Mpumalanga, Letaba District, Duiwelskloof, Enkeldoorn, *Scheepers 1187* (G, K, M, PRE, PRU, Z).

— **24º08'52" S, 30º12'36" E:** Mpumalanga, Lekgalametse Nature Reserve, past Malta-Marinella drainage line, 15-01-1981, *Stalmans 960* (K).

— **24º34'16" S, 30º47'12" E:** Mpumalanga, Blyde Poort Holiday Resort, Kadishi Trail, 30-11-1978, *Buitendag, G. 1200* (K, MO, NBG, PRE); Blyde River Canyon, at Forever Resort, along Lourie Trail, by large waterfall, 28-11-2008, *Joubert, L. 43* (BLFU).

— **24º34'20" S, 30º47'10" E:** Mpumalanga, Blyde River Canyon, Forever Resort, along Louri Trail, on steep cliff along river, 28-11-2008, *Joubert, L. 44* (BLFU).

— **25º14'11" S, 30º53'16" E:** Mpumalanga, Lydenburg District, Witklip Forestry Station, 19-02-1973, *Kluge, J.P. 334* (PRE).

— **25º36' S, 30º58' E:** Mpumalanga, Barberton, 08-01-1911, *Janse, A.J.T. 9872* (PRE); Moodies, *Thorncroft 607* (NH); 04-1909, *Thorncroft, J. 9595* (GRA, PRE).

— 26º52' S, 32º22' E: KwaZulu-Natal, Bella Vista District, Pongola River flood-plain, Mavilo Hill, 04-11-1969, *Moll 4279* (K, NH).

— 27º08' S, 32º02' E: KwaZulu-Natal, Ingwavuma Pass, 27-11-1960, *Wells 2204* (G, GRA, K, M, PRE, Z).

— 27º52' S, 31º24' E: KwaZulu-Natal, Vryheid District, Ngome Forest, 13-01-1969, *Hilliard & Burtt 5941* (NH); Ngomi Forest, 50 m E of stream crossing below waterfall, 07-01-1983, *Venter, H.J.T. 8783* (BLFU); Ngomi Forest, 14-11-1983, *Venter, H.J.T. 8999* (BLFU).

— 27º54' S, 32º06' E: KwaZulu-Natal, near Hluhluwe Forest, Makowe Hill, 24-11-1960, *Wells 2149* (PRE).

— 27º55' S, 30º50' E: KwaZulu-Natal, Vryheid District, Nhlagatshe Mountain, 18-12-1965, *Hilliard, D.* & *Burtt 3356* (NU).

— 28º05' S, 32º02' E: KwaZulu-Natal, Hluhluwe Game Reserve, 26-11-1955, *Ward, J.C. 2820* (NH, PRE); 12-11-1959, *Ward, J.C. 3287* (K, M, NH, NU, PRE, SRGH).

— 28º08'14" S, 31º52'30" E: KwaZulu-Natal, Zululand Region, Hlabisa District, Wome, 25-01-1936, *Gerstner 2845* (NH).

— 28º52' S, 31º29' E: KwaZulu-Natal, Eshowe District, 09-10-1946, *Acocks, J.P.H. 12969* (PRE); Eshowe Forest, 01-1927, *Kotze, P.C. 6708* (PRE); Eshowe, forest opposite city hall, 07-01-1949, *Lawn, J.G. 111* (NH).

— 29º19' S, 31º24' E: KwaZulu-Natal, Nonoti River, *Gerrard 1319* (BM,K).

— 29º22'30" S, 30º07'30" E: KwaZulu-Natal, about 15 km from Karkloof, or dirt road between Greytown and Pietermaritzburg, 27-01-2005, *Styles 2337* (NH).

— 29º34'50" S, 30º18'30" E: KwaZulu-Natal, Pietermaritzburg District, Winterskloof, NW of railway station overlooking "World's View", *Smith, C.A. s.n.* (PRE).

— 29º42' S, 30º56' E: KwaZulu-Natal, Inanda, 1870, *McKen 6* (K); 01-1880, *Wood, J.M. 701* (K); 02-01-1881, *Wood, J.M. 886* (SAM); 02-01-1882, *Wood, J.M. 1583* (BOL, lecto.; BM, K, MO, NH, isolecto.).

— 29º42'20" S, 31º02'20" E: KwaZulu-Natal, Mount Edgecombe, 12-1909, *Wood, J.M. 11589* (GRA, J, NH, NU, PRE, Z); *Wood, J.M. 11590* (NH, NU).

— 29º44' S, 30º36' E: KwaZulu-Natal, Camperdown, Drummond, old road, 15-01-1967, *Strey 7310* (BR, K, M, NH, NU, PRE).

— 29º44' S, 31º05' E: KwaZulu-Natal, Durban District, forest above Umhlanga Rocks Hotel, 28-12-1954, *Watmough, R. 445* (K, M, NH, PRE, W).

— 29º46'30" S, 30º55'30" E: KwaZulu-Natal, Pinetown District, Everton, Molwani Kloof in Kranzkloof Nature Reserve, 02-01-1975, *Hilliard , Burtt 7575* (K, NU).

— **29º47' S, 30º57' E:** KwaZulu-Natal, Pietermaritzburg District, Krantzkloof Nature Reserve, 12-1921, *Haygaith, W.J. 91* (STE).

— **29º49' S, 31º02' E:** KwaZulu-Natal, Durban District, 22-11-1921, *Fries, R.E Fries. & Th.C.E. 3368* (UPS); Durban, 04-1869, *McKen 21* (K, PRE).

— **30º12' S, 30º35' E:** KwaZulu-Natal, Pinburg District, Ismont Farm, 26-01-1969, *Strey 8352* (K, NH, NU, PRE, SRGH, WAG).

— **30º14' S, 29º44' E:** Eastern Cape, Alexandra District, Dumisa Railroad Siding, Umpampanyoni, 01-01-1914, *Rudatis, H. 2058* (STE).

— **30º41'60" S, 30º10'69" E:** KwaZulu-Natal, Port Shepstone, Oribi Gorge, Hell's Gate, 18-01-1979, *Balkwill & Crow 232* (J).

— **31º02'27" S, 30º10'03" E:** KwaZulu-Natal, Port Edward, Mtamvuna Nature Reserve, along Fish Eagle hiking trail, starting from Clearwater Trail Centre, about 100 m down trail, 12-01-2009, *Joubert, L. 62* (BLFU).

— **31º02'40" S, 30º10' E:** KwaZulu-Natal, Port Edward, Mtamvuna Nature Reserve, at beginning of fish Eagle hiking trail, starting from Clearwater Trail Centre, about 200 m down ravine, 12-01-2009, *Joubert, L. 60* (BLFU); Mtamvuna Nature Reserve, along Fish Eagle hiking trail, starting from Clearwater Trail Centre, beyond first waterfall, 12-01-2009, *Joubert, L. 61* (BLFU).

— **31º02'50" S, 30º10'15" E:** KwaZulu-Natal, Port Edward, along Izingolweni road, at Clearwater Trails, Fish Eagle trail, about 200 m down the ravine, 22-11-2006, *Joubert, L. 31* (BLFU).

— **31º04' S, 30º11'12" E:** KwaZulu-Natal, Port Edward, Umtamvuna River Lodge, 18-01-1996, *Abbott, A.T.D. 6891* (NH); Umtamvuna Nature Reserve, river trail in forest, *Abbott 1564* (NH, PRU).

— **31º04' S, 30º12' E:** KwaZulu-Natal, Umtamvuna Nature Reserve, SE of Rooielsbos, *Abbott 1687* (NH, PRU); Umtamvuna Nature Reserve, Verrassend Kloof, *Abbott 1497* (NH, PRU).

— **31º37'44" S, 29º32'09" E:** Eastern Cape, Port. St. Johns, 24-02-1985, *Hutchings* & *Plumstead 1559* (NU).

— **32º14'28" S, 28º54'40" E:** Eastern Cape, Elliotdale District, The Haven Hotel, 21-01-1967, *Gordon-Gray, J.L. 1311* (NU).

— **32º21' S, 28º19' E:** Eastern Cape, Kentami, 12-1901, *Pegler 663* (BOL).

Cryptolepis cryptolepioides

Mozambique:

— **14º57' S, 38º19' E:** Niassa District, Ribaue, Mepalué, 25-01-1964, *Torre, A.R. & Paiva, J. 10.248* (BR).

South Africa:

— **22º54' S, 29º56' E:** Louis Trichardt District, Wyllie's Pass, 08-04-1988, *Venter, H.J.T. 9203* (BLFU).

— **22º57' S, 29º56' E:** Limpopo, Soutpansberg, Wyllie's Pass, W side of ravine, 29-01-1962, *Ihlenfeldt, H.D. 2194a* (PRE).

— **23º15' S, 29º30' E:** Limpopo, Matoks, 24-08-1930, *Hutchinson , Gillett 4476* (K).

— **23º45' S, 29º45' E:** Houtbosh, 1880, *Rehmann, A. 5880* (BM, K, Z).

— **23º47' S, 29º04' E:** 51 km N of Potgietersrus, at granite domes, 08-04-1988, *Venter, H.J.T. 9197* (BLFU).

— **23º52' S, 29º28' E:** Pietersburg District, Blaauwberg, ravine leading to beacon, 12-01-1955, *Codd* & *Dyer 9084* (K, PRE); Blaauwberg, Mohlakeng Plateau, 13-01-1955, *Codd & Dyer 9139* (K, PRE); plateau on Baauwberg, 25-04-1961, *Van der Schyff, H.P. 5350* (PRE, PRU).

— **23º54' S, 29º42' E:** Pietersburg, University of the North Campus, 14-03-1962, *Van Vuuren, D.R.J. 1415* (PRE).

— **23º55' S, 29º28' E:** Pietermaritzburg, 17-10-1930, *Fries , Norlindh & Weimarck 2021* (MO, PRE).

— **24º07' S, 30º22' E:** Mpumalanga, Letaba, Cyprus Farm, near Ofcalaco, 20-01-1965, *Rennie & Scheepers 3* (PRE).

— **24º15' S, 27º30' E:** Thabazimbi District, Kransberg, 08-05-1977, *Venter, F. 1941* (K, MO, PRE, SRGH).

— **24º25' S, 27º37' E:** Limpopo, Waterberg District, Kransberg, 08-05-1977, *Germishuizen, G. 253* (BR, K, MO, PRE).

— **24º34'12'' S, 30º47'55'' E:** Mpumalanga, Blyde River Canyon, Three Rondawels viewpoint, 29-11-2008, *Joubert, L. 45* (BLFU).

— **24º34'16'' S, 30º47'56'' E:** Mpumalanga, Blyde River Canyon, Three Rondawels viewpoint, 29-11-2008, *Joubert, L. 46* (BLFU).

— **24º34'18'' S, 30º47'57'' E:** Mpumalanga, Blyde River Canyon, Three Rondawels viewpoint, 29-11-2008, *Joubert, L. 47* (BLFU).

— **24º34'27'' S, 30º47'12'' E:** Mpumalanga, Blyde River Canyon, at Forever Resort, along Guinifowl Hiking Trail above river, 28-11-2008, *Joubert, L. 40* (BLFU).

— **24º34'29'' S, 30º47'58'' E:** Mpumalanga, Blyde River Canyon, Three Rondawels view point, 15-11-2006, *Joubert, L. 27* (BLFU).

— **24º40'30'' S, 30º48'45'' E:** Mpumalanga, Blyde River Canyon, Bourke's Luck, river bank at potholes, 28-02-1984, *Herman 719* (K, WAG); Bourke's Luck potholes, on rocks opposite Treur River waterfall, 16-11-2006, *Joubert, L. 28* (BLFU); Bourkes Luck, on hill E of potholes, at beginning of hiking trail, 01-12-2008, *Joubert, L. 55* (BLFU).

— **24º52' S, 28º22' E:** Limpopo, Waterberg District, near Warmbaths, 01-1906, *Bolus 12154* (K, BOL).

— **24º52' S, 29º52' E:** Mpumalanga, Lydenburg District, Magnet Heights Farm, 08-01-1939, *Barnard* & *Mogg 869* (K, PRE).

— **25º00' S, 27º00' E:** Limpopo, Magaliesberg, 07-1923, *Mogg, A.O.D. 10312* (SAM).

— **25º26' S, 29º20' E:** Loskopdam, Zaagkuil, 18-07-1967, *Theron, G.K. 1490* (PRE, PRU).

— **25º27' S, 31º58' E:** Mpumalanga, Komatipoort, 11-1910, *Rogers, F.A. 12633* (SRGH).

— **25º30' S, 28º10' E:** Gaueng, Pretoria, hills around Pretoria, 03-1932, *Murray, D.P. 688* (PRE).

— **25º38' S, 28º11' E:** Gauteng, Pretoria, Wonderboompoort, 1880, *Rehmann, A 4506* (Z); Wonderboompoort, 08-01-1905, *Leendertz, L.C.C. 519* (BOL, K, PRE); Wonderboompoort, 01-09-1905, *Rogers, F.A. 2502* (K, PRE); Wonderboom Nature Reserve, by mountain, 01-09-1905, *Galpin, E.E. 6978* (PRE); Wonderboom Nature Reserve, 12-1924, *Thode A 432* (NH, PRE); Wonderboom, on mountain behind Wonderboom, 05-07-1925, *Smith, C.A. 289* (J, PRE); Wonderboom Nature Reserve, 12-1925, *Smith, C.A. 1691* (PRE); Wonderboompoort, 04-12-1926, *Bremekamp 883* (PRU); Wonderboom Nature Reserve, 05-03-1935, *Dyer, R.A. 3134* (PRE); Little Wonderboom Nature Reserve, 13-02-1938, *Van Son, G. 38168* (PRE); Wonderboom Nature Reserve, 06-1940, *Lanham, F.N. 37654* (SRGH); Wonderboom Nature Reserve, 07-01-1944, *Repton, J.E. 1513* (PRE); Wonderboom, 17-11-1944, *Wasserfall* & *Van Niekerk s.n.* (NBG, PRE); Wonderboom Nature Reserve, 12-04-1946, *Codd 1148* (K); Wonderboom Nature Reserve, 06-03-1953, *Marais, W. 259* (PRE, SRGH); Wonderboom Nature Reserve, 20-02-1960, *Strey, R.G. 3168* (PRE); Wonderboom Nature Reserve, 19-1963, *Meebold, A. 12556* (M);

— **25º38' S, 28º15' E:** Gauteng, Pretoria, Baviaan's Pass, along righthand river bank, 25-09-1925, *Smith, C.A. 641* (PRE).

— **25º38' S, 29º26' E:** Botsabelo, Botsabelo, *Schlechter, R. 1236* (SRGH); 29-03-1893, *Schlechter, R. 4082* (K, lecto.; BM, BOL, G, GRA, NH, PRE, SAM, SRGH, isolecto.).

— **25º40'51" S, 27º10'46" E:** Rustenburgkloof, 19-06-1987, *Venter, H.J.T. 9183* (BLFU).

— **25º41'11" S, 27º11'46" E:** Rustenburgkloof Resort, 01-1985, *Venter, H.J.T. 9075* (BLFU).

— **25º41'20" S, 28º11'38" E:** Gauteng, Pretoria, Wonderboom Reserve, 19-06-1987, *Venter, H.J.T. 9181* (BLFU).

— **25º42' S, 27º45' E:** Limpopo, Brits District, Magaliesberg, Jackson's Garden, 04-1930, *Obermeyer, A.A. 4110* (PRE); 01-02-1946, *Acocks, J.P.H. 12355* (PRE); in Jackson's Garden, W of Hartebeespoort Dam, 01-02-1946, *Story, R. 728* (BR, PRE); Jackson's Garden, 5 m W of Hartebeespoort Dam, 01-02-1946, *Story, R. 741* (PRE).

— **25º44'12" S, 28º16'29" E:** Gauteng, Pretoria, near Herbarium in Pretoria National Botanical Garden, 01-2007, *Joubert, L. 33* (BLFU).

— **25º45' S, 27º12' E:** Rustenburg District, Magaliesberg, 12-07-1943, *Moss 21331* (J); Rustenburg Nature Reserve, 29-03-1970, *Jacobsen, N.H. 902* (PRE); Rustenburg District, 13-02-1986, *Acocks, J.P.H. 18738* (PRE).

— **25º45' S, 29º29' E:** Mpumalanga, Witbank District, Middelburg, Doornkop, *Du Plessis, C.J. 1333* (PRU).

— **25º46' S, 30º50' E:** Mpumalanga, Barberton District, Shagen, on the E side of mountain, 08-02-1931, *Leendertz, L.C.C. 2350* (PRE).

— **25º52' S, 27º15' E:** Limpopo, Magaliesberg, near Olifantshoek Dam, 27-09-1964, *Venter, F. 39463* (J).

— **26º26' S, 32º16' E:** KwaZulu-Natal, Ndumo Game Reserve, 14-11-1983, *Venter, H.J.T. 8983* (BLFU).

— **26º38' S, 28º11' E:** Gauteng, Pretoria, 03-02-1922, *Wilson, E.H. 132* (PRE).

Zimbabwe:

— 17º36' S, 31º09' E: Harare District, Domboshawa, 07-03-1946, *Wild 917* (K, M); Domboshawa Rock near Harare, 11-06-1962, *Loveridge, J.P. 475* (K, SRGH); 03-03-1966, *Dale, M. SKF 289* (LISC, MO).

— 17º50' S, 31º05' E: Harare District, 02-02-1966, *Dale, M.O. SKF 233* (SRGH).

— 17º55' S, 31º05' E: Harare District, 14 miles on Widdicombe road, 20 Dales Estate, 02-02-1966, *Simon, B.K. 670* (K, LISC, SRGH).

— 18º21' S, 32º17' E: Makoni District, Diana's Vow Farm, 12-06-1957, *Chase, N.C. 6517* (K).

— 18º25' S, 32º10' E: Makoni Distric, 14-02-1960, *Chase, N.C. 7261* (SRGH).

— 18º32' S, 32º07' E: Makoni District, 8 km NW of Rusape, 22-01-1949, *Chase, N,C. 1219* (K).

— 18º36' S, 32º41' E: Inyanga District, Honzo Mountain, on Kukwanisa Training Farm, 05-01-1968, *Chase 8480* (K, LISC, MO, SRGH).

— 19º04' S, 32º36' E: Umtali [Mutare] District, Dora Farm, 17-12-1950, *Chase, N.C. 3439* (SRGH).

— 19º14' S, 30º37' E: Chilimanzi, Shesha Hill, 02-05-1951, *Greenhow, K.W. 50/51* (MO, SRGH).

— 19º25' S, 29º50' E: Gwelo District, White Waters Dam, 05-02-1967, *Biegel, H.M. 1898* (K, LISC, MO, SRGH).

— 20º11' S, 31º01' E: Victoria, Lake Kyle, 02-1979, *Burrows, H.H. 1338* (SRGH).

— 20º16' S, 30º54' E: Victoria District, between Zimbabwe Ruins and Morgenster Mission, about 8 km from Ruins, 18-12-1970, *Muller, T. , Pope, G. 1721* (K, SRGH).

— 20º24' S, 28º25' E: Matobo District, Lucydale, 05-1945, *West 2162* (K, SRGH).

— 20º30' S, 28º25' E: Bulawayo District, Gulubahwe Cave, 64 km S of Bulawayo on old Gwanda road, 30-11-1969, *Camell, I. 92* (K, SRGH).

— 20º35' S, 28º40' E: Matobo District, Besna Kobila Farm, about 24 km E of Matopos Research Station, 30-01-1973, *Grosvenor, R.K. 795* (K, SRGH); *Miller 1818* (MO).

— 20º35' S, 28º40' E: Molopo Hills, 05-1915, *Rogers 7912* (J, K).

— 20º35' S, 28º40' E: Matapo Hills, 03-1929, *Eyles 6305* (K); 27-06-1936, *Barker, W.F. 401* (NBG); 02-1944, *Martineau, R.A.S. 200* (SRGH); Quaringa Farm, 07-1955, *Miller, O.B. 2950* (K, SRGH); 02-1983, *Miller, O.B. 1598* (SRGH).

Cryptolepis decidua

Angola:

— 14º15' S, 12º15' E: 108.5 km along Mssamedes Railway, 29-04-1909, *Pearson 2845* (BM, BOL, K).

— 14º47' S, 12º48' E: Mossamedes, 100 km from Cape Ferro, Chipia, 20-05-1937, *Gossweiler 10954* (COI, K).

— 14º59' S, 12º10' E: Mossamedes, Caraculo, 19-06-1967, *Menezes , Brites 2904* (SRGH); 08-03-1968, *Menees, A 3096* (SRGH); 19-01-1972, *Menezes, A. 4079* (LISC, SRGH).

— 15º32' S, 12º35' E: 22 km E of Pico de Azevedo [Pedras Salvadoras], 15-04-1973, *Bamps, Martins & Matos 4505* (K, LISC, WAG).

— 15º39' S, 12º58' E: Mossamedes, Estrada Porto Alexandre-Virei, 28-02-1960, *Teixeira 12837* (LISC); Mossamedes, Virei, 64 km on road from Espinheira to Mossamedes, 12-05-1973, *Menezes, Barros & Sousa 4942* (LISC, SRGH).

— 16º15' S, 12º00' E: Mossamedes, Porto Alexandre, 56 km para Espinheira, 24-02-1970, *Mendonça 184* (LISC, SRGH).

— 16º30' S, 13º30' E: Cunene, Mossamedes, Curoca, Tchichihua, 02-07-1950, *Teixeira 355* (BM, WIND); 24-03-1973, *Menezes, Barroso & Sousa 4882* (LISC, SRGH).

— 16º50' S, 12º20' E: Mossamedes, Iôna, 02-05-1969, *Teixeira 13064* (LISC); Pico-Rio, Dos Flamingos, 16-04-1969, *Teixiera 12961* (LISC); Morro, 09-12-1957, *Teixeira, J. 2893* (SRGH).

— Coordinates unknown: *Curror s.n.* (K, holo.).

Botswana:

— 25º07' S, 25º22' E: Kanye District, Pharing, 11-1947, *Miller, O.B. B 527* (K).

Namibia:

— 16º58' S, 13º12' E: Kao (Epupa Falls), 05-05-1962, *Kotze 97* (M, PRE, WIND); W of falls, 11-01-1973, *Owen-Smith, G. 197* (WIND).

— 17º15' S, 12º40' E: Baynes Mountains at Quelle Okonbambi, 16-06-1965, *Giess 8986* (K, M, PRE, WIND).

— 17º22' S, 13º07' E: Kaokoveld, Swartbooisdrif District, 15 km W of Otjiyanyesemo, 10-04-1973, *Giess, W.* & *Van der Walt 12686* (M, PRE, WIND).

— 17º27' S, 13º56' E: Swartbooisdrif, at memorial on hill slope, 22-03-1974, *Merxmüller, H.* & *Giess, W. 30480* (M, WIND).

— 17º27' S, 14º10' E: Kunene, Great Falls, 03-1923, *Barnard, K.H. 556* (SAM).

— 17º28' S, 13º03' E: Otjihipa Mountains, *Vahrmeijer, J.* & *Du Preez, P. 2573* (PRE).

— 17º52' S, 13º15' E: Kaokoveld, Otjiwero, 05-04-1957, *De Winter, B.* & *Leistner 5389* (K, M, PRE, WIND).

— 17º57' S, 14º06' E: 15 km W of Ruacana Falls along the Kunene., 19-02-1959, *De Winter, B.* & *Giess, W. 7105* (K, M, PRE, SRGH, W, WIND).

— 18º10' S, 12º33' E: Kaokoveld, Orupembe, 08-06-1951, *Hall, H. 379* (BOL, NBG); Kaokoveld, Orupembe, at Anabib, 12-08-1956, *Story 5740* (BM, K, M, PRE).

— 18º16' S, 12º40' E: Sanitatas, Okonjombo, *Smith, G.D.* & *Malan, J. 310* (WIND).

— 18º45' S, 12º04' E: Khumib River, on mountains along river, *Müller, M.* & *Loutit, B. 2303* (WIND).

— 18º47' S, 12º54' E: Sanitatas District, 10 km W of Purros, *Viljoen, P.J. 282* (WIND).

— 18º52' S, 14º07' E: Sargdeckelburg, Okongwe, 14-12-1961, *Seydel, R. 3036* (K, MO).

— 19º08' S, 13º36' E: Kowarib, 22 km from hotsprings, opposite Oiri Bridge, 28-12-1978, *Lukaschile, M. 15* (M, WIND).

— 19º24' S, 13º58' E: Sesfontein, Khowarib, 01-1980, *Rusch, W. s.n.* (WIND).

— 19º32' S, 13º10' E: Hoamib, 20 km S of Hoanib River, 40 km from sea, 06-04-1979, *Cooper, T.G. 20* (WIND).

— 20º05' S, 14º14' E: Twyfelfontein, 22-04-1972, *Schmidt 210* (M,WIND).

— 20º19' S, 14º58' E: Welwitschia, Korixas, 22-01-1907, *Galpin* & *Pearson 7495* (K, SAM, PRE); 05-03-1909, *Pearson, H.H.W. 4414* (BOL, K); Khorixas, Welwitschia Rest Camp, 11-03-1975, *Carr, J.D. 43* (PRE).

— 20º22' S, 14º37' E: Khorixas, Bloemhof Farm, 25-03-1977, *Müller, M.* & *Giess, W. 388* (M, PRE, WIND).

— 20º26' S, 14º55' E: 17 km from Kamanjab, Khorixas at Torra Bay junction, 31-10-1984, *Venter, H.J.T. 9037* (BLFU).

— 20º29' S, 13º37' E: Unjab Mouth, 15 km S of Sringbokwater, *Müller, M.* & *Loutit, B. 1147* (WIND).

— 20º36' S, 14º14' E: Welwitschia District, Twyfelfontein, 18-02-1978, *Craven, P. 651* (WIND); Outjo, Twyfelfontein Farm, 10-05-1959, *Van Vuuren, D. 590* (PRE, SRGH, WIND).

— **20º38' S, 14º52' E:** Khorixas District, S of Dorros, near Goantagab River, 08-04-1977, *Craven, P.* & *Craven, D. 4394* (WIND).

— **20º58' S, 14º10' E:** Omaruru, Otjihorongo Reserve, at Ugab, SW of Anigab, 15-02-1958, *Merxmüller, H.* & *Giess, W. 1623* (M, PRE, WIND).

— **20º59' S, 14º10' E:** Outjo, Henrysvelde Fram, near Brandberg, 11-04-1955, *De Winter 3140* (K, M, NBG, PRE, W).

— **21º08' S, 14º37' E:** Omaruru District, Around Brandberg, at the White Lady., *Giess, W. 9179* (M, WIND).

— **21º14' S, 14º28' E:** Uis District, Numas Valley, Brandberg, 28-02-1976, *Craven, P.* & *Craven, D. 21* (WIND).

— **21º15' S, 14º30' E:** Brandberg, 03-05-1963, *Nordenstam 2457* (M).

— **21º52' S, 15º52' E:** Karibib, Dernburgbruch, 27-04-1959, *Seydel, R. 1950* (M).

— **21º55' S, 15º04' E:** Road between Usakos and Ameib, on Goabeb Farm (63), 10 km N of Usakos, 14-04-1968, *Wanntorp, H.* & *Wanttorp, H.E. 868* (K).

— **21º55' S, 15º46' E:** Along road between Karibib and Usakos, on Kranzberg Farm (59), 10 km before Usakos, 14-04-1968, *Wanttorp, H.* & *Wanttorp, H.E. 865* (K, WIND).

— **21º56' S, 15º15' E:** Usakos District, Groot Spitskoppe, 21-03-1980, *Van Koenen, E. 596* (WIND).

— **21º56' S, 15º23' E:** Karibib, 12-11-1922, *Dinter 4211* (Z, G, BM); 15-02-1953, *Kinges, H. 3226* (PRE); Usakos, Ameib Farm, 17-02-1969, *Jensen, M.K. 93* (PRE, WIND); Karibib, Nordenburg, 29-09-1975, *Griffin, E. 190* (WIND).

— **22º02' S, 15º52' E:** Margin of Namib, Karibib, Nudis, 19-03-1955, *Seydel 444* (BR).

— **22º07' S, 16º07' E:** Karibib, Otjosondu, 09-04-1965, *Seydel, R. 4330* (G, K, M, MO, SRGH, WAG, WIND).

— **22º22' S, 15º37' E:** Karibib, Nudis, 12-02-1953, *Walter, H. , Walter, E. 1194* (WIND).

— **22º37' S, 15º37' E:** Karibib District, Nudis Farm, 06-07-1954, *Seydel, R. 316* (K, M, MO, Z).

— **23º07' S, 15º07' E:** Namib Desert Park, Auachanbirab Beacon Hill, 08-01-1976, *Ward, J.D. 173* (NU, WIND).

— **23º07' S, 17º37' E:** Gravenstein, 22-02-1956, *Volk, O.H. 11565* (WIND).

— **23º20' S, 16º15' E:** Djab, Gamsberg Pass, 04-02-1970, *Jensen, M.K. 468* (PRE).

— **23º22' S, 17º07' E:** Rehoboth, Koos Farm, 16-07-1953, *Schwudsfeger 4299* (WIND).

— **23º22' S, 17º37' E:** Rehoboth District, Gravenstein, 06-05-1963, *Leippert, H. 4628* (WIND).

— **23º52' S, 16º07' E:** Abbabis, N of Geitsigubib, 10-12-1915, *Pearson, H.H.W. 9257* (K).

— **23º52' S, 19º52' E:** 12 km W of Sandverhaar, 10-02-1913, *Pearson, H.H.W. 4630* (K).

— **24º10' S, 16º24' E:** Buellsport, Rehoboth, *Strey s.n.* (M, NBG, PRE).

— **24º16' S, 18º28' E:** 75 km S of Keetmanshoop, 28-10-1984, *Verhoeven, R.L. 165* (BLFU).

— **24º27' S, 16º54' E:** Nomtsas, 23-12-1915, *Pearson, H.H.W. 9312* (BOL).

— **24º32' S, 18º02' E:** 10 km E of Mariental, along Stampriet Road, on Narris Farm, 01-11-1984, *Venter, H.J.T. 9061* (BLFU).

— **24º33' S, 17º58' E:** Mariental, *Watt, D.J. 242* (WIND).

— **24º33' S, 17º47' E:** Mariental District, Hardap Dam Reserve, 14-03-1988, *Goldblatt* & *Manning, J. 8782* (G).

— **24º35' S, 17º58' E:** N of Mariental, on road to Kalkrand, 10-05-1955, *De Winter 3488* (K, PRE).

— **24º37' S, 17º37' E:** Gibeon, Friedabrun, 1939, *Steyn, D.G. 1913* (PRE, WIND); 27-04-1956, *Volk, O.H. s.n.* (WIND); 04-04-1956, *Volk, O.H. 12176* (M).

— **24º45' S, 16º22' E:** Maltahöhe, Tsaris Mountains, 05-1956, *Basson, P.A. 209* (PRE).

— **24º45' S, 17º33' E:** 50 km from Mariental, on Maltahöhe road, 10-03-1965, *Hardy, D.S. 1951* (K, PRE, WIND).

— **24º49' S, 16º59' E:** Maltahöhe, 01-04-1971, *Coppejans 557* (BR).

— **24º50' S, 16º31' E:** Namaqualand, 50 km E of Maltahöhe, 14-02-1950, *MacDonald, E.C. 361* (BM).

— **24º50' S, 17º30' E:** Between Satansplatz and Voigtsgrund, 19-12-1915, *Pearson, H.H.W. 9360* (BOL, K).

— **24º52' S, 17º07' E:** Mariental, Karichab Farm, *Van Koenen, E. 68* (WIND).

— **24º58' S, 16º23' E:** Maltahöhe, Tzaris Farm, 16-05-1978, *Müller, M.* & *Tilson 896* (M, PRE, WIND).

— **25º07' S, 17º07' E:** Gibeon District, Sandrücken Farm, *Van Koenen, E. 60* (WIND).

— **25º55' S, 16º21' E:** Helmeringhausen, above Ais, 16-12-1974, *Müller, M. 41* (PRE, PRU, WIND).

— **26º00' S, 17º16' E:** Berseba, (Gross Namakwaland), 02-1885, *Schenk 353* (Z).

— 26º05' S, 18º06' E: Keetmanshoop, 05-1949, *Liebenberg, L.C.C. 5202* (PRE).

— 26º06' S, 16º52' E: Bethanien, Chamis-Süd, 25-03-1953, *Walter, H. , Walter, E. 2179* (WIND).

— 26º10' S, 16º16' E: Aus, *Logan 327* (GRA, WIND).

— 26º39' S, 18º06' E: 11 km from Keetmanshoop, on road to Seeheim, 06-05-1976, *Oliver, Muller & Steenkamp 6315* (K).

— 26º40' S, 15º10' E: Lüderitz, 02-1886, *Brem 111* (Z).

— 26º54' S, 18º36' E: Narubis, 29-10-1984, *Venter, H.J.T.V. 9009* (BLFU).

— 26º56' S, 17º55' E: Seeheim, 09-02-1909, *Pearson, H.H.W. 3729* (BOL, K, PRE).

— 26º57' S, 18º53' E: Keetmanshoop, Sandmodder, 08-04-1975, *Müller, M. 161* (WIND).

— 27º03' S, 19º16' E: Warmfontein, *Lensing, J.E. A 161/75* (WIND).

— 27º07' S, 17º37' E: Inachab, (Groot Namaqualand), 08-1897, *Dinter 1046* (Z).

— 27º07' S, 18º52' E: foothills of the Great Karas Mountains, 17-11-1938, *Lynes, H. 1918* (BM).

— 27º14' S, 18º24' E: Grünau, 95 km from Grünau, along road to Keetmanshoop, 28-01-1974, *Clarke, B. 661* (PRE).

— 27º16' S, 18º28' E: 75 km S of Keetmanshoop, 88 km N of Grünau, 29-10-1984, *Venter, H.J.T. 9007* (BLFU).

— 27º22' S, 18º07' E: Klein Karasberg, Holoog, 19-01-1916, *Pearson, H.H.W. 9764* (BOL, K, MO, SAM).

— 27º22' S, 18º52' E: Great Karasberg, Naruda South, 04-01-1913, *Pearson, H.H.W. 8325* (BM, BOL, K, SAM).

— 27º22' S, 19º22' E: Karasburg, Nudis, 01-1974, *Auret, W.P. 5576* (PRE).

— 27º26' S, 17º43' E: 19 miles from Ai-Ais, 01-04-1973, *Henrici, R. 73* (PRE).

— 27º35'30" S, 17º37'30" E: Fish River Canyon, viewpoint, 20-04-2000, *Venter, H.J.T.V 9351* (BLFU).

— 27º36' S, 17º09' E: Chamaites, Uitsig Farm, 27-09-1976, *Wendt, W.* & *Giess, W. 14739* (WIND).

— 28º19' S, 17º37' E: Vioolsdrif, 15-08-1967, *Van der Schijff, H.P. 8194* (PRE).

— 28º22' S, 17º22' E: Between Sjambok River and Onsekjer, 09-1931, *Pillans, N.S. 6475* (BOL).

— 28º25' S, 18º37' E: Little Bushmanland, near Dabenoris, 12-01-1909, *Pearson, H.H.W. 3018* (K, BOL).

— 28º30' S, 18º45' E: S of Warmbad, 26-01-1909, *Pearson, H.H.W. 4024* (BM, BOL, K, SAM, Z).

— 28º43'11'' S, 18º30'38'' E: Warmbad, Sandfontein Farm, 20-03-1986, *Beukes, G.J. 022* (BLFU).

— 28º45' S, 19º18' E: Warmbad District, about 1 km NW of Orange River, along road between Onseepkans and Karasburg, 01-02-1974, *Davidse, G.* & *Loxton, A. 6199* (M, MO, PRE, WAG); Along road between Onseepkans and Karasburg, about 1 km NW of Orange River, 01-02-1974, *Davidse, G.* & *Loxton, A. 6200* (PRE, WAG).

— 28º49' S, 18º34' E: Homs River, 20-06-1986, *Beukes, G.J. 024* (BLFU).

— 28º52' S, 17º27' E: Mabas, 18-04-1987, *Williamson 3678* (MO).

— 28º52' S, 18º37' E: Little Bushmanland, near Dabenoris, 11-01-1909, *Pearson, H.H.W. 3007* (BOL, K, SAM).

South Africa:

— 26º44'49'' S, 20º12'19'' E: Northern Cape, on E shore of Hakskeen Pan, 08-06-2007, *Joubert, L. 32* (BLFU).

— 28º22' S, 20º07' E: Upington, Noap Hills, 06-1925, *Barnard, K.H. 36083* (SAM).

— 28º37' S, 20º25' E: Northern Cape, Augrabies National Park, S along the Rooipad road, 07-05-1969, *Werger, M.J.A. 336* (PRE, SRGH).

— 28º37' S, 20º37' E: Northern Cape, Kakamas District, Rooipad, part 1, 07-05-1969, *Leistner, O.A. 3332* (PRE, SRGH, WIND).

— 28º44' S, 20º50' E: Northern Cape, Kenhardt, 30 km E of Kakamas, 29-03-1948, *Acocks, J.P.H. 14288* (PRE).

— 28º48' S, 20º37' E: Nothern Cape, N bank of Orange River, Kakamas, *Esterhuyzen, E. 23574* (K, BOL, PRE).

— 28º50' S, 20º20' E: Northern Cape, Kenhardt, 15 miles WSW of Alheit, 28-03-1948, *Acocks, J.P.H. 14268* (PRE).

— 28º55' S, 18º13' E: Northern Bushmanland, near Goodhouse, S of Orange River, 09-09-1985, *Beukes, G.J. 002* (BLFU).

— 29º01' S, 18º12' E: Nothern Cape, 16 km S of Goodhouse, 30-05-1961, *Schlieben 9090* (K).

— 29º02' S, 19º09' E: Northern Cape, Groot Pellaberg, 10-08-1982, *Van Jaarsveld, E.* & *Patterson, J. 6715* (NBG).

Cryptolepis delagoensis

Mozambique:

- **— 26º28'75" S, 32º27'12" E:** Maputo District, southern end of Licuati Forest Reserve, about 30 km SW of Bela Vista, 17-12-2001, *Goyder, D.J. 5034* (K).

South Africa:

- **— 25º47'10" S, 31º03'11" E:** Mpumalanga, Barberton, 12-1912, *Thorncroft 825* (NH, NU).
- **— 25º57' S, 31º06' E:** Mpumalanga, near Swaziland border, near Havelock, Ida Doyer Reserve, on Schoonoord Farm (380JU), 1960, *Fourie, E. 1641* (PRE).
- **— 26º43' S, 30º42' E:** Mpumalanga, 9 km S of Amsterdam, 12-12-2002, *Bruyns, P.V. 9365* (BOL).
- **— 27º00'40" S, 32º04' E:** KwaZulu-Natal, Tembe Elephant Park, 03-02-1987, *Ward 1928* (NH, PRE).
- **— 27º25'10" S, 32º25'19" E:** KwaZulu-Natal, Tembe Game Reserve, along Ngobozana Trail, *Venter, H.J.T. 9335* (PRE, neo.; BLFU, isoneo.).
- **— 27º31'10" S, 31º03'15" E:** KwaZulu-Natal, Vryheid District, along road to Bhivane [Paris] Dam, 11-12-2002, *Bruyns, P.V. 9357* (BOL).
- **— 27º36' S, 31º16' E:** KwaZulu-Natal, Itala Game Reserve, slope above square davel, 10-12-1987, *MacDevette 2220* (NH, PRE-photocopy).
- **— 27º37'30" S, 31º07'30" E:** KwaZulu-Natal, Vryheid Coronation, Paris Dam site, along Manzana River, *Singh, Y. 372* (NH).
- **— 28º01' S, 32º29' E:** KwaZulu-Natal, False Bay, Bird Sanctuary near Mr. Redmans house, 27-07-1944, *Gerstner 4731* (NH).

Cryptolepis dubia

Bhutan:

- **— 27º15' N, 91º07' E:** Mongar District, near Lingmethang, Shongar Chu Valley, 02-07-1979, *Grierson, A.J.C. & Long, D.G. 2433* (K).
- **— 27º19'49" N, 91º33'12" E:** Tashigang Dzong [Fortress], 18-06-1979, *Grierson, A.J.C. & Long, D.G. 2060* (K).

Sri Lanka (Ceylon):

- **— 6º57'32" N, 81º10'43" E:** Badulla District, near bridge 101/15 between Lunugala and Passara, 06-10-1968, *Huber, H. 19* (K).

— **7º17'03" N, 80º38'13" E:** Kandy District, E of Madugoa, 19-07-1974, *Jayasuriya, A.H.M., Moldenke, H.N., Moldenke, A.L. & Sumithraarachichi, D.B. 1419* (K).

— **7º32'03" N, 80º52'57" E:** Central Province, Matale District, 4 miles [6.4 km] E of Pallegama, 10-10-1974, *Davidse, G. 7307* (K).

China:

Coordinates unknown : *Morse, H.B. 228* (K).

India:

— **11º46' N, 78º23' E:** Tamil Nadu, Attur Taluk, Periakalrayan Nadu, Pattivalava forest, 15-05-1977, *Arockiasamy, D.I. 8174* (K).

— **13º01'42" N, 75º53'40" E:** Mysore, Hassan District, Kesagodu, Alur-Belur road, 15-05-1969, *Saldanha, C.J. 13503* (K); Mysore, Hassan District, near Balupet, 21-11-1969, *Saldanha, C.J. 15667* (K).

— **24º49'42" N, 74º31'30" E:** Rajastan, Chittor Garh, Central Circle, Allahabad, 13-12-1963, *Verma, D.M. 1688* (G).

— **26º44'42" N, 83º28'11" E:** Upper Gangetic Plain, Uttar Pradesh, 02-05-1898, *Harsukh 22140* (K); Upper Gangetic Plain, Uttar Pradesh, 18-05-1898, *Harsukh 22163* (K).

— **Coordinates unknown:** *Franciscus Buchanan [Francis Buchanan-Hamilton] s.n.* (BM, holo.).

Myanmar (Burma):

— **22º39'02" N, 93º36'56" E:** Haka, 04-1937, *Dicksason, F.G. 7593* (L).

Nepal:

— **23º42' N, 82º12' E:** [Mid-Western Region], Jajarkot, 18-06-1974, *Dobremez, J.F. & Naiandhan, N.P. 2611* (G).

— **26º55'45" N, 87º19'02" E:** Burungdi Khola, Dhankuta District, 04-09-1967, *Williams, L.H.J.* & *Stainton 8358* (BM, K).

— **27º52'12" N, 83º32'42" E:** Western Region, near Tansing [Tansen], 09-10-1954, *Stainton, Sykes, W.R. & Williams, L.H.L. 8860* (UPS).

— **27º55'37" N, 83º40'44" E:** Eastern Region, Baglung District, [Kali Gandaki River], 20-04-1954, *Stainton, Sykes, W.R., Williams, L.H.L. 75* (UPS).

— **28º15'48" N, 83º58'20" E:** [Western Region], Pokhara, 15-04-1954, *Stainton, Sykes, W.R. & Williams, L.H.L. 2486* (BM).

— **28º16'67" N, 81º90' E:** [Bardiya District], Sarda Khola, 28-03-1952, *Polunin, O., Sykes, W.R. & Williams, L.H.J. 3719* (UPS).

— **28º18'31" N, 83º57'02" E:** Western Region, Annapurna, 20-05-1954, *Stainton, Sykes, W.R. & Williams, L.H.L. 5351* (UPS).

Thailand (Siam):

— **14º01'90" N, 99º31'47" E:** [Kanchanaburi Region], Kanburi, 30-12-1925, *Kerr, A.F.G. 10108* (BM).

— **14º23' N, 101º21' E:** Maung District, Kow Kieo [Mount Khiaw], between Manug and Chon Buri, 16-02-1976, *Maxwell, J.F. 76-114* (L).

— **16º56'36" N, 104º43'33" E:** Nakhon Phanom Province, That Phanom, 11-03-1952, *Kerr, A.F.G. 21401* (BM).

— **18º46'35" N, 99º14'53" E:** Chiang Mae Province, Mae On, 28-01-1921, *Kerr, A.F.G. 4693* (BM, L).

— **18º48'11" N, 98º54'35" E:** Chiang Mae Province, Maung District, Doi Sutep-Phi National Park, S of Mae Heeyah Nai Village, 19-12-1989, *Maxwell, J.F. 89-1559* (L).

Vietnam:

Coordinates unknown: Tonkin, Fu Phap [Region of France], *D'alleizette 4685* (L).

Location unknown: *C.V. 2548* (BM).

Cryptolepis eburnea

Ghana:

— **5º06'18" N, 1º14'49" W:** Cape Coast, 07-07-1959, *Hall, J.B. 1511* (K).

— **7º01' N, 1º24' W:** Mampong Scarp, *Vigne, C. 1739* (EA).

Guinea:

— **7º41'40" N, 8º26'20" W:** Nzérékoré, Nimba Mountains, along restored road from Ziela to Nion, 14-08-2008, *Jongkind, C.C.H. 8341* (WAG).

Guinea Bissau:

— **11º55' N, 15º48' W:** [Biombo Province], Bijinita [Pinhossenol], 25-09-1945, *Da Graca, J.V.* & *Santo, E. 2181* (LISC).

Ivory Coast:

— **5º11' N, 4º32' W:** [Lagunes Province], about 10 km W of Jacqueville, 03-08-1970, *Leeuwenberg, A.J.M. 8083* (WAG x3).

— **5º17'43'' N, 3º53'36'' W:** [Lagunes Province], between Grand Bassam and Port Bouêt, in Abouabou Forest, 07-12-1956, *De Wilde, J.J.F.E. 996* (WAG x3); [Lagunes Province], between Abidjan and Grand Bassam, in Abouabou Forest, 04-02-1959, *Leeuwenberg, A.J.M. 2654* (WAG x2); [Lagunes Province], between Abidjan and Grand Bassam, in Abouabou Forest, 23-05-1962, *Leeuwenberg, A.J.M. 4235* (K, WAG, isoneo.).

— **6º59'20'' N, 6º10'90'' W:** Western part of Marahoue National Park, just E from the western border, 18-05-1999, *Jongkind, C.C.H. & Diomaude, H. 4613* (WAG).

— **Coordenates unknown:** 11-10-1960, *Ake Assi, L. 6990* (P).

Liberia:

— **7º45' N, 9º26' W:** [Lofa Province], Zorzor District, Gbarnga road, W of St. Paul's river, 27-07-1966, *Bos, J.J. 2152* (WAG x2).

Sierra Leone:

— **8º13' N, 10º29' W:** [Eastern Province], Mamaba District, 02-11-1914, *Thomas, N.W. 4544* (K); [Eastern Province], Mamaba District, 1915, *Thomas, N.W. 4377* (K).

— **8º32'27'' N, 11º54'43'' W:** [Northern Province], Mayosso Wildlife Sanctuary, 06-08-1914, *Thomas, N.W. 1373* (K).

— **8º45'48'' N, 12º47'38'' W:** [Port Loko Province], Port Loko, 15-12-1914, *Thomas, N.W. 6585* (K).

— **8º45'50'' N, 11º01'29'' W:** [Eastern Province], Kono District, Sukudu, 08-1923, *Dawe, M.Y. 543* (K).

Cryptolepis gillettii

Somalia:

— **10º20' N, 45º05' E:** Woqooyi Galbeed Region, Dubar [Buuraha Dubar Mountain], 02-01-1933, *Gillett, J.B. 4773* (K, holo.).

Cryptolepis gossweileri

Angola:

— **14º28' S, 16º18' E:** [Huila District], Vila da Ponte [Kuvango], 01-1906, *Gossweiler, J. 3428* (BM, holo.; LISC, iso.).

— **16º33' S, 17º50' E:** Between Fort Princeza Amelia and Cubango [River], 13-12-1905, *Gossweiler. J. 2390* (BM, K, LISC).

Cryptolepis grandiflora

India:

— **08º54'45" N, 77º16'22" E:** Tamil Nadu [State], Tirunelveli District, Courtallum [Courtallam], 1885, *Beddome, R.H. 8* (BM).

— **11º13'54" N, 76º32'28" E:** Tamil Nadu [State], Coimbatore District, Nilgiri Hills, *Thomson, G. s.n.* (K).

— **11º15'40" N, 78º34'05" E:** Tamil Nadu [State], Tiruchi [Tiruchirappalli] District, between Thuraiyur and Sobanapuram, near Forest Rest House, 27-11-1978, *Matthew, K.M. , Manickam, V.S. & Manoharn, C. 19337* (K); Tamil Nadu [State], Tiruchirappalli District, Pacchaimalai foothills near Sobanapuram, 2 km away from Forest Rest House, 27-11-1978, *Matthew, K.M. , Manickam, V.S. & Manoharan, C. 19368* (L).

— **12º40'26" N, 79º58'30" E:** Tamil Nadu [State], Kancheepuram District, Chingleput [Chengalputta], 16-03-1901, *Bourne, A.G. 2530* (K).

— **13º33' N, 79º58' E:** Tamil Andhra Pradesh [State], Chittoor District, Nagari Hillls, 04-1837, *Wight, R. 2234* (E, holo.).

— **13º56'42" N, 79º21'10" E:** Tamil Andhra Pradesh [State], Raylaseema Region, Kodur, 02-1883, *Gamble, J.S. 11191* (K).

— **14º20'37" N, 78º53'55" E:** Tamil Andrha Pradesh [State], Raylaseema Region, Cuddapa [Kadapa] Hills, 1885, *Beddome, R.H. 7* (BM); Tamil Andhra Pradesh [State], Raylaseema Region, Balli Valley, 10-1886, *Gamble, J.S. 18168* (K).

— **Coordinates unknown:** 1967, *Hooker s.n.* (K); *Thomson, G. 898.166-348* (L); *Wallich 4457* (K-W, holo. of *C. wightiana* Wall.); Madras, *Herb Rottlerianum anno 02-03-1804* (K

Cryptolepis hypoglauca

Cameroon:

— 9º55'51'' N, 13º46'17'' E: Bossum, 06-1914, *Michael 9689* (K).

Central African Republic:

— 6º19' N, 16º22' E: Bozoum District, 01-06-1935, *Tisserant, R.P.C. 3334* (BM).

Kenya:

— 3º08'58'' S, 40º07'36'' E: Malindi District, Sabaki River, 05-1960, *Rawlins, S. 892* (EA, K).

— 3º18' S, 40º01' E: Kilifi District, Gedi Forest, 27-07-1971, *Faden, R.B., Evans, A. & Rathbun, G. 71/677* (K).

— 3º58' S, 39º45' E: Coast Province, Shanzu, 10 miles [16 km] N of Mombasa, 21-07-1970, *Bally 13911* (G).

— 4º10' S, 39º37' E: Ras Kikadini, 16-08-1982, *Robertson, S.A. 3357* (EA, K).

— 4º26' S, 39º13' E: Kwale District, Dzombo Hill, 09-02-1989, *Robertson, S.A., Luke, Q. & Khayota, B. MDE 281* (EA).

— 4º38'31'' S, 39º22'49'' E: Kwale District, Shimoni, 20-08-1953, *Drummond, R.B.* & *Hemsley, J.H. 3917* (K, LISC).

Tanzania:

— 5º02' S, 39º05' E: Tanga District, Sawa, 19-04-1965, *Faulkner, H.G. 3657* (WAG); 23-08-1965, *Faulkner, H.G. 3630* (SRGH); 14-11-1965, *Faulkner, H.G. 3702* (K); 09-07-1976, *Faulkner, H.G. 4914* (K).

— 5º09'17'' S, 38º27'37'' E: Korogwe, Mission offices, 02-11-1972, *Archbold, M.E. 1541* (EA).

— 6º10' S, 39º25' E: Zanzibar, Chwaka, 17-05-1960, *Faulkner, H.G. 2561* (K).

— 6º40' S, 39º13' E: Kunduchi, near ruins, 11-05-1017, *Harris, B.J. 1711* (WAG).

— 7º50' S, 36º52' E: Udzungwa Mountain NP, Mwaya-Mwanihana Route, 05-11-1997, *Luke, W.R.Q. & Luke, P.A. 4883* (K).

— 10º30' S, 39º02' E: Masasi District, Ndanda Mission, 18-03-1991, *Bidgood, S., Abdallah, R. & Vollesen, K. 2086* (EA).

— Coordinates unknown: Amboni, *Holst, C. 2728* (K, lecto.)

Cryptolepis ibayana

Kenya:

— 2º21' S, 37º55' E: Mbinzao Hill [Mbuinzau], 29-01-1942, *Bally, B. 1749* (K).

Tanzania:

— 4º10' S, 38º10' E: Mkomazi Game Reserve, Ibaya Stream, 22-01-1996, *Abdallah, R.D.* & *Mboya, E.I. 3979* (K, holo.; EA, iso.).

Cryptolepis intricata

Socotra:

— 12º27' N, 54º04' E: Rhizehum, 29-10-1993, *Miller, A.G. M.12621* (E).

— 12º29'35'' N, 53º59'30'' E: Dixsam plateau, 24-09-1998, *Miller, A.G.*, *Hyam, Al Khulaidi, Salaiman & Talib M.16022* (E).

— 12º32'58'' N, 54º02'59'' E: Adho Dimellus, 22-08-1956, *Guyune, M.D. 120* (BM).

— 12º35' N, 54º03' E: Hagghier Mountains, 08-1880, *Balfour, B. 508* (E, lecto.; BM, isolecto.); Hagghier Mountains, below Adho Dhemalu, 22-04-1967, *Smith, A.R.* & *Lavranos, J. 492* (K).

— 12º35' N, 54º17' E: Hamaderoh Plateau, 08-04-1967, *Smith, A.R.* & *Lavranos, J. 332* (K).

— 12º35'31'' N, 54º18'57'' E: Homhil, 25-02-1953, *Popov, G. GP/So/160* (BM).

— Coordinates unknown: 01-05-1881, *Schweinfurth, G. 651* (E, syn.).

Cryptolepis macrophylla

Socotra:

— 12º10' N, 52º15'28'' E: Abd-al-Kuri, Jebel Hassala, Quarat Saleh, [Jebel Saleh], 07-05-1967, *Smith, A.R.* & *Lavranos, J. 675* (K).

— 12º10'17'' N, 52º14'29'' E: Abd-al-Kuri [Abd-al-Kuri], foothills of Jebel Saleh, 18-02-1999, *Miller, A.G. , Alexander, Sulaiman, Talib, Hyam M. 17098* (E).

— 12º10'20'' N, 52º15'41'' E: Abd-al-Kuri, Jebel Saleh, 05-12-1898, *Forbes, H.O. & Ogilvie-Grant, W.R. 74* (E); Abd-al-Kuri, Jebel Saleh, 26-10-1966, *Vurzo, K.J. A 27* (K).

— 12º11' N, 52º15' E: Abd-al-Kuri [Abd-al-Kuri], norhtern slope of Jebel Saleh, 09-02-1992, *Miller, A.G. & Nyberg M. 11410* (E).

— 12º32'31'' N, 53º36'43'' E: Wadi Eyek, 05-02-2000, *Miller, A.G. & Talib M. 19103* (E).

— 12º33'30'' N, 54º00'46'' E: Eastern Hagghier mountains, S of Jebel Shihali, Wadi Dajuj, 23-04-1967, *Smith, A.R. & Lavranos, J. 515* (K, holo.; PRE, iso.).

— 12º35'58'' N, 53º59'48'' E: Wadi Ayheft, 01-03-1999, *Miller, A.G., Alexander, Sulaiman, Talib & Hyam M.17150* (E).

— 12º36' N, 54º15' E: Hamadero Plateau, Above Homhil, 01-02-1992, *Miller, A.G. & Nyberg M.11242* (E).

Cryptolepis microphylla

Angola:

— 9º02' S, 15º03' E: Golungo Alto, Queta Mountains, 1856, *Welwitsch 5939* (BM, K, LISU); *Welwitsch 5940* (BM, lecto. G, K, LISU(x2) iso.).

— 14º55' S, 14º39' E: Huila District, Gambos, Proximo de Chibemba., *Menezes, A. 3590* (PRE); Huila District, Humpata, Das Neves., *Teixeira, B. 342* (BM); 13-06-1950, *Teixeira, B. 342* (BM).

— Coordinates unknown: Kikuya, Mfidi Mabele, 22-10-1979, *Nsiowndele 592* (BR).

Central African Republic:

— 4º23' N, 18º37' E: Baangui, 08-12-1967, *Breyne 1327* (BR).

Democratic Republic of the Congo:

— 4º11' S, 15º42' E: Menkao District, Malukuzane, 20-02-1979, *Breyne 3637* (BR).

— 4º22' S, 15º14' E: Binza Territory, Kitnuenza, Lovaneum, 31-01-1957, *Rolufet 4265* (BR).

— 4º24'09'' S, 15º18'35'' E: Kinshasha, Lovanium, Lovanium University, 14-12-1967, *Pauwels, L. 5087* (WAG (x2)).

— 4º25'09'' S, 15º18'35'' E: Kinshasha, Unaza Campus, Lemba, 06-06-1980, *Pauwels, L. 6379* (BR, WAG).

— 4º28' S, 15º17' E: Kimuenza, *Gillett 245* (K); Kimuenza District, 10-1961, *Gillett 7901* (BR).

— 4º36' S, 15º10' E: Leopoldtville Province, Kasangulu Territory, 31-01-1957, *Robyns 4265* (K).

— **4º42' S, 16º00' E:** Kisia District, Maluku Zane, *Breyne 4362* (BR).

— **4º47' S, 13º07' E:** Kiobo, 09-02-1940, *Donis, C. 178* (BR).

— **5º08'14" S, 15º06'14" E:** Kisantu, Camp di Mpemba, (Zerr. Madimba), 16-02-1959, *Pauwels, L. 1632* (BR).

— **6º54' S, 17º38' E:** Kidima District, 19-02-1952, *Collens 3492* (BR).

— **Coordinates unknown**: Mvanva District, 06-1903, *Gillett 5228* (BR); Moyen Congo, 02-1920, *Popeguin 173* (P); Kwamouth, *Laurent, E. & Laurent, M. 1032* (BR!, holo.)

Cryptolepis migiurtina

Somalia:

— **7º54' N, 49º37' E:** Nugaal Region, Dhanaane District, 33 km on track from Dhanaane to Eyl, 11-05-2001, *Thulin, M., Dahir, A., Khalid, A. & Osman, A. 10534* (K, UPS).

— **8º01' N, 49º48' E:** Nugaal Region, Eyl District, 5 km N of Eil [Eyl], 25-11-1986, *Lavranos* & *Carter 24945* (K).

— **8º28' N, 49º14' E:** Nugaal Region, Garoe [Garoowe] District, 75 km E of Garoe [Garoowe], 06-11-1980, *Hemming, C.F.* & *Watson, R.M. 3014* (EA).

— **8º56' N, 50º09' E:** Bari Region, upper part of Togga Qundheed [River], 19-05-2001, *Thulin, M., Dahir, A., Khalid, A. & Osman, A. 10658* (K, UPS).

— **9º56'05" N, 50º09'27" E:** Bari Region, Karkaar Mountains, between Gardo [Qardho] and Iscusciuban [Iskushuban], 50 km on Rako [Rako Raaxo] -Heriro [Xiriiro] road, 23-11-1985, *Thulin, M. & Warfa, A.M. 5468* (UPS).

— **10º01' N, 49º36' E:** Bari Region, Gardo [Qardho] District, 75 km NE of Gardo [Qardho], 12-11-1980, *Hemming, C.F. & Watson, R.M. 3064* (EA).

— **10º17' N, 50º13' E:** Bari Region, [Iskuxhuban District], in dry Togga [River], 12-11-1980, *Beckett, J.J. 539* (EA).

— **10º41'27" N, 50º53'13" E:** Bari Region, Hordio District, 106 km ENE of Scusciuban [Iscushuban], 15 km NW of Hordio, in Wadi Has Uanagi [River], 07-01-1973, *Bally, P.R.O. & Melville, S.R. 15622* (EA, G).

— **10º50' N, 49º27' E:** Bari Region, Tisjiic, near the upper village, 02-01-2000, *Thulin, M., Dahir, A. & Osman, A. 10099* (K, UPS).

— **10º57' N, 49º24' E:** Bari Region, Karin District, 29-10-1929, *Collenette, C.N. 198* (K).

— **11º02' N, 48º55' E:** Sanaag Region, Einad District, 18-11-1929, *Collenette, C.N. 316* (K).

— **Coordinates unknown :** Costa dei Migiurtini: Boschetto di Tabantòh, 09-06-1924, *Puccioni, N. & Stefanini, G. 1043 [794]* (FT, holo.); Mared Valley, 13-02-1945, *Glover, P.E. & Gilliland, H.B. 729* (BM, EA).

Cryptolepis nugaalensis

Somalia:

— **7º36' N, 49º42' E:** Nugaal Region, Gaalogod District, 5 km along track from Gaalogod to Garadeen, 09-05-2001, *Thulin, M., Dahir, A., Khalid, A. & Osman, A. 10504* (K, iso.).

Cryptolepis oblongifolia

Angola:

— **8º41' S, 14º48' E:** Cuanza Norte Province, Bula Atumba District, along road to the old Administrative Post, 19-01-1963, *Cardoso, F. 71* (COI).

— **8º49' S, 20º30' E:** Lunda Norte Province, Luachimo District, 04-1937, *Gossweiler, J. 11496* (COI).

— **11º28' S, 16º58' E:** Nova Lisboa [Huambo], between Andulo and Nharea, 11-11-1963, *Teixeira, B. 9373* (LISC).

— **11º43' S, 15º55' E:** [Huambo Province], Chitende, 26-01-1940, *De Camos Andrada, E 91* (LISC).

— **12º24' S, 15º15' E:** Cacoma District, Luimbale, 7 km NW of Capira, 06-04-1973, *Bamps, P. , Martins, S. 4439* (WAG)

— **12º28' S, 15º10' E:** [Huambo Province], highlands between Ganda and Caconda, 12-1933, *Hundt, O. 747* (BM).

— **12º34' S, 15º38' E:** Nova Lisboa, Huambo District, near Chianga, on banks of the Culimaála River, 23-09-1964, *Teixeira, B., Figueira 7907* (COI); 15-10-1964, *Teixeira, B., Figueira 7907b* (LISC).

— **12º46' S, 15º44' E:** Benuela High Plateau, Huambo District, 31-12-1933, *Gossweiler, J. 9745* (K); Nova Lisboa [Huambo], 21-11-1969, *Barbosa, G. 11845* (LISC).

— **14º15' S, 16º57' E:** [Cuando Cubango Province], between Cataca and Cubango River, 21-11-1905, *Gossweiler, J. 2257* (LISC).

— **14º45'30" S, 13º28'53" E:** Huila Province, Bibala Pass, 16.8 km E of Bibala, 18.4 km NNW of Lubango, 26-01-2009, *Bester, S.P. 9294* (PRE).

— **14º55'20" S, 13º16'40" E:** Huila Province, 15 km NW of Humpata, Estacao Zootecnica, 16-01-2009, *Bester, S.P. 9062* (PRE).

— **14º58'15" S, 14º41'44" E:** Huila Province, Biquar National Park, 129 km E of Lubango, 24-01-2009, *Bester, S.P. 9229* (PRE).

— **14º58'30" S, 13º20'57" E:** Huila Province, 5.8 km NW of Humpata to Estaçoa Zootécnica da Humpata, 13-01-2009, *Bester, S.P. 9002* (PRE).

— **15º10'20" S, 13º19'16" E:** Huila Province, Tchivinguilo Research Station, 23 km SW of Humpata, 15-01-2009, *Bester, S.P. 9013* (PRE); Huila Province, Tchivinguilo Research Station, 23 km SW of Humpata, 15-01-2009, *Bester, S.P. 9014* (PRE).

— **15º23' S, 17º57' E:** [Cuando Cubango Province], Menongue, Cuiriri River, 04-04-1906, *Gossweiler, J. 4167* (COI, LISC); 1906, *Gossweiler, J. 4168* (COI, LISC).

— **16º33' S, 17º50' E:** Huila District, along the Cubango River, between Fort Princess Amelia and Vila da Ponte, 1906, *Gossweiler, J. 4003* (LISC).

— **16º42' S, 14º47' E:** [Cuneen Province], Humbe District, Kaunduunganga, 12-05-1969, *Figueira de Sousa, A. 1337* (COI).

— **Coordinates unknown:** Huila Provinde, Tchivinguiro, near Regent School of Agriculture, 08-01-1962, *Barbosa, G. , Moreno, F. 9866* (COI); 01-1955, *Machado, A.B. ANH 1.55-354* (LISC); Bie Province, Libra Parto, *Cardoso, A. s.n.* (LISC); Huila District, near Lopollo, *Welwitsch 4204* (BM, holo.; K, iso.).

Benin:

— **8º24' N, 1º46' E:** [Collines Province], Zou District, Banté, 21-07-1998, *Akoégninou, A. 1604* (WAG).

— **10º20' N, 1º41' E:** Atakora Province, Kouandé, 22-09-2001, *Essou, J.-P. 2777* (WAG).

Burundi:

— **3º06' S, 30º33' E:** [Cankuzo Province], Kigamba District, 12-10-1978, *Reekmans, M. 7212* (EA).

— **3º57' S, 29º58' E:** [Rutana Province], Rutana District, 02-05-1981, *Reekmans, M. 10192* (EA,UPS).

Cameroon:

— **5º11' N, 10º23' E:** [West Province], Bangwa District, 15 km NW of Banganté [Bangangte], 29-04-1964, *De Wilde, W.J.J.O., De Wilde-Duyfjes, B.E.E. 2316* (WAG).

— **7º13'02'' N, 13º36'01'' E:** Ngaoundéré District, 10 S of Ngaoundéré, along road to Meiganga., 01-02-1966, *Leeuwenberg, A.J.M. 7669* (K).

Democratic Republic of the Congo:

— **2º17'60'' N, 30º34' E:** Eastern Province, [Ituri Province], Mahagi District, Kampala, 06-05-1952, *Sperry 564* (EA).

— **4º39' S, 16º22' E:** [Kwango province], Batéké Plateau, Kenge District, 2 km E of Bationgo, 09-12-1982, *Lejoly, J. 82/ 769* (BR).

— **9º42' S, 27º47' E:** [Haut-Katanga Province], 6.4 km NNW of Psote de Kashupa, 17-10-1966, *Malaisse, F. 4667* (BR).

— **11º30'31'' S, 27º26'16'' E:** Katanga District, Luiswishi [Mine], 28-11-1974, *Malaisse, F. 7986* (BR); 21-10-1982, *Malaisse, F. 12439* (BR); 25-11-1982, *Malaisse, F. 12500* (BR); 06-01-1983, *Malaisse, F. 12628* (BR).

— **11º36' S, 27º36' E:** [Haut-Katanga Province], Elizabethville [Lubumbashi], 30-12-1919, *Shanty, H.L. 4685* (K).

— **Coordinates unknown:** [Haut-Katanga Province, Lubumbashi District], Nieuwdorp, 12-1912, *Rogers, F.A. 10409* (K); Mbikondo-Kaheniba, 03-11-1954, *Deired, R. 1418* (SRGH); Mayaga, 31-05-1954, *Liben 1484* (BR, EA).

Gabon:

— **1º00' S, 14º17' E:** Haut-Ogooué, 8 km SSE of Lékoni, edge of cirque de Lékoni, 29-08-1992, *Wieringa, J.J., Van De Poll, H.M. 1523* (WAG (x2)).

Ghana:

— **7º44' N, 1º50' W:** Brong-Ahafo Region, between Techiman and Kintampo, 16-04-1996, *Jongkind, C.C.H. , Nieuwenhuis, C.M.J. 2724* (WAG).

Guinea Bissau:

— **12º16' N, 14º13' W:** Gabu Province, Between Calicunda and Paunca, 23-04-1950, *Collector unknown 2791* (LISC).

Ivory Coast:

— 7º57' N, 6º40' W: Séguélon [Séguéla], 15-06-1978, *Aké Assi, L. 14134* (G).

— 9º35' N, 5º12' W: Ferkéssédougou, 05-1963, *Garnier, P. s.n.* (K).

Malawi [Nyasaland]:

— 10º22' S, 33º47' E: Northern Region, Chitipa District, Nyika National Park, escarpment below Jalwe Viewpoint, 25 km N of Chelinda, 25-01-1992, *Goyder, D.J., Paton, A.J., Tawakali, E.J. 3577* (K).

— 11º08' S, 34º00' E: Vipya Plateau, 11-1948, *Beuson, J.U. 1507* (BM).

Mozambique:

— 16º25' S, 36º44' E: [Zambezia Province], Lugela District, January, *Faulkner, H. 113* (LISC).

Namibia:

— 17º43' S, 18º12' E: [Kavango Province], 3 miles S of Omuramba Mpungu on road to Tsinsabis, 12-12-1955, *De Winter, B. 3892* (K).

Nigeria:

— 10º35' N, 7º15' E: Plateau Province, Jos District, Afaka Forest Reserve, 05-07-1963, *Okafor, J.C., Bimiyo, A. 47543* (K).

Rwanda:

— 2º33' S, 29º36' E: Astrica District, [Butare], Rubona, 02-12-1954, *Michel 4643* (BR, LISC).

South Africa:

— 22º18' S, 30º00' E: [Limpopo Province], Soutpansberg, 06-1977, *Rogers, F.A. 20006* (NH).

— 22º25' S, 29º58' E: [Limpopo Province], Soutpansberg, Scott Farm, 6 km E of Soutpansberg slopes, Vivo District, 29-06-1978, *Scott, L. 211* (PRE).

— 22º46' S, 29º55' E: [Limpopo Province], Soutpansberg, Wylliespoort, 16-12-1928, *Gillett, J.B. 2891* (BOL).

— 23º02'53'' S, 29º54'56'' E: [Limpopo Province], Soutpansberg, 01-1919, *Junod, H.A. 4159* (PRE).

— 23º03' S, 29º54' E: [North West Province], Louis Trichardt, Happy Rest School, 28-02-1946, *Gerstner, J. 6030* (PRE).

— 23º06'08" S, 28º58'34" E: [Limpopo Province], Soutpansberg District, Blouberg, The Beauley Farm 260 LR, 20-03-2009, *Bester, S.P. 9376* (PRE).

— 23º08'28" S, 28º59'51" E: [Limpopo Province], Pietersburg [Polokwane], Blaauwberg [Blouberg], 26-12-1923, *Smuts, Pole-Evans 828* (PRE); 17-01-1931, *Bredenkamp, Schweickerdt 104* (PRE).

— 23º50' S, 31º35' E: [Limpopo Province], Letaba, 18-11-1960, *Scheepers 1051* (BM, K, M, PRE, PRU, SRGH).

— 24º08' S, 28º05' E: [Limpopo Province], Waterberge, 11-1918, *Rogers, F.A. 21711* (SAM); Waterberge, 45 km N of Vaalwater, 01-02-1979, *Van Rooyen, N. 1561* (PRU).

— 24º10' S, 30º15' E: [Limpopo Province], Pietersburg, The Downs, 11-1918, *Rogers, F.A. 18916* (PRE).

— 24º11'31" S, 29º00'46" E: [Limpopo Province], Potgietertsrust, Riebeeckwest, 12-1938, *McDonald, G. 235* (PRE).

— 24º14'45" S, 31º12'50" E: [Mpumalanga Province], Pilgrim's Rest District, Klaserie, 20-11-1958, *Killick , Strey 2510* (PRE).

— 24º15'50" S, 28º43'30" E: [Limpopo Province], Moorddrift [Nylstroom], 17-10-1909, *Leendertz, R. 7319* (PRE); Nylstroom, Sterk River Dam Nature Reserve, 09-02-1972, *Jacobsen, N 2041* (PRE).

— 24º21' S, 28º50' E: [Limpopo Province], Potgietersrust [Mokopane], Naboomfontein, 13-12-1934, *Galpin 13472* (BOL, K, PRE, W).

— 24º25'59" S, 27º31'59" E: [Limpopo Province], top of Krantzberg, [In Marakele National Park], 12-01-1942, *Dyer , Verdoorn 4233* (PRE).

— 24º30' S, 28º06' E: [Limpopo Province], Alma, 12-12-1973, *Van Wyk, A.E. 49* (BLFU, PRE).

— 24º34' S, 28º40' E: [Limpopo Province], between Nylstroom [Modimolle] and Naboomspruit [Mookgopong], 30.2 km along highway N of Nysltroom [Modimolle], 08-04-1988, *Venter, H.J.T. 9196* (BLFU).

— 24º34' S, 30º47' E: [Mpumalanga Province], Blyde Poort Nature Reserve, 10-02-1977, *Botha, D.J. 2002* (PRU); Blydeport Nature Reserve, upper hiking trail, 10-01-1978, *Botha, D.J. 2348* (BLFU).

— 24º34'37" S, 30º47'80" E: [Mpumalanga Province], Blyde River Canyon, at Three Rondawels viewpoint, W of parking area, 29-11-2008, *Joubert, L. 48*

(BLFU); *Joubert, L. 49* (BLFU); Three Rondawels viewpoint, N of viewpoint, 01-12-2008, *Joubert, L. 51* (BLFU).

— **24º36'34" S, 30º48'86" E:** [Mpumalanga Province], Blyde River Canyon, at first viewpoint over Mariepskop, along road from Bourke's Luck to Forever Resort, left of parking area, 15-11-2006, *Joubert, L. 26* (BLFU).

— **24º36'40" S, 30º48'93" E:** [Mpumalanga Province], Blyde River Canyon, at Lowveld View, 08-04-1988, *Venter, H.J.T. 9208* (BLFU); Lowveld View, E of parking area, 30-11-2008, *Joubert, L. 50* (BLFU).

— **24º39' S, 28º42' E:** [Limpopo Province], Naboomspruit, Mosdene, 01-1920, *Galpin 495* (PRE, W, Z).

— **24º40' S, 28º20' E:** [Limpopo Province], Nylstroom, on top of Krantzberg, 16-12-1951, *Prosser, S.M. 1726* (PRE, UPE).

— **24º40'17" S, 30º48'76" E:** [Mpumalanga Province], Blyde River Canyon, Bourke's Luck, 27-04-1967, *Davidson, L.E. 82* (J); 15-04-1972, *Davidson, L.E. 2226* (J); Bourke's Luck, on rock in front of researchers house no. 11, 01-12-2008, *Joubert, L. 54* (BLFU).

— **24º41'60" S, 30º49'14" E:** [Mpumalanga Province], Blyde River Canyon, 4 km S of Bourke's Luck, 01-12-2008, *Joubert, L. 52* (BLFU); *Joubert, L. 53* (BLFU).

— **24º50' S, 28º45' E:** [Limpopo Province], Between Warmbad and Nylstroom, 04-01-1936, *Smuts, Gillett 3442* (PRE).

— **24º53' S, 28º17' E:** [Limpopo Province], Warmbad, 21-10-1909, *Leendertz, R. 7598* (PRE); 04-1945, *Gerstner, J. 5287* (BOL, PRE).

— **24º55'36" S, 30º37'29" E:** [Mpumalanga Province], Pilgrim's Rest District, Ohrigstad Nature Reserve [Ohrigstad Dam Nature Reserve], 19-11-1970, *Jacobsen, N 1332* (PRE); 20-01-1976, *Theron, G.K. 3472* (PRE, PRU).

— **24º57'39" S, 30º51'46" E:** [Mpumalanga Province], 8 km from Kowyns Pass, along Acornhoek Road, 18-12-1934, *Galpin, E.E. 14653* (PRE); Kowyns Pass, 18-12-1937, *Galpin, E.E. 32211* (BOL, PRE).

— **25º06'46" S, 29º28'42" E:** [Mpumalanga Province], Middleburg, Broodboomspruit, near N border, 20-01-1968, *Du Plessis, C.J. 246* (PRE).

— **25º09' S, 27º15' E:** [North West Province], Rustenburg, Bergheim, ravine in Magaliesberg, 03-11-1957, *Merxmüller 259* (BM, K, M).

— **25º09' S, 31º12' E:** [Mpumalanga Province], Kruger National Park, Numbi, 14-01-1953, *Van der Schijff, H.P. 1626* (PRE).

— **25º10' S, 29º16' E:** [Limpopo Province], 28.5 miles ENE of Groblersdal, 20-11-1959, *Acocks 20917* (K, PRE).

— **25º10' S, 30º50' E:** [Mpumalanga Province], Sabie, Langverwag, 22-11-1962, *Louw, W.J. 2333* (STE).

— **25º11' S, 27º15' E:** [North West Province], Potchefstroom, Sandfontein, 19-03-1983, *Venter, H.J.T. 8805* (BLFU).

— **25º13' S, 30º53' E:** [Mpumalanga Province], Lydenburg [Mashishing], Witlkip, 26-11-1973, *Kluge, J.P. 355* (PRE).

— **25º15' S, 27º10' E:** [North West Province], Bophuthatswana, Mankwa District, Houwaterdam Farm, 17-01-1977, *Matlhaku, R. 89* (PRE).

— **25º17' S, 30º43' E:** [Mpumalanga Province], Nelspruit, 12-1917, *Breyer, H.G. 17079* (PRE); Nelsruit, Lowveld Botanical Garden, 17-11-1969, *Buitendag, E. 298* (PRE).

— **25º20'39'' S, 30º35'52'' E:** [Mpumalanga Province], Lydenbrug [Mashishing], Wonderkloof Nature Reserve, 22-10-1974, *Elan-Puttick, D. 125* (PRE); 26-01-1976, *Elan-Puttick, D. 315* (PRE).

— **25º24'36'' S, 28º16'06'' E:** [Gauteng Province], Pretoria, Baviaanspoort, 30-01-1925, *Smith, C.A. 345* (J, PRE).

— **25º25' S, 28º43' E:** [Gauteng Province], Enkeldoorn, *Eyles, F. 2795* (SAM).

— **25º25' S, 29º23' E:** [Mpumalanga Province], Loskop Dam, E of Scheepersloop, 12-06-1966, *Theron, G.K. 810* (PRE); Loskop Dam, Tweeloopfontein, 29-03-1967, *Theron, G.K. 1302* (PRE).

— **25º28' S, 28º21' E:** [Gauteng Province], Pretoria, Roodeplaat, near gate of Transvaal Regional Research Station, 02-12-1973, *Clarke, B. 556* (PRE).

— **25º28' S, 30º58' E:** [Mpumalanga Province], Nelspruit, 5 km S of Nelspruit, *Leach 11347* (BM, K, M, PRE, SRGH, Z); *Noel 735* (GRA).

— **25º30' S, 27º40' E:** [Gauteng Province], Pretoria, 46.8 miles W of Pretoria, 01-09-1948, *Bruce, E.A. 114* (PRE).

— **25º32' S, 26º05' E:** [North West Province], Zeerust, 05-1941, *Steyn, D.G. 1820* (PRE).

— **25º32' S, 31º20' E:** Mpumalanga, Kaapmuiden, 09-01-1938, *Mogg, A.O.D. s.n.* (PRE).

— **25º34' S, 26º25' E:** [North West Province], Groot Marico, Lekkerlach, 26-12-1939, *Louw, W.J. 614* (PRE).

— **25º35' S, 27º10' E:** [North West Province], Rustenburg, 02-1917, *Van Dam, J. 16506* (PRE).

— **25º35' S, 28º30' E:** [Gauteng Province], 20–30 miles NE of Pretoria, 06-12-1958, *Werdermann, E. , Oberdieck 1262* (WAG).

— **25º35'30" S, 30º53'30" E:** [Mpumalanga Province], Nelspruit-Barberton Road, Hilltop Pass, 24.01-1979, *Viljoen, G. 37* (PRE).

— **25º36' S, 30º18' E:** [Mpumalanga Province], Waterval Boven, 12-1914, *Rogers, F.A. 14285* (NH).

— **25º38' S, 27º42' E:** [North West Province], Brits, Jacksons Garden., 21-09-1957, *Van Vuuren, D. 377* (PRE).

— **25º38'08" S, 27º11'72" E:** [North West Province], Rustenburg District, along road to Swartruggens, 2 km W of town, 14-11-2002, *Venter, H.J.T. , Venter, J. 9882* (BLFU x2).

— **25º38'09" S, 28º03'31" E:** [Gauteng Province], Pretoria District, Hornsnek, 19 km W of Pretoria, *Schlieben 7766* (G, K, M).

— **25º39' S, 26º42' E:** [North West Province], Rustenburg, Zwartruggens, 25-03-1934, *Sutton, J.D. 806* (PRE).

— **25º39' S, 29º20' E:** [Mpumalanga Province], Botsabelo, 29-12-1893, *Schlechter 4096* (BM, BOL, G, GRA, K, SAM); 12-1911, *Thode 2652* (STE).

— **25º40' S, 27º15' E:** [North West Province], Rustenburg, 11-1903, *Pegler, A. 1019* (BOL, GRA, SAM); Rustenburg, 02-01-1904, *Nakien, O. 23* (K, PRE); Rustenburg, 04-10-1910, *Leendertz, R. 9589* (PRE); Rainhill Farm, 20-01-1942, *Moss, M. 21009* (J); Rustenburg, Rainhill Farm, 8 km SW of Rustenburg, 19-03-1946, *Codd 1088* (K, PRE).

— **25º43' S, 27º10' E:** [North West Province], Rustenburg, 8 km SW of Rustenburg, 19-03-1946, *Story 980* (PRE).

— **25º43' S, 29º55' E:** [Mpumalanga Province], Kein Olifants River, 26-11-1893, *Schlechter 3804* (K, M, PRE, SRGH, Z).

— **25º43'18" S, 28º15'11" E:** [Gauteng Province], Pretoria, Koedoespoort, 06-12-1925, *Smith, C.A. 1530* (PRE).

— **25º43'26" S, 27º14'32" E:** [North West Province], Rustenburg Nature Reserve, [Kgaswane Game Reserve], 27-02-1970, *Jacobsen, N. 840* (PRE).

— **25º43'59" S, 28º13'06" E:** [Gauteng Province], Pretoria, Rust der Winter, 07-1937, *Smuts & Gillett 3294* (PRE).

— **25º44'14" S, 28º16'24" E:** [Gauteng Province], Pretoria, Pretoria National Botanical Garden, 12-1974, *Dryfhout, P. 986* (PRE).

— **25º44'20" S, 27º12'56" E:** [North West Province], Rustenburg, Uitkoms (499JQ), 19-11-1970, *Coetzee, B.J. 410* (PRE).

— **25º44'26" S, 28º12'43" E:** [Gauteng Province], Pretoria, Reservoir E of Union Building, 11-1925, *Smith, C.A. 1293* (PRE).

— **25º44' S, 28º11' E:** [Gauteng Province], Pretoria Koppies, 27-04-1904, *Leendertz, R. 8455* (PRE); *Leendertz, R. 8456* (BLFU, PRE); Pretoria Kopjes, 11-10-1904, *Leendertz, R. 88* (BLFU); Pretoria, 11-10-1904, *Leendertz, R 345* (K, GRA); 31-01-1920, Pretoria, Louis Botha Home, 11-1925, *Smith, C.A. 1237* (PRE); 05-1920, *Marloth, R. 9506* (PRE, STE); *Verdoorn, J.C. 85* (PRE); 18-11-1928, *Leeman, A. 20* (PRE); *Phillips 3123* (GRA).

— **25º45' S, 28º11' E:** [Gauteng Province], Pretoria, Ashburu, 29-11-1925, *Smith, C.A. 1328* (PRE).

— **25º45' S, 28º12' E:** [Gauteng Province], Pretoria, Premiere Mine, 10-1916, *Rogers, F.A. 18962* (J); 28-10-1919, *Phillips, E.P. 3123* (PRE, SAM).

— **25º45' S, 28º16' E:** [Gauteng Province], Pretoria, Near WNNR, 21-12-1964, *Joynt, V. 3* (PRE); Apies Poort, 1882, *Rehmann 4159* (BM, K, Z).

— **25º45' S, 29º25' E:** [Mpumalanga Province], Middelburg, Buffelsvlei, 23-11-1934, *Rudatis, H.H. 70* (STE).

— **25º45'46" S, 27º29'26" E:** [North West Province], Rustenburg, Buffelspoort, 08-11-1934, *Turner, F.A.S. 28* (PRE).

— **25º46' S, 28º12' E:** [Gauteng Province], Pretoria, Groenkloof, *Mogg, A.O.D. 9750* (PRE).

— **25º46'30" S, 28º11'05" E:** [Gauteng Province], Pretoria, Schauskop Fort, 11-11-1917, *Pole-Evans, J.B. 180* (PRE).

— **25º46'38" S, 28º11'47" E:** [Gauteng Province], Pretoria, Fonteine, 1919, *Moss, C.E. 10003* (J); 14-11-1928, *Repton, J.E. 119* (PRE); 19-11-1928, *Verdoorn, J.C. 587* (PRE); Monument Hill., 07-05-1962, *Hardy 933* (K, PRE, Z).

— **25º47' S, 28º14' E:** [Gauteng Province], Pretoria, Waterkloof, 01-04-1921, *Hofmeyr, J.M s.n.* (PRE); 27-05-1928, *Mogg, A.O.D. 15727* (PRE).

— **25º47' S, 31º03' E:** [Mpumalanga Province], Barberton, 11-1923, *Thorncroft, G. 2024* (PRE).

— **25º47'02" S, 28º16'13" E:** [Gauteng Province], Pretoria, Garsfontein Hill., 02-1977, *Liebenberg 6840* (K, MO, PRE, SRGH).

— **25º47'10" S, 31º03'11" E:** [Mpumalanga Province], Barberton, Saddleback Mountain, 22-02-1890, *Galpin, E.E. 833* (BOL, PRE); Barberton, 11-1915, *Rogers, F.A. 18357* (J, K).

— **25º48'25" S, 28º09'52" E:** [Gauteng Province], Pretoria-West, Swartkop, 22-08-1965, *Dahlstrand, K.A. 3791* (UPE).

— **25º48'32" S, 27º34'34" E:** [Gauteng Province], Magaliesberg, Castle Gorge, 04-01-1974, *Van Wyk, A.E. 113* (BLFU).

— **25º49' S, 27º51' E:** [Gauteng Province], Magaliesberg, at Crocodile River, , *Zeyher 1182* (G, K, P).

— **25º50' S, 27º59' E:** [Gauteng Province], Pretoria, Hennops River, 16-12-1923, *Moss, C.E. 8636* (J).

— **25º50' S, 28º10' E:** [Gauteng Province], Pretoria, Leeuwhoek, 18-03-1959, *Swart, L.S. 481* (PRE).

— **25º50'32" S, 25º38'01" E:** [North West Province], Mafeking, Ferndale, 02-1946, *Brueckner, A. 587* (PRE).

— **25º53' S, 28º25' E:** [Gauteng Province], Pretoria, SE of Pretoria on Tygerberg Road, 25-11-1939, *Young, R.G.N. 2533* (J, PRE).

— **25º53'50" S, 28º17'38" E:** [Gauteng Province], Pretoria, Riet Valley, *Acocks 11269* (K, PRE).

— **25º57' S, 27º37' E:** [Gauteng Province], Magaliesberg, Elandskraal, Hekpoort, 04-01-1974, *Van Wyk, A.E. 113* (PRE).

— **25º59' S, 27º33' E:** [Gauteng Province], Magaliesberg, 1843, *Burke s.n.* (BM, Z); *Burke 322* (K).

— **26º02' S, 27º45' E:** [Gauteng Province], Krugersdorp, 09-01-1938, *Phillips, J. 1098* (PRE); 2 miles NE of Krugersdorp, Honingklip, 02-01-1950, *Mogg, A.O.D. 18158* (J).

— **26º05' S, 27º43' E:** [Gauteng Province], Krugersdorp Municipal Reserve, 25-10-1950, *Mogg, A.O.D. 20347* (J); Krugersdorp, Jack Scott Nature Reserve, 01-02-1961, *Wells 2237* (K, PRE, SRGH).

— **26º06' S, 27º48' E:** [Gauteng Province], Krugerdorp, Skeerpoort, 11-04-1938, *Phillips, J. 1211* (PRE).

— **26º08'03" S, 27º53'17" E:** [Gauteng Province], Johannesburg, Witpoortjie Ravine, 10-1917, *Rogers, F.A. 19308* (G); 17-06-1924, *Moss, C.E. 10001* (BM, J); Witpoortjie Valley, 12-11-1949, *Prosser 1318* (J, K, PRE); Witpoortjie Valley, [in walter Sisulu National Botanical Garden], 09-12-1962, *Dahlstrand, K.A. 3790* (UPE).

— **26º09'40" S, 28º05'13" E:** [Gauteng Province], Johannesburg, Orange Grove, 1898, *Conrath, P. 1061* (K).

— **26º10' S, 27º44' E:** [Gauteng Province], Randfontein, Sanatorium, Fishing Mines, *Junod, H.A. 864* (G, K, Z).

— **26º10'17" S, 28º01'01" E:** [Gauteng Province], Johannesburg, Park View, 27-12-1923, *Moss, C.E. 10002* (J).

— **26º11'37" S, 28º05'06" E:** [Gauteng Province], Johannesburg, Jeppestown Ridge, 12-1898, *Gilfillan, D.F. 6144* (K).

— **26º12' S, 28º02' E:** [Gauteng Province], Johannesburg, 11-1898, *Gilfillan, D.F. 132* (PRE).

— **26º18'39" S, 28º01'45" E:** [Gauteng Province], Johannesburg, Klipriviersbeerg, 02-04-1949, *Mogg, A.O.D. 17661* (J).

— **26º20' S, 28º40' E:** [Gauteng Province], 33.5 miles SE of Johannesburg, Houtpoort, 03-02-1950, *Mogg, A.O.D. 18483* (J).

— **26º30' S, 27º06' E:** [North West Province], Potchefstroom, Blyvooruitzicht, near E5, 22-01-1938, *Phillips, J. 1268* (PRE).

— **26º32'31" S, 27º06'16" E:** [North West Province], Potchefstroom, Boskop Dam Nature Reserve, 11-11-1939, *Louw, W.J. 462* (PRE).

— **26º34' S, 28º27' E:** [Gauteng Province], Heidelberg, 11-1927, *Thode A 1327* (K, NH, PRE); 01-1932, *Murray, D.P. 687* (PRE); Heidelberg District, Houtpoort 309, 6 miles South of Heidelberg, 03-02-1950, *Mogg, A.O.D. , Edwards, G., Koane, K. 18483* (LISC); 03-01-1953, *Mogg, A.O.D. 20484* (BOL, J).

— **26º37'57" S, 27º40'51" E:** [North West Province], Potchefstroom, Losberg, Elandsfontein, 60 km E of Potchefstroom, 15-12-1934, *Theron, J.J. 844* (PRE).

— **26º39' S, 27º30' E:** [North West Province], Fochville District, Weltevreden 156, near Loopspruit, 39 miles WSW of Johannesburg, 04-04-1949, *Mogg, A.O.D., Cunliff, K.M. 26136* (UPS).

— **26º40' S, 27º48' E:** [Gauteng Province], Vereeniging, Hontkop 3, Langerand Hills., 21-03-1953, *Mogg, A.O.D. 21034* (J).

— **26º43' S, 27º00' E:** [North West Province], Potchefstroom District, Sandfontein, 19-03-1983, *Venter, H.J.T. 8805* (BLFU).

— **26º43'16" S, 26º41'47" E:** [North West Province], Klerksdorp District, Faan Meintjies Nature Reserve, 19-03-1983, *Venter, H.J.T. 8802* (BLFU); 19-06-1987, *Venter, H.J.T. 9187* (BLFU).

— **26º58' S, 27º22' E:** [Free State Province], Vredefort District, Mispah, 22-12-1983, *Du Preez, P.J. 299* (BLFU).

— **27º08'56" S, 27º06'18" E:** [Free State Province], Vredefort District, Esperanza, 06-01-1983, *Du Preez, P.J. 183* (BLFU).

— **27º30' S, 31º22' E:** [KwaZulu-Natal Province], Itala Nature Reserve, Craigadam Farm, Mabamvu Ridge, 05-01-1978, *McDonald, G. 390* (K, PRE).

— **27º52' S, 31º24' E:** [KwaZulu-Natal Province], Ngome, 01-12-1944, *Gerstner 5173* (K, SRGH, PRE).

— **28º01'08" S, 32º16'03" E:** [KwaZulu-Natal Province], Hlabisa, Hluhluwe Game Reserve, 09-04-1961, *Hitchins* & *Ward 11* (NH, PRE).

— **28º02'24" S, 32º03'36" E:** [KwaZulu-Natal Province], Zululand, Hlabisa District, Hluhluwe Game Reserve, 02-01-1956, *Ward, C.J. 2934* (NH, PRE).

— **28º25' S, 32º11' E:** [KwaZulu-Natal Province], Mtubatuba, 19-11-1969, *Bourquin, O. 655* (PRE).

— **28º33'27" S, 30º00'53" E:** [KwaZulu-Natal Province], Alexandra District, St. Dumisa, 10-04-1909, *Rudatis, H.H. 641* (BM, G, K, PRE, STE).

— **28º50' S, 31º29' E:** [KwaZulu-Natal Province], Zululand, Umlalazi, 13-05-1952, *Lawn, J.G. 2281* (NH).

— **29º25' S, 30º43' E:** [KwaZulu-Natal Province], 28 km from Wartburg on Noodsberg Road, 25-03-1963, *Edwards 2998* (K, M, PRE).

— **29º28' S, 30º14' E:** [KwaZulu-Natal Province], Umgeni River, 11-1839, *Krauss s.n.* (G).

— **29º40' S, 31º07' E:** [KwaZulu-Natal Province], Umdloti River, Oakford [near river mouth], 1880, *Rehmann 8466* (Z).

— **29º41' S, 30º56' E:** [KwaZulu-Natal Province], Inanda, 05-1879, *Wood 446* (BM, BOL, G, K, PRE, Z).

— **29º45' S, 30º39' E:** [KwaZulu-Natal Province], Pinetown, first view site, Forest Hills, 27-10-1958, *Johnson, S.M. 1371* (NH, PRE); Forest Hills, 20-02-1962, *Redshaw, C. 2* (NH, PRE).

— **29º45'50" S, 30º50'47" E:** [KwaZulu-Natal Province], Krantzkloof, 11-1921, *Haygarth, W.J. 23852* (PRE); *Rogers, F.A. 30191* (Z).

— **29º47' S, 30º47' E:** [KwaZulu-Natal Province], Hill Crest, 04-1917, *Thode, J. 2654* (STE).

— **29º48' S, 30º45' E:** [KwaZulu-Natal Province], New Germany, 29-01-1914, *Wood, J.M. 12568* (PRE); 12-1916, *Thode, J. 2655* (STE).

— **29º48' S, 31º02' E:** [KwaZulu-Natal Province], Umgeni River, just below Howic Falls, 11-1839, *Schinz s.n.* (Z).

— **29º49' S, 30º50' E:** [KwaZulu-Natal Province], Port Natal [Durban], near Umgeni River, 1840, *Krauss 132* (K-herb. Bentham, lecto.; K-herb. Hooker, BM, isolecto).

— **29º49' S, 30º51' E:** [KwaZulu-Natal Province], Pinetown, 11-03-1967, *Coleman, T.A. 390* (NH).

— **29º49'52" S, 30º55'59" E:** [KwaZulu-Natal Province], Westville, 05-09-1965, *Coleman, T.A. 210* (NH).

— 29º51' S, 30º53' E: [KwaZulu-Natal Province], near Northdene, 25-10-1893, *Wood 4984* (Z); 11-1993, *Evans, M.S. 593* (NH).

— 29º51' S, 30º59' E: [KwaZulu-Natal Province], Durban, 05-05-1903, *Wood, J.M. 9084* (NH); Sydenham, 20-10-1913, *Wood, J.M. 12428* (NH).

— 29º53' S, 31º03' E: [KwaZulu-Natal Province], Durban (Natal Bay), *Krauss 661* (M).

— 30º40' S, 30º33' E: [KwaZulu-Natal Province], Camperdown, Skongweni Dam, 22-02-1966, *Morris, J.W. 770* (PRE).

— 30º43'11" S, 30º16'12" E: [KwaZulu-Natal Province], Oribi Gorge, 02-1973, *Davidson, L.E. 2522* (J).

South Sudan:

— 4º07' N, 30º40' E: Bahr al Jabal, [Central Equatoria State], Yei River, 23-10-1919, *Sillitoe, F. 310* (K (x2)).

Swaziland

— 26º19' S, 31º08' E: Mbabane, Mpalaleni, 16-01-1964, *Karsten, M. s.n.* (PRE).

— 26º22' S, 31º05' E: 10 miles SE of Mbabane, 26-11-1948, *Codd, L.E. 4753* (PRE).

Tanzania:

— 4º31' S, 38º17'02" E: [Taga Province], Shagayu Forest, near Sunga, in the Western Usambara Mountains, 17-05-1953, *Drummond, R.B. & Hemsley, J.H. 2603* (EA).

— 7º19' S, 36º56' E: Ulanga District, 01-1972, *Haerdi, F. 347/6743* (G).

— 7º46'60" S, 36º46' E: [Iringa Province], Mlale District, 24-10-1976, *Leedal, G.P. 3908* (EA).

— 8º14' S, 35º00' E: Iringa Province, Mufindi District, along the Mafinga-Madibira road, shortly before Madibira, 54.5 km from Morogoro road, 06-01-1989, *Taylor, C.M., Gereau, R.E. & Lovett, J. 8447* (UPS).

— 8º15' S, 35º25' E: Iringa Region, Mufindi District, Lady Chathams house, drive ending on main road, 12-11-1986, *Lovett, J. , Goldblatt, P. & Brummitt, D. 1052* (K).

— 8º50' S, 33º20' E: Mbeya District, Pungaluma Hills, 15-12-1989, *Lovett, J., Sidwell, K. & Kayombo, C.J. 3715* (K).

— **10º40' S, 35º34' E:** Songea District, Songea airfield, 04-04-1956, *Milne-Redhead, E. & Taylor, P. 8125* (BR, K, SRGH).

— **10º40' S, 35º39' E:** [Ruvuma Province], Songea, near Government Rest House, 25-12-1955, *Milne-Redhead, E. & Taylor, P. 7745* (BR, K).

Uganda:

— **0º51' S, 29º54' E:** Rukungiri District, Nyakageme, 11-1946, *Purseglove, J.W. P2240* (K).

Zambia:

— **8º49'60'' S, 31º22'60'' E:** Northern Province, Abercorn District, 23-10-1952, *Siame, W. 202* (BM); Kalandbo Falls, 14-10-1952, *White, F. 3644* (K).

— **8º51' S, 31º19' E:** [Northern Province], old aerodrome, Mpulungu-Abercorn [Mbala] Road, 18-10-1954, *Richards, H.M. 2063* (K).

— **8º56' S, 31º11' E:** Mbala District, 24 km W of Mbala along Mbala-Mpulungo Road to Power Station Road (D549), between 22.6 and 25.6 km along D549 becoming road RD2, 01-12-1993, *Nkhoma, C.N., Harder, D.K. & Merello, M. 105* (K).

— **9º56' S, 33º18' E:** Isoka District, NW slopes of Mafinga Mountain, 18-07-1964, *Robinson, E.A. 6297* (K).

— **10º16'37'' S, 33º05'21'' E:** Northern Province, Isoka District, 67.9 km from the turnoff on the Isoka-Nakonde Road towards Muyombe, 25-05-1995, *Nkhoma, C.N., Harder, D.K., Schmidt, H.H. & Louwiika, B. 294* (WAG).

— **10º18' S, 33º10' E:** Northern Province, Kuta District, between Bangweolo and Luvingo, 22-10-1911, *Fires, R.E. 1080* (UPS).

— **10º28' S, 29º10' E:** Mwenda District, 19-11-1992, *Breteler, F.J. 11918* (WAG).

— **11º30' S, 31º55' E:** 40 km SE of Shiwa Ngandu, 24-11-1992, *Breteler, F.J. 11990* (WAG).

— **11º43' S, 24º48' E:** Mwinilunga District, 28 miles E of Mwinilunga, 11-09-1930, *Milne-Redhead, E. 1085* (K); Mwinilunga District, NE of Matonchi Farm, 05-10-1937, *Milne-Redhead, E. 2577* (K).

— **12º01' S, 24º31' E:** [North-Western Province], Mwinilunga District, SE of Matonchi Farm, 31-10-1937, *Milne-Redhead, E. 3040* (K).

— **12º48'26'' S, 28º13'01'' E:** Kitwe District, 07-12-1955, *Fanshawe, D.B. 2640* (SRGH); 15-12-1955, *Fanshawe, D.B. 2658* (SRGH).

— 13º09'16'' S, 30º42'07'' E: Central Province, Kanona District, Kundalila Falls Picnic Area, 13 km S of Serenje-Mpika, 22-11-1993, *Harder, D.K. , Merello, M.C. & Nkhoma, C. 207* (WAG).

— 13º27' S, 32º41' E: [Chipata District], 3 miles NE of Fort Jameson, 30-12-1958, *King, A.E. 444* (SRGH).

— 14º50'04'' S, 24º39'13'' E: Western Province, Kaoma District, 3 km NW along Kaoma-Lukulu Road from junction of Kaoma-Mongu Road, 01-03-1996, *Zimba, N.B., Harder, D.K. & Luwiika, B. 710* (G).

— 15º04'14'' S, 28º08'32'' E: Kabwe Rural District, Chisamba, 7 km W of Great North Road on road to Wardy Farm, 31-01-1995, *Harder, D.K.* & *Bingham, M.G. 2542* (WAG).

— 15º43' S, 28º01' E: Hachile District, 24-12-1960, *Fanshawe, D.B. 6019* (BR).

— 16º37' S, 26º11'16'' E: [Southern Province], Siantambo, 18-12-1962, *Mataunde 17/30* (SRGH).

— 16º48'59'' S, 26º58'35'' E: Southern Province, Choma District, 23-11-1962, *Astle, W.L. 1691* (SRGH).

Zimbabwe:

— 17º32' S, 30º35' E: Umvukwe Range, (Great Dyke), near Mpinga, 05-02-1997, *Goyder, D.J. & Paton, A.J. 4107* (K).

— 17º53' S, 31º16' E: [Mashonaland East], Ruwa, 03-10-1997, *Poilecot, P. & Dulieu, D. 7314* (G).

— 17º76' S, 30º70' E: Mungwe District, Mungwe Nature Reserve, 23-11-1953, *Wild, H. 44467* (SRGH); Mungwe Nature Reserve, Zwipani Camp, 30-11-1957, *Goodier, R. 422* (SRGH).

— 18º08' S, 28º54' E: Gokwe District, On Gokwe-Chinyenyetu [Nyenyetu] road, 5 miles from Gokwe, 04-05-1962, *Bingham, M.G. 139* (K, SRGH).

— 18º11' S, 31º33' E: Marandellas District, [Marondera], 24-11-1949, *Corby, H.D.L. 554* (SRGH).

— 18º58'41'' S, 32º41'50'' E: [Manicaland Province], Umtali [Mutare] Commonage, 01-1946, *Chase, N.C. 239* (LISC).

— 19º10' S, 28º40' E: Shangani District, Gwampa Forest Reserve, 03-02-1955, *Goldsmith 54/55* (SRGH).

— 19º18'20'' S, 27º43'15'' E: Uyamandhlovu District, Gwaai Forest, 01-1906, *Allen, C.E.F. 239* (SRGH).

— **19º27'51" S, 29º49' E:** Gwelo District, Gwelo Teachers College, 18-11-1966, *Biegel, H.M 1440* (K, SRGH).

— **20º24'09" S, 32º42'57" E:** Melsetter, [Chimanemane District], Gungunyana [Forest Area], 15-02-1907, *Johnson, M. 132* (K).

Location unknown:

— 01-1940, *Becquet, A. 1020* (BR).

— *Gossweiler, J. 41* (COI).

Cryptolepis obtusa

Kenya:

— **2º21' S, 37º55' E:** Mbizao Hill, 29-01-1942, *Bally 1749* (K).

— **4º25' S, 39º29' E:** Kwale District, Buda Mafisini Forest, 8 miles WSW of Gazi, 16-08-1953, *Drummond, R.B.* & *Hemsley, J.H. 3836* (BR).

Malawi:

— **9º42' S, 33º95' E:** Northern Province, Karonga, 15-07-1970, *Brummitt, R.K. 12149* (K).

— **9º44' S, 33º95' E:** Kondowe to Karonga, 07-1896, *White, A. s.n.* (K).

— **10º00' S, 34º45' E:** East coast of Lake Nyasa, 22-09-1900, *Johnson, W.P. 56* (K).

— **10º42' S, 34º10' E:** Rumphi District, 8 km S of Livingstonia, escarpment road jucntion, S of Chiweta, along lake, 20-04-1972, *Pawek, J. 5148* (K).

— **10º50' S, 34º05' E:** 16 km S of Chilumba, 27-04-1975, *Pawek, J. 9597* (K, MO, SRGH, WAG).

— **11º00' S, 33º46' E:** Northern Province, Rumphi District, Rumphi Gorge, 1.6 km E of Rumphi, 15-08-1977, *Pawek, J. 12883* (BR, K, MO, MA, SRGH).

— **11º37' S, 34º20' E:** Nkhata Bay District, 08-05-1977, *Phillips, E. 2236* (SRGH, MO, WAG).

— **12º05' S, 33º58' E:** Nkhata Bay District, 88 km S of Mzuzu-N.B. Road, Kilwa, 01-10-1972, *Pawek, J. 5851* (K, SRGH).

— **14º30' S, 35º15' E:** Mangochi, Mpamantha Village, 09-07-1975, *Seyami, J.H. 295* (MO, SRGH).

— **15º23' S, 35º34' E:** Zomba District, 3 km W of Lake Chilwa at Katchoka, 01-06-1970, *Brummitt, R.K.* & *Williams 11203* (BR, K, SRGH).

— **15º36' S, 34º31' E:** Mwanza District, Mkurumadzi River, 26-04-1979, *Blackmore, Patel & Masiye 810* (K).

Mozambique:

— **11º30' S, 39º00' E:** Cabo Deladu, Macondes, 32 km from Muada to Mocimmboa do Rovuma, 15-04-1964, *Torre, A.R.* & *Paiva 12004* (LISC).

— **13º00' S, 38º00' E:** Niassa, Vila Gabral, Meponda, 30-08-1958, *Monteiro 21* (LISC).

— **14º33' S, 40º40' E:** Niassa Province, Nacala, De Memba, 15-05-1937, *Torre, A.R. 1539* (LISC).

— **14º59' S, 40º31' E:** Niassa Province, Mossuril, Naguema, 05-05-1948, *Pedro* & *Pedrogáo 3154* (BR, K).

— **15º09' S, 39º14' E:** Niassa Province, Nampula, 11-05-1937, *Torre, A.R. 1394* (LISC).

— **15º15' S, 39º00' E:** 7 km from Nampula, 13-04-1961, *Balsmhas* & *Marrime 385* (BM, K, LISC).

— **15º48' S, 31º45' E:** Zambezi, Borôma, 10-1891, *Menyha, A.L. 829* (K, Z).

— **16º10' S, 33º35' E:** Between Tete and sea coast., 03-1860, *Kirk s.n.* (K, syn.).

— **17º12' S, 34º55' E:** Baroda District, Sisitso, Zambesi River, near Messanguere [Messangadeze] River, 15-07-1950, *Chase 2228* (BM, K, SRGH).

— **17º20' S, 35º20' E:** lower valley of Shire River, 05-1861, *Meller, C.J. s.n.* (K, lecto.).

— **17º27' S, 35º04' E:** Tete, Mutarara, 27-10-1971, *Haffern, J.K. 52* (SRGH).

— **18º54' S, 36º04' E:** Luabo River, 17-05-1958, *Kirk 38* (K, syn.).

— **18º57' S, 33º16' E:** Manica, Sofala, Chimoio, Vandúzi, *Barboza 1316* (LISC).

— **19º30' S, 33º00' E:** Manica District, Sojala, Busi River, 04-1962, *Goldsmith 129/62* (K, LISC, MO, SRGH).

— **20º04' S, 34º09' E:** Inhaca, Macchamba, 03-07-1975, *Moura 65* (WAG).

— **20º12' S, 33º38' E:** Gazaland, Chibabava, Buzi, 30-11-1906, *Swynnorton, C.F.M. 565* (K); Manica District, Sofala, Chibabava, 02-08-1967, *De Carvalho, M 906* (BR, MO).

— **20º58' S, 35º02' E:** Save River, 14-11-1958, *Mogg 28990* (K, J, SRGH).

— **21º00' S, 35º00' E:** Meeringua District, S bank of Sabi River, *Chase 2225* (BM, COI, K, LISC).

— **23º51' S, 35º31' E:** Inhambane, near Maxixe, 29-08-1942, *Mendonca 26* (LISC).

— **24º42' S, 33º33' E:** Gaza, entrance to Chibuto, 12-06-1960, *De Lemos* & *Balsinhas 90* (BM, K, SRGH).

— **25º02' S, 33º06' E:** Sul do Save, Macia, 08-07-1947, *Pedrot* & *Pedrogao 1369* (COI, SRGH); Gaza, Magal, Macia, 01-06-1959, *Barbosa, L.* & *De Lemos, F. 8550* (COI, LISC).

— **25º58' S, 32º30' E:** Maputo, 1860, *Speke s.n.* (K, syn.), Maputo, Mahota, 04-1893, *Guintas, F. 28* (COI), Maputo, 04-1895, *Schlechter 20* (BM, BR, COI, K, PRE); 30-11-1897, *Schlechter 11544* (BM, Z). 15-07-1922, *Moss, C.E. 7006* (J); Costa do Sol, 14-09-1949, *Bachir, J. 9* (K, NU); 22 miles E of Maputo, 16-12-1956, *Mogg, A.O.D. 30000* (J); 08-1878, *Neculeiks, J.J. s.n.* (K, syn.);

— **26º00' S, 32º33' E:** Maputo, 4 km from Catembe, 06-05-1981, *De Koning, J.* & *Boane, C. 8676* (K, WAG).

— **26º00' S, 32º55' E:** Inhaca Island, 1935, *Weintrand, D. 28849* (J); 11-07-1944, *Moss, M. 21542* (J); 09-07-1949, *Moss, M.* & *Maguire, B. 16* (J); 02-07-1952, *Davidson, R.L. 28458* (J); 1956, *Mogg, A.O.D. 29068* (J); Inhaca Island W coast, S of Laboratienes, 26-07-1957, *Mogg 29383* (BM, J); 15-07-1957, *Barbosa, L.A.G. 7747* (SRGH); 11-09-1964, *Mogg, A.O.D. 31753* (J); Inhaca Island, Bušali (Ronga), 02-04-1967, *Saikomo* & *Mogg 33652* (J); Maputo, Inhaca, 29-07-1980, *De Koning, J.* & *Nuvanga, A. 8382* (K, SRGH, WAG); *Jansen* & *De Koning 7314* (MO, WAG).

— **Coordinates unknown :** Lugela-Mocuba District, Namagoa Estate, Lugela, 22-05-1949, *Faulkner 460* (BR, K, SRGH).

South Africa:

— **22º54'19" S, 30º10'37" E:** Limpopo, Soutpansberg, Mpefu [Mphephu] location at Hotspring, 06-1938, *Smuts, J.C. 2044* (K).

— **22º57' S, 30º38' E:** Limpopo, Soutpansberg, Makonde Mission Station, 15 miles NE of Sibasa, 18-02-1952, *Codd, L.E. 6812* (PRE).

— **22º58' S, 29º34' E:** Limpopo, Soutpansberg, at foot of mountain, 13-04-1934, *Schweickerdt* & *Verdoorn 591* (K, PRE, W).

— **24º59' S, 31º36' E:** Mpumalanga, Kruger National Park, Skukuza, Guesthouse, 31-03-1952, *Van der Schyff, H.P. 459* (PRE).

— **25º14' S, 31º33' E:** Mpumalanga, Kruger National Park, N of Malelane, 04-05-1949, *Codd 5508* (K, PRE, SRGH, MO, UPS).

— **25º15' S, 31º54' E:** Mpumalanga, Kruger National Park, along Lower Sabie road, 22-04-1953, *Van der Schyff, H.P. 2720* (PRE).

— **25º21'56'' S, 31º53'54'' E:** Mpumalanga, Crocodile Bridge, near Kruger National Park, Elephant Walk Retreat, along access road, 17-11-2006, *Joubert, L. 29* (BLFU).

— **25º26' S, 31º57' E:** Mpumalanga, Komati Poort, 30-11-1906, *Rogers 900* (K); *Rogers 4725* (GRA).

— **26º54'43'' S, 32º15'48'' E:** KwaZulu-Natal, Ingwavuma, Ndumu Game Reserve, Usutu Forest, 23-04-1969, *Pooley, E.S. 489* (NU).

— **26º56'50'' S, 32º14'20'' E:** KwaZulu-Natal, S of Ndumo Game Reserve, at bridge over Ingwavuma River, 14-11-1983, *Venter, H.J.T. 8985* (BLFU).

— **27º00' S, 32º12' E:** KwaZulu-Natal, Pongola River Pont between Otobotini and Maputa [Makane's Drift], 12-05-1965, *Vahrmeijer* & *Tölken 973* (K); Makane's Pont Bridge, over Pongola River at Makanesdrif, 14-11-1983, *Venter, H.J.T. 8986* (BLFU); Zululand, Makane's Drift, 06-12-1992, *Venter, H.J.T. 9249* (BLFU); KwaZulu-Natal, Makani's Pont, N of Josini, 19-11-2006, *Joubert, L. 30* (BLFU).

— **27º02'06'' S, 32º15'45'' E:** KwaZulu-Natal, Makni's Pont, along dirt road among crop fields E of bridge over Pongola River, 09-01-2009, *Joubert, L. 57* (BLFU).

— **27º02'06'' S, 32º15'47'' E:** KwaZulu-Natal, Makani's Pont, along dirt road E of bridge over Pongola River, 09-01-2009, *Joubert, L. 58* (BLFU).

— **27º06'02'' S, 32º14'30'' E:** KwaZulu-Natal, W of turn off to Ndumo Game Reserve, along Josini-Kosi Bay road, about 2.5 km S of Makani's Pont over the Pongola River, 09-01-2009, *Joubert, L. 59* (BLFU).

— **27º26' S, 32º04' E:** KwaZulu-Natal, Lebombo Mountains, Pongola Poort, Jozini, 07-08-1963, *Repton, J.E. 6036* (PRE).

— **27º26' S, 32º06' E:** KwaZulu-Natal, Josini Dam, 1 km E of dam wall, on riverbank of the Pongola River, 09-01-1983, *Venter, H.J.T. 8792* (BLFU).

— **27º38' S, 32º12' E:** KwaZulu-Natal, Mkuzi Game Reserve, 29-04-1960, *Tinley 619* (K, NH).

— **27º58' S, 32º05' E:** KwaZulu-Natal, Zululand, Hlabisa District, Bird Sanctuary Bushveld Reserve, 27-07-1944, *Gerstner, F.C. 4731* (PRE).

— **30º41'60'' S, 30º10'69'' E:** KwaZulu-Natal, Oribi Gorge, Hell's Gate, 15-01-1979, *Balkwill* & *Cron 298* (J).

Swaziland:

— 26º14' S, 32º05' E: Blue Jay Ranch, [in 1978 proclaimed as Nolzindza Nature Reserve, now part of Mlawula Nature Reserve], 26-06-1977, *Culverwell 895* (K, PRE).

Tanzania:

— 4º26' S, 38º00' E: Lindi, Saliman-Mamba, *Busse, W. 2682* (BM, BR).

— 6º25' S, 38º54' E: Mpimbini (T6), 9 km SE of Bagomoyo, *Raya , Minjas 1844* (BR).

— 6º48' S, 38º55' E: Along road from Morogoro to Dar es Salaam, abouit 64 km W of Dar es Salaam, 19-07-1968, *Harris, B.J. 2980* (K).

— 6º48' S, 39º15' E: Dar es Salaam, University College, 30-07-1966, *Harris, B.J. 308* (WAG); Dar es Salaam, 5 miles up Bagamoyo Road, 22-06-1968, *Batty, M. 158* (K); Dar es Salaam, University, 15-08-1966, *Harris, B.J. 333* (K, WAG); Mtomi, near Dar es Salaam, 13-09-1969, *Harris, B.J. 3313* (K, MO); Dar es Salaam, 29-09-1978, *Archbold, M.E. 2401* (K);

— 6º49' S, 37º40' E: Ukani, Morogoro, Ngerengire Fluss, 29-03-1926, *Peter, A. 39270* (WAG).

— 6º51' S, 39º18' E: Usaramo, Dar es Salaam, Sherambi, 29-08-1926, *Peter, A. 44604* (WAG); Usaramo, Dar es Salaam, Am Teich von Tjckanzombe, 07-09-1926, 04-09-1926, *Peter, A. 44837* (WAG); *Peter, A. 46903* (WAG).

— 6º52' S, 39º11' E: Ukonga, 18-09-1938, *Vaughan, J.H. 2482* (K).

— 6º55' S, 37º50' E: Morogoro North, 07-1930, *Haarer, A. 1906* (K).

— 7º10' S, 37º40' E: Moragora, Ulunguru Mountains, W side of mountains, 24-04-1933, *Schlieben 3814* (BM, BR, G, K, LISC, M, MO, SRGH, Z).

— 7º50' S, 39º02' E: Near Great Ruaha River, about 11 km W of Kidatu Bridge, 16-07-1970, *Thulin, M.* & *Mhoro, B. 440* (K).

— 8º08' S, 36º41' E: Katinduka, Ifakara, 23-07-1958, *Haerdi, F 15/82* (BR, K).

— 8º26' S, 38º32' E: about 3 km NNW of Kingupira, 01-06-1976, *Vollesen, K. 3699* (K).

— 9º00' S, 36º30' E: Ulanga District, 09-1972, *Haredi, F. 345* (G).

— 9º20' S, 33º30' E: Rungwe District, Lufiro River, 21-05-1957, *Richards, H.M. 9858* (BR, K).

— 9º30' S, 39º00' E: Kilwa District, Mtowe (Mwera), Kilwa Masoko, 22-07-1970, *Ruffo, C.K. 388* (K).

— **9º55' S, 35º20' E:** Mahenge, Sali, 24-05-1931, *Schliebben 2241* (BM, BR, G, M, Z).

— **10º00' S, 39º43' E:** Lindi-Bazirk, 02-02-1935, *Schlieben 5937* (LISC).

— **10º03' S, 39º28' E:** Lindi District, Lutamba lake, 40 km W of Lindi, 14-09-1934, *Schlieben 5335* (BM, BR, G, Z).

— **17º19' S, 31º29' E:** Usaramo, 26-10-1925, *Peter, A. 31432* (WAG).

— **Coordinates Unknown:** Ulanga District, *Haerdi 345* (G).

Zambia:

— **13º15' S, 31º55' E:** Luangwa Valley, Lupande area, Munkanya, 19-04-1065, *Phiri, R. 184* (K).

— **15º45' S, 26º20' E:** Namwala District, 23 km W of Namwala Boma, 24-06-1952, *White, F. 2982* (BR, K).

— **15º45' S, 26º27' E:** Namwala District, near Kafue River, 11-06-1949, *Hornby, R. 3017* (K, SRGH).

— **16º50' S, 26º57' E:** Choma, 18-03-1960, *Fanshawe, D.B. 5511* (K).

Zimbabwe:

— **16º22' S, 31º35' E:** Kaitano, Chiswiti Tribal Trust Land, 08-04-1965, *Bingham, M.T. 1442* (K, SRGH).

— **18º58' S, 32º40' E:** Umtali District, Glenshiel, along Odzi River, 09-06-1957, *Chaswe, N.C. 6539* (BR, K, SRHG); Umtali Village, 23-03-1961, *Chase, N.C. 5532* (BM, K, SRGH).

— **19º50' S, 32º30' E:** Melsetter, Lusitu River, about 5 km upstream from Lusitu, 23-04-1973, *Ngoni, J.F. 218* (BR, K, MO, SRGH).

— **20º12' S, 32º20' E:** Chipinga District, Tawona Pumping Station, bank of Sabi River, Mutema Rserve, 18-04-1965, *Chase, N.C. 8288* (K, LISC, MO,S RGH).

— **20º12' S, 32º38' E:** Chipinga District, Sabi River, near Mutandaura Hills, 21-07-1958, *Phelps, R.J. 242* (SRGH).

— **20º56' S, 29º01' E:** Gwanda, Bubye River, near Bubye Ranch, 03-05-1958, *Drummond, R.B. 5544* (SRGH).

— **21º15' S, 30º20' E:** Bubye-Limpopo confluence, 05-1961, *Bonghey, A.S. 176* (SRGH).

— **21º28' S, 29º24' E:** Gwanda, Doddieburn Ranch, 06-05-1972, *Pope 651* (MO).

Cryptolepis orbicularis

Somalia:

— **0º18'14'' S, 42º34'48'' E:** Jubbada Hoose Region, Chisimaio [Kismaayo] District, 1926, *Gorini, P. 322* (FT, holo.).

— **1º07'47'' N, 43º58'57'' E:** Shabeellaha Hoose Region, Brava [Baraawe] District, 30-04-1983, *Thulin, M*. & *Warfa, A.M. 99* (UPS).

— **1º57'33'' N, 45º12'09'' E:** Banaadir Region, S of Mogadishu, 12-11-1985, *Thulin, M.* & *Warfa, A.M. 5305* (UPS).

— **3º45' N, 47º02' E:** Galguduud Region, Ceeldheer District, 10-05-1990, *Thulin, M., Hedrén, M. & Dahir, A.M. 7410* (K, UPS).

— **4º38' N, 47º41' E:** Mudug Region, Xaradheere District, on road to Bulo Berti, 10-06-1979, *Gillett, J. B., Hemming, C.F. & Watson, R.M. 22534* (EA).

— **5º00' N, 47º59' E:** Mudug Region, Xaradeere District, 1 km S of Ad [Qeycad] on road to Haghadera [Xaradeere], 08-06-1979, *Gillett, J.B., Hemming, C.F. & Watson, R.M. 22484* (EA).

— **7º33' N, 49º21' E:** Nugaal Region, Xas Bahale District, 52 km SE of Xasbahale [Xas Bahale] on road to Godub Jiraan, 07-05-2001, *Thulin, M., Dahir, A., Khalid, A. & Osman, A. 10480* (K, UPS).

Cryptolepis sanguinolenta

Angola:

— **7º22' S, 20º51' E:** Nordeste da Lunda, [Lunda Norte Province], Dundo District, near Luachima River, 11-1946, *Gossweiler, J. 13.921* (BM, K).

— **9º13'45'' S, 15º24'27'' E:** [Cuanza Norte Province], N'dalatando District, Cazengo, 1935, *Gossweiler, J. 10357* (COI).

— **9º21' S, 14º53' E:** Cazengo, 1903, *Gossweiler, J. 656* (BM).

— Coordinates unknown**:** Hochland von Quila, Regenwald, *Nolde, B. 870* (COI x2).

Benin:

— **6º31' N, 1º52' E:** Forest near Houeyogbé, 16-07-1986, *Aké Assi, L. 17308* (G).

— **6º51' N, 2º06' E:** Atlantique Department, Toffo District, in plantation, 27-08-1999, *Essou, J.-P. 1714* (K).

Cameroon:

— 3º24' N, 11º47' E: Yaounde [District], Colline Rocheuse de Mokomessi [Hill], 20 km NNW of Zoetele, which lies 35 km NNW of Sangmelima, 07-07-1972, *Letouzey, R. 11442* (COI, K).

— 3º51' N, 11º28' E: Nkolbisson, summit of Mt. Akouandoué, 23-05-1970, *Bos, J.J. 6883* (WAG x2).

— 4º34' N, 14º16' E: Pandi Mountain, 14-04-1962, *Breteler, F.J. 2789* (LISC x2, WAG x2).

— 4º35' N, 14º16' E: Pandi Mountain, 14-04-1962, *Letouzey, R. 4744* (K, LISC, WAG).

Central African Republic:

— 3º51' N, 17º59' E: [Lobaye Province], Mbaïki District, Central Station at Boukoko, 19-11-1947, *Le Testu, G. 475* (BM); [Lobaye Province], Mbaïki District, Central Station at Boukoko, 27-07-1953, *Le Testu, G. 2569* (BM).

Democratic Republic of the Congo:

— 1º30' N, 29º42' E: [Ituri Province], Irumu District, Mount Homas, 06-1949, *Germain, R. 5180* (BR).

— 3º27' N, 25º42' E: Uele [Bas-Uele Province], Bambesa District, 1936, *Pittery, 188* (BR x2).

— 3º51' N, 30º14' E: [Haut-Uele Province], Kurukwata District, Aba, 03-08-1957, *Gerard, P.H. 3638* (BR).

— 4º08' N, 24º06' E: Putu District, near Niomgasa and Wembo [Airport], 06-1931, *Lebrun, J. 3210* (BR).

— 5º05' N, 28º22' E: [Bas-Uele Province], Tukpwo [Tukpo], 13-05-1958, *Gerard, P.H. 3881* (BR).

— Coordinates unknown : Bile, Uele-Himburi, Cambeau Forest, 05-1931, *Lebrun, J. 2822* (BR).

Ghana:

— 5º06'23'' N, 1º14'54'' W: Cape coast, 23-07-1955, *Hall, J.B. 32* (K).

— 5º56'33'' N, 0º05'25'' W: Volta Region, Larteh, Center for Scientific Research into Plant Medicine (CSRPM) farm, 16-09-1996, *Allen, J.T. 38* (MO).

— 6º31' N, 1º23' W: Lake Bosumtwe, 01-04-1954, *Adams, C.D. 2473* (K).

Guinea:

— **10º41' N, 12º14' W:** Mamou [Region], Vers Dalaba, 21-04-1949, *Adam, J.G. 4572* (MO).

— **11º18' N, 12º17' W:** Labé [Region], Labé, 31-03-1956, *Adam, J.G. 11758* (MO).

— **8º13' N, 9º16' W:** [Nzéréroké Region], Macenta [District], Mount Djiba, 28-07-1949, *Adam, J.G. 5824* (MO); [Nzéréroké Region], Macenta District, 24-10-1957, *Jacques-Félix, H. 1581* (K).

— **8º15' N, 8º36' W:** Nzérékoré [Region], Sibamou, 26-06-1949, *Adam, J.G. 5472* (MO x2).

Guinea-Bissau:

— **11º10'08'' N, 15º06'54'' W:** [Tombali Province], Jemberem District, Cassincha, 25-01-1995, *Malaisse, F. 14642* (BR).

— **11º34' N, 15º29' W:** Bolama, 09-0401945, *Santo, E. 1925* (K).

— **11º40'19'' N, 15º10'15'' W:** [Quinara Province], Lamane District, Cufada Lagoons Natural Park, 20-11-1997, *Martins, E.S.* & *Catarino, L. 1342* (LISC).

— **11º42' N, 15º04' E:** Along road from Fulacunda to Bedanda, 29-01-1954, *Collector unknown 245* (LISC).

— **11º55' N, 15º34' W:** Bissau, 07-02-1945, *Santo, E. 1739* (K).

— **12º13' N, 15º26' W:** Bissorã, Animal Research Centre, 17-12-1993, *Diniz, M.A.*, *Candé, U. & Bancessi, Q. 913* (LISC).

Ivory Coast:

— **6º21'59'' N, 4º54' W:** [Lacs Province], Orombo-Boka, [Orumboboka Forest], 30-06-1985, *Aké Assi, L. 16883* (G); [Lacs Province], Orumboboka [Forest], 14-07-1963, *Garnier, P. 67* (K).

— **6º31' N, 4º38' W:** Between Tiémélékro and Télébo, 23-06-1963, *Garnier, P. PG/UB 23* (K); Road between Tiémélékro and Télébo, 02-09-1963, *Garnier, P. PG/UB 133* (K, SRGH).

— **8º45' N, 3º35' W:** South of Bouna, Comoé National Park, 20-08-1991, *Poilecot, P. 4534 CI* (G).

Nigeria:

— **12º56'23'' N, 5º08'28'' E:** Sokoto Province, Dinyadi [Dingyadi], 16-12-1924, *Morrice, Dr. s.n.* (K).

— **6º25' N, 3º16' E:** Western Lagos, 1893, *Rowland, Dr.* (K).

— **7º11' N, 3º21' E:** [Ogun State], Abeokuta, rocky hill near Arakanga Forest Reserve, 13-05-1975, *Keay, R.W.J. & Onochie, C.F.A. 37013* (K).

— **7º24' N, 3º54' E:** [Oyo State], Ibadan District, hill above waterworks, 18-03-1950, *Meikle, R.D. 1296* (K x3).

— **Coordinates unknown:** Kabba Province, Ankpa District, by the edge of the Acharane Forest Reserve, *Daramola, B.O. 38040* (K, WAG x2).

Senegal:

— **12º23' N, 16º34' W:** [Ziguinchor Province], Oussouye District, Basse Casamance National Park, 21-11-1963, *Berhaut, R.P. 7325* (BR).

— **12º49' N, 16º19' W:** Ziguinchor District, Diégoun Village, 26-09-1961, *Adam, J.G. 18060* (SRGH).

Sierra Leone:

— **Coordinates unknown:** 1794, *Afzelius, A. 133* (UPS); 1794, *Afzelius, A. 337* (UPS); near Lumbaraya, 20-02-1892, *Scott Elliot, G.F. 5013* (K); *Don, G. s.n.* (K, holo.).

Tanzania:

— **2º17'50'' N, 32º00'14'' E:** Maisome Island Lake Region, Kigasi, 10-08-1962, *Carmichael 891* (EA).

— **4º40' S, 29º37' E:** Buha District, Kasakela Reserve, [Gombe National Park] at top of valley leading to Melinda Stream, 19-11-1962, *Verdcourt 3372* (EA); Kigoma District, Gombe Stream National Park, base camp, 06-02-1964, *Pirozynski, K.A. P337* (EA); Kigoma, Gombe National Park, near beach above M's house growing high up trunk of fig, 10-12-1969, *Clutton-Brock, T. 354* (EA); Kigoma, Gombe National Park, 16-03-1970, *Clutton-Brock, T. 353* (EA); Kigoma, Gombe National Park, 22-07-1970, *Clutton-Brock, T. 354A* (EA x2, K); Kigoma District, Gombe Stream Reserve, along the path to Peak Ridge from NP.H2., 06-05-1992, *Mbango, F. & Lyanga, M. 1115* (K).

— **5º01' S, 30º05' E:** Kigoma District, Tubira Forest, 01-04-1994, *Bidgood, S.* & *Vollesen, K. 3018* (EA, K, MO, UPS).

Togo:

— **7º31'06" N, 1º11'22" E:** about 8 km NE of Atakpamé, near Akpaka Runway (airfield), E of the road to Blitta, 19-09-1973, *Hiepko, P.* & *Schultze-Motel, W. 289* (WAG).

Uganda:

— **0º29' N, 30º23' E:** Kabarole District, Kibale Forest, Ngogo, 15-06-1997, *Eilu, G. 112* (K).

— **1º21' N, 32º27' E:** [Central Region], Nakasongola District, Buruli, 04-09-1943, *Thomas, A.S. Tu 3763* (EA).

— **2º60' N, 32º00' E:** Murchison Falls National Park, Rabongo Forest, [Kabarega National Park], 12-06-1993, *Sheil, D. 1640* (K).

— **1º02' S, 29º43' E:** Rukungiri District, Kinkizi County, Kayonza Sector, Ishasha Gorge, 17-02-1998, *Eilu, G. 255* (K).

Location unknown:

— 19-01-1926, *Gillett, J.* (BR).

Cryptolepis sinensis

China:

— **19º57'45" N, 110º21'15" E:** Canton, Hoihow [Haikou in Hainan Province], 10-10-1921, *McClure, F.A.* & *Merrill, E.D. 7652* (BM).

— **23º10' N, 113º17' E:** [Guangdong Province], Canton, 14-06-1884, *Sampson, T. 413* (BM).

— **23º23'06" N, 114º18'08" E:** Kwangtung [Guangdong Province], Luo-fu Shan [Mountains], 20-09-1978, *K'tung 78-6136* (L).

— **23º57'10" N, 113º16'03" E:** Canton [Gunagdong Province], North River, 1866, *Hance, H.F. 1887* (BM).

Hong Kong:

— **22º23'54" N, 114º06'48" E:** 1952, *Ch. Ford. 413 bis* (BM).

India:

— **18º34'52" N, 82º58'22" E:** Orissa [Odisha State], Koraput District, Pottangi, 10-07-1950, *Mooney, H.F. 3847* (K).

— **23º22'28" N, 77º34'13" E:** [Madhya Pradesh District], Dewanganj, 23-12-1808, *Wallich 1849* (K).

— **23º24'28" N, 86º35'27" E:** West Bengal, Kalabani District, 31-08-1873, *Maulu 3220B* (K).

— **25º34'58" N, 91º37'59" E:** [Meghalaya District], Khasi Hills [Khasia Mountains], 07-06-1850, *Hooker, J.D. & Thomson, V.T. 307* (K, L).

— **26º34'56" N, 89º00'18" E:** West Bengal, Dhupguri, 01-1880, *Gamble, J.S. 7650* (K).

— **27º03' N, 88º25' E:** [West Bengal], Mangwa, 11-11-1875, *Gamble, J.S. 227A* (K).

— **27º08'08" N, 88º16'48" E:** Sikkim District, Rangeet Valley, 22-07-1974, *C.h. 400* (K).

— **Coordinates unknown:** Assam District, 1841, *Jenkins & Hooker, J.D. s.n.* (K).

Indonesia:

— **7º24'28" S, 112º38'45" E:** [East Java], Soerabaja [Surabaya], 06-12-1924, *Dolgelo, J.D. 3167* (L).

— **7º53'51" S, 113º08'43" E:** [East Java], Koeripan [Kuripan], *Herb. Lugd. Bat. 898.166-349* (L, holo.).

— **8º40'13" S, 118º36'50" E:** [Nusa Tenggara Barat], Sumbawa [Island], Sultanat Bima [Bima], 11-12-1909, *Elbert, J. 3757* (L).

— **8º40'29" S, 122º09'42" E:** Lesser Sunda Islands, [East Nusa Tenggara Province], Flores, Nita, 25-01-1962, *Loeters, P.J.J. 1387* (L).

— **Coordinates unknown:** Java, 20-10-1909, *Hallier 217* (L).

Myanmar (Burma):

— **26º33'09" N, 97º03' E:** [Kachin State], Sumpra Bum, 18-02-1853, *Kingdon-Ward, F. 20553* (BM).

Nepal:

— **26º48' N, 87º55' E:** [Eastern Region], 5 miles [8 km] E of Soktim T.E., 24-05-1971, *Stainton, J.D.A. 6894* (BM).

Philippines:

— **12º46'20" N, 124º03'26" E:** Luzon, Sorsogon Province, Mount Bulusan, near Irosin, 09-1916, *Elmer, A.D.E. 17399* (BM, K).

— **Coordinates unknown:** *Cuming, H. 818* (L).

Taiwan (Formosa):

— **21º55'58" N, 120º49'45" E:** South Cape, 04-1895, *Henry, A. 626* (K); South Cape, 05-1894, *Henry, A. 1706* (BM).

Thailand (Siam):

— **18º06'23" N, 102º58'45" E:** Udon Thani Province, Nong Han District, 03-07-1931, *Lakshnakara, M.C. 1041* (K).

Vietnam:

— **20º59'26" N, 106º36'15" E:** Tonkin [Province], [Thuy Nguyen District], Taai Wong Mo Shan, near Chuk-phai, Ha-coi, 03-05-1939, *Tsang, W.T. 29098* (UPS).

— **21º29' N, 107º32' E:** Tonkin [Province], [Quang Ninh Province], Dam-ha District, near Lung Wan Village, at Sai Wong Mo Shan (Sai Vong Mo Leng) [Sai Wong Mountain], 18-05-1940, *Tsang, W.T. 29825* (UPS).

Location unknown:

— Cissam, Hallong, northern Cackar Hills, 06-1929, *Parry, N.E. 721* (K)

— *Herb. Lugd. Batav. 898.166-344* (L); *Herb. Lugd. Batav. 898.166-345* (L).

Cryptolepis socotrana

Socotra:

— **12º20'13" N, 53º36'46" E:** Nogad Plain, Qa'arah, 03-10-1998, *Miller, A.G., Hyam, Al Khulaidi, Salaiman & Talib M.16133* (E).

— **12º20'14" N, 54º00'34" E:** Nogad Plain, Wadi Irih, 1 km from mouth, 06-02-1990, *Miller, A.G., Bazara'a, M., Guarino, L. & Kassim, N. M. 10289* (E).

— **12º21' N, 53º34' E:** 1 km E of Ras Kattanahan, 16-01-1994, *Thulin, M.* & *Gifri, A.N. 8571* (K).

— **12º25'55" N, 54º00'21" E:** Nogad Plain, Wadi Irih draining south into Nogad Plain due south of Hadiboh, 28-02-1989, *Miller, A.G., Guarino, L., Obadi, N., Hassan, M. & Mohammed, N. M.8528* (E).

— **12º29'42" N, 54º19'52" E:** Killisan, 22-09-1998, *Miller, A.G., Hyam, Al Khulaidi, Salaiman & Talib M.16010* (E).

— **12º35' N, 54º03' E:** Hagghier Mountains, 02-1880, *Balfour, I.B 525* (E, holo.; BM, GH, K, iso.).

— **Coordinates unknown:** 02-1880, *Balfour, I.B. s.n.* (E); 02-1880, *Balfour, I.B. 107* (E); Adla, 22-03-1953, *Popov, G. GP/So/ 275* (BM); *Morris, M. 21* (E).

Cryptolepis somaliensis

Somalia:

— **7º42' N, 49º38' E:** Nugaal Region, Gaalogod District, 19 km along track from Gaalogod to Garadeen, 09-05-2001, *Thulin, M. , Dahir, A., Khalid, A. & Osman, A. 10509* (UPS, holo.).

Cryptolepis stefaninii

Somalia:

— **8º21'42'' N, 48º25'50'' E:** Nugaal Region, Garoowe District, 6.4 km S of Garue [Garoowe], 14-06-1958, *Hemming, C.F. 1372* (K).

— **8º34' N, 47º21' E:** Nugaal Region, Las Anod [Laascaanood] District, 8 km S of Las Anod [Laascaanood], 30-12-1972, *Bally, P.R.O.* & *Melville, R. 15400* (K).

— **8º24'35'' N, 47º18'56'' E:** [Nugaal Region], Burao-Las Anod road, 13 km N of Las Anod [Laaschaanood], 01-07-1980, *Gillett, J.B. 23935* (K).

— **9º05' N, 48º40' E:** Nugaal Region, Halin District, 5 km E of Halin along road to Gardo [Qardho], 21-06-1985, *Thulin, M.* & *Warfa, A.M. 5417* (UPS).

— **9º06' N, 47º49' E:** Nugaal Region, Resourse Management and Research Northern Rangelands Survey, Nugaal Region, 03-12-1980, *Beckett, J.J. 652* (K); 10-02-1981, *Beckett, J.J. 856* (K).

— **10º13' N, 49º02' E:** Bari Region, 6 km from Dalweyn along road to Qardho, 04-05-2001, *Thulin, M., Dahir, A., Khalid, A. & Osman, A. 10422* (K, UPS).

— **10º17'56'' N, 49º55'21'' E:** Bari Region, Darror [Dharoor] District, Halil Damolle, 03-07-1924, *Puccioni, N. & Stefaninii, G. 1001 [1105]* (FT, holo.).

— **Coordinates unknown:** Somalia, *Glover, P.E. & Gilliland, H.B. s.n.* (BM).

Cryptolepis thulinii

Somalia:

— **2º18' N, 45º23' E:** Shabeellaha Dhexe Region, Balad [Balcad] District, 5 km along road from Balad to Mogadishu, 12-11-1985, *Thulin, M.* & *Warfa, A.M. 5287* (UPS, holo.; K, iso.).

— **2º21' N, 45º25' E:** Shabeellaha Dhexe Region, Balad [Balcad] District, 1 km S of Balad [Balcad], on track to Uarsciek [Warshiikh], 16-05-1983, *Thulin, M. & Warfa, A.M. 4712* (K, UPS).

— **2º24' N, 42º57' E:** Bay Region, Dinsoor [Diinsoor] District, Bur Kurtungale, 23-02-1982, *Beckett, J.J.* & *White, R. 1610* (K).

— **3º21' N, 45º40' E:** Hiiraan Region, Jalalaksi [Jalalaqsi] District, 8 km SE of Jalalaksi [Jalalaqsi], 29-10-1987, *Kuchar, P. 17552* (UPS).

— **5º40' N, 47º57' E:** Mudug Region, 10 km N of Ad, on road from Wisil, 08-06-1979, *Gillett, J.B., Hemming, C.F. & Watson, R.M. 22455* (EA).

— **0º10' S, 41º36' E:** Jubbada Hoose Region, 38 km E of Hoswein [Hoosingo] on Kisimaio [Kismaayo] road, 04-07-1983, *Gillett, J.B., Hemming, C.F., Watson, R.M. & Julin, H. 25286* (EA, K).

Cryptolepis villosa

Tanzania:

— **8º41' S, 38º04' E:** Selous Game Reserve, source of Nahomba River, 10-02-1978, *Vollesen, K. 4920* (K, holo.; K, iso.).

— **4º46' S, 39º07' E:** Kilulu Hill, 26-07-2001, *Luke, W.R.Q. , Chidzinga, S. 7546* (K).

Cryptolepis volubilis

Socotra:

— **12º19'57" N, 54º00'26" E:** Nogad Plain, mouth of Wadi Irih (River), 06-02-1990, *Miller, A.G., Bazara'a, M., Guarino, L. & Kassim, N. M.10308* (K).

— **12º34' N, 54º02' E:** Wadi Kischen (River), [Wadi Qishn], 08-05-1881, *Schweinfurth, G.A. 667* (K, syn.).

— **12º36'38" N, 54º03'52" E:** 7 km SE of Hadiboh, Wadi Deneghan (River), [Wadi Dininghen], 19-02-1989, *Miller, A.G., Guarino, L., Obadi, N., Hassan, M. & Mohammed, N. M.8243* (K, UPS).

— **12º37'37'' N, 54º02' E:** Wadi Keregnigiti (River), 20-04-1880, *Schweinfurth, G.A. 472* (E, P, syn.).

— **12º38'12'' N, 53º30'39'' E:** Qaysoh [Qashio], S of Qalansiyah, 30-01-1990, *Miller, A.G., Bazara'a, M., Garino, L. & Kassim, N. M.10172* (UPS).

— **12º38'43'' N, 53º29'11'' E:** Qallansiya [Qalansiyah], Jebel Ma'alih (Mountain), 27-03-1967, *Smith, A.R.* & *Lavranos, J. 171* (EA, WAG).

— **12º39' N, 54º05' E:** Hadibu [Hadiboh], 7 km E of Hadibu along road to Mumi, 20-01-1994, *Thulin, M.* & *Gifri, A.N. 8629* (K, UPS).

— **Coordinates unknown:** *Balfour, B. 259* (E, lecto.; BM, K, isolecto.); 02-1880, *Balfour, I.B. 696* (BM, E, K, syn.); 05-1893, *Balfour, I.B. s.n.* (K); Malss, 24-08-1956, *Gwynne, M.D. 130* (BM).

Cryptolepis yemenensis

Yemen:

— **13º36'32'' N, 45º49'06'' E:** Abyan, between Shaqra and Lodar, 17-10-1962, *Popov, G. P34/10* (BM).

— **14º16'30'' N, 47º04'14'' E:** Shabwah, Habban, 5 km S of Habban, along Lawdar–Al-Mukalla road, 12-06-1987, *Boulos, L., Rowaished, A.K., Gifri, A.N., Saeed, W.A. & Hussein, M.A. 16899* (K, holo.; BM, iso.).

— **14º50'47'' N, 48º26'33'' E:** Hadramaut, 64 km S of Jahi Pass, along Jol West road, 16-08-1949, *Guichard, K.M. KG/HAD 15* (BM).

— **14º56'24'' N, 48º25'36'' E:** Hadramaut, Djol Plateau, 17-04-1939, *Wissman, H.v. 1378* (BM).

Appendix 2

Voucher information for sequences previously published by *Ionta and Judd (2007) and **Meve and Liede (2004) and specimens used for DNA extraction and sequencing in this study. Dashes indicate missing sequences. For *Sacleuxia newii* two GenBank numbers are indicated: the first number indicates *trnL-F* and the second (only last two digits given) *trnT-L.* Three GenBank numbers are given for *Camptocarpus mauritianus, Ischnolepis graminifolia, Pentopetia grevei, Periploca visciformis, Petopentia natalensis, Raphionacme flanaganii, Raphionacme madiensis* and *Schlechterella abyssinica*: the first indicates *trnT-L*, the second indicates *trnL* intron (only last two digits given) and the third indicates *trnL-F* (only last two digits given). Where current names differ from those used by Ionta and Judd (2007) the current name is given first followed by the name used by Ionta and Judd (2007).

Taxon	**Origin**	**Voucher**	**GenBank accession numbers**		
			trnT-F	***trnD-T***	***ITS***
OUTGROUP					
Rhazya stricta Decne. (Rauvolfioideae)	Yemen	*Bruyns 10930a* (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Apocynum venetum A.DC. (Apocynoideae)	Saudi Arabia	*Naylor 84* (E)	Genbank no. pending	—	Genbank no. pending
**Forsteronia leptocarpa* A.DC. (Apocynoideae)	Brazil, Udatuba	*Simões & Singer 1037* (UEC)	DQ916868	—	DQ916831
Nerium oleander L. (Apocynoideae)	Ex hort	*Bruyns* s.n. (BOL)	Genbank no. pending	Genbank no. pending	Genbank no. pending
**Rhabdadenia biflora* Müll.Arg. (Apocynoideae)	U.S.A., Florida	*Zona 616* (FTG)	DQ916869	DQ916903	DQ916832
PERIPLOCOIDEAE					
**Atherandra acuminata* Decne.	Thailand, Surat	*Put 4139* (P)	—	—	DQ916833
**Baroniella camptocarpoides* Costantin & Gallaud	Madagascar, Toliara	*Phillipson et al. 3956* (MO)	—	—	DQ916834
**Baseonema gregorii* Schltr. & Rendle	Tanzania	*Cox & Abdallah 2928* (K)	—	—	DQ916835
**Batesanthus purpureus* N.E.Br.	Zaire	*Hart 620* (MO)	—	—	DQ916836
**Buckollia volubilis* (Schltr.) Venter & R.L.Verh.	Ethiopia, Sidamo	*Hangen 2041* (K)	—	—	DQ916837
*/***Camptocarpus mauritianus* (Lam.) Decne.	Madagascar, Toliara	*Petignat s.n.* (UBT)	**AJ581794/95/96	*DQ916887	**AJ581677

**Chlorocyathus lobulata* (Venter & R.L.Verh.) Venter [=*Raphionacme lobulata* Venter & R.L.Verh.]	South Africa, Eastern Cape	*Dold 4461* (GRA)	—	—	DQ916862
Cryptolepis apiculata K.Schum.	Tanzania	*Sennblad 214* (UPS)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis arbuscula (Radcl.-Sm.) Venter	Adho di Melho, Socotra	*Bruyns 11280* (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis capensis Schltr. 1	South Africa	*Joubert 60* (BLFU)	Genbank no. pending	Genbank no. pending	Genbank no. pending
**Cryptolepis capensis* Schltr. 2	South Africa	*Abbott 7761* (Z)	DQ916871	DQ916889	DQ916839
Cryptolepis cryptolepioides (Schltr.) Bullock	South Africa	*Joubert 27* (BLFU)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis decidua (Planch. ex Hook.f. & Benth.) N.E.Br. 1	South Africa	*Du Preez* s.n. (BLFU)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis decidua (Planch. ex Hook.f. & Benth.) N.E.Br.2	W. Ruacana, Namibia	*Bruyns* s.n. (BOL)	Genbank no. pending	Genbank no. pending	Genbank no. pending
**Cryptolepis delagoensis* Schltr.	South Africa, KwaZulu-Natal	*Bruyns 9357* (BOL)	—	—	DQ916840
Cryptolepis dubia Roem. & Schult.1	India	*Bruyns 11428* (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
**Cryptolepis dubia* Roem. & Schult. 2	Pakistan, Islamabad	*Sultan s.n.* (UBT)	DQ916870	DQ916888	DQ916838
Cryptolepis eburnea (Pichon) Venter	Guinea	*Jongkind 8341* (WAG)	Genbank no. pending	Genbank no. pending	Genbank no. pending
**Cryptolepis hypoglauca* K.Schum. ex Engl.	Tanzania, Masasi Distr.	*Bidgood et al. 2086* (K)	—	—	DQ916841
Cryptolepis intricata (Balf.f.) Venter	Adho di Melho, Socotra	*Bruyns 11279* (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis macrophylla (Radcl.-Sm.) Venter 1	J. Ma'Lih, Socotra	*Bruyns 11282* (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis macrophylla (Radcl.-Sm.) Venter 2	Hoq Cave, Socotra	*Bruyns* s.n. (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis macrophylla (Radcl.-Sm.) Venter 3	Abd-al-Kuri, Socotra	*Banfield 1148* (E)	—	—	Genbank no. pending
Cryptolepis macrophylla (Radcl.-Sm.) Venter 4	Socotra	*Miller et al. 17150* (E)	Genbank no. pending	—	Genbank no. pending
Cryptolepis migiurtina Chiov.	Somalia	*Thulin et al. 10099* (UPS)	—	Genbank no. pending	Genbank no. pending

Cryptolepis nugaalensis Venter & Thulin	Somalia	*Thulin et al. 10504* (UPS)	Genbank no. pending	—	Genbank no. pending
Cryptolepis oblongifolia (Meisn.) Schltr. 1	Zambia	*Zimba et al. 710* (G)	Genbank no. pending	Genbank no. pending	—
Cryptolepis oblongifolia (Meisn.) Schltr. 2	Ghana	*Jongkind 2724* (WAG)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis oblongifolia (Meisn.) Schltr. 3	Zaïre	*Lejoly 82/769* (BR)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis oblongifolia (Meisn.) Schltr. 4	Angola	*Bester 9013* (PRE)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis oblongifolia (Meisn.) Schltr. 5	Angola	*Bester 9014* (PRE)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis oblongifolia (Meisn.) Schltr. 6	Angola	*Bester 9002* (PRE)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis oblongifolia (Meisn.) Schltr. 7	Angola	*Bester 9062* (PRE)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis oblongifolia (Meisn.) Schltr. 8	Angola	*Bester 9294* (PRE)	Genbank no. pending	Genbank no. pending	Genbank no. pending
**Cryptolepis oblongifolia* (Meisn.) Schltr. 9	South Africa, Transvaal	*Bruyns 9367* (E)	DQ916872	DQ916890	DQ916842
Cryptolepis producta N.E.Br.	Zambia	*Fanshawe 6019* (BR)	—	—	Genbank no. pending
Cryptolepis obtusa N.E.Br.	South Africa	*Joubert 57* (BLFU)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis sanguinolenta (Lindl.) Schltr.	Tanzania	*Bidgood & Vollesen 3018* (EA)	Genbank no. pending	—	—
Cryptolepis sinensis (Lour.) Merr.	Nepal	*Stainton 6894* (BM)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis socotrana (Balf.f.) Venter	Darha, Socotra	*Bruyns 11271* (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis somaliensis Venter & Thulin	Somalia	*Thulin et al. 10509* (UPS)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis stefaninii Chiov. 1	Somalia	*Thulin et al. 4206* (UPS)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis stefaninii Chiov. 2	Somalia	*Thulin et al. 10422* (UPS)	Genbank no. pending	—	Genbank no. pending
Cryptolepis stefaninii Chiov. 3	Somalia	*Thulin & Warfa 5417* (UPS)	Genbank no. pending	—	Genbank no. pending
Cryptolepis volubilis (Balf.f.) Schwartz	Wadi Eyhaft, Socotra	*Bruyns* s.n. (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Cryptolepis yemenensis Venter & R.L.Verh.	Yemen	*Thulin et al. 9931* (UPS)	Genbank no. pending	Genbank no. pending	Genbank no. pending

**Cryptostegia madagascariensis* Bojer	U.S.A., Florida, cult.	*Ionta 418* (FLAS)	DQ916873	DQ916891	DQ916843
**Cryptostegia madagascariensis* Bojer	U.S.A., Florida, cult.	*Ionta 538* (FLAS)	—	—	DQ916844
**Decalepis arayalpathra* (J.Joseph & V.Chandras) Venter	India, Cirzar Hills, 1989	*Rajasekharan s.n.* (K)	—	—	DQ916845
Decalepis hamiltonii Wight. & Arn.	India	*Bruyns 11447* (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Decalepis nervosa (Wight. & Arn.) Venter	India	*Bruyns 11472* (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
Decalepis salicifolia (Bedd. ex Hook.f.) Venter	India	*FRLHT 58354*	Genbank no. pending	Genbank no. pending	Genbank no. pending
**Ectadium latifolium* N.E.Br.	Namibia	*Albers 2413* (UBT)	DQ916874	DQ916892	DQ916846
**Epistemma rupestre* H.Huber	Cameroon, Rocher Ako'okas	*deWilde 7462* (MO)	—	—	DQ916847
**Finlaysonia insularum* (King & Gamble) Venter	Thailand	*Middleton 1164* (A)	DQ916875	DQ916893	DQ916848
**Finlaysonia lanuginosa* (Ridl.) Venter	U.S.A., Cornell Univ., cult.	*Livschultz 03-41* (BH)	DQ916876	DQ916894	DQ916849
**Gymnanthera oblonga* (Burm.f.) P.S.Green	Australia, Northern Territory	*Forster 6133* (K)	—	—	DQ916850
**Hemidesmus indicus* (L.) R.Br. ex Schult.	India	*Civeyrel 1008* (TL)	DQ916877	DQ916895	DQ916851
***Ischnolepis graminifolia* (Costantin & Gallaud) Klack.	Madagascar, Ambinanitelo	*Röösli s.n.* (UBT)	AJ581799/98/97	—	AJ581678
**Mondia whitei* (Hook.f.) Skeels	South Africa, Univ. Natal, Pietermaritzburg. cult.	*ex hort. Ollerton s.n.*	DQ916878	DQ916896	DQ916852
**Myriopteron paniculatum* Griff.	s. loc.	*Shuncheng 9801135* (MO)	—	—	DQ916853
Parquetina calophylla (Baill.) Venter 1	Benin	*Essau 1711* (WAG)	Genbank no. pending	—	Genbank no. pending
**Parquetina calophylla* (Baill.) Venter 2 [= *Omphalogonus calophyllus* Baill.]	Tanzania , Muheza District	*Mwangoka et al. 1241* (MO)	—	—	DQ916854
Parquetina nigrescens (Afzel.) Bullock 1			Genbank no. pending	—	Genbank no. pending

**Parquetina nigrescens* (Afzel.) Bullock 2 [= *Periploca nigrescens* Afzel.]	Ghana	*Merello et al. 1354* (MO)	—	—	DQ916859
*/***Pentopetia grevei* (Baill.) Venter	Madagascar, Ambinanitelo	*Mangelsdorff 516* (UBT)	**AJ581805/04/03	*DQ916897	**AJ581681
**Pentopetia longipetala* Klack.	Madagascar, Ambalabao	*Allorge 2422* (P)	DQ916879	—	DQ916855
**Periploca calophylla* (Wight) Falc.	China, Sichuan Prov.	*Liu Zheng Yu 15548* (GH)	DQ916880	—	DQ916856
**Periploca graeca* L.	Switzerland, Bot. Gard. Zurich, cult.	*Endress s.n.* (Z)	DQ916881	DQ916898	DQ916857
**Periploca laevigata* Ait.	Spain, Canary Islands	*Fernandez s.n.* (Z)	DQ916882	DQ916899	DQ916858
Periploca somaliensis Browicz	Yemen	*Bruyns 10916* (E)	Genbank no. pending	Genbank no. pending	Genbank no. pending
***Periploca visciformis* (Vatke) K.Schum.	Socotra, Wadi Ayhaft	*Mies 1444* (UBT)	AJ431734/35/36	—	AJ581683
*/***Petopentia natalensis* (Schltr.) Bullock	s. loc.	*ex hort. Kiel.* (UBT)	**AJ581810/09/08	*DQ916900	**AJ581684
**Phyllanthera grayi* (P.I.Forst.) Venter	Australia	*Forster 24232* (BRI)	DQ916883	DQ916901	DQ916860
***Raphionacme flanaganii* Schltr.	South Africa, Pietermaritzburg	*Albers 1577* (MSUN)	AJ581817/18/19	—	AJ581688
**Raphionacme galpinii* Schltr.	South Africa	*Abbott s.n.* (Z)	DQ916884	DQ916902	DQ916861
***Raphionacme madiensis* S.Moore	Tanzania, Dodoma	*Specks 682* (UBT)	AJ581828/27/26	—	AJ581690
**Sacleuxia newii* (Benth.) Bullock	Tanzania, Kilosa	*Bruyns 8653* (K)	DQ916909/10	—	DQ916863
*/***Schlechterella abyssinica* (Chiov.) Venter & R.L.Verh.	Kenya, Furole	*Newton 4555* (UBT)	**AJ581829/30/31	*DQ916904	**AJ581691
*/***Stomatostemma monteiroae* N.E.Br.	s. loc.	*IPPS 1427* (UBT)	**AJ431779/80/81	*DQ916905	**AJ581692
**Stomatostemma pendulina* Venter & D.V.Field	Mozambique, Ribaue	*Bruyns 7716* (K)	—	—	DQ916864
**Streptocaulon juventas* (Lour.) Merr.	Laos, Sii Phan Don, Kong District	*Middleton 267* (A)	—	DQ916906	DQ916865
**Tacazzea apiculata* Oliver	Zambia, Luapula District	*Renvoize 5760* (MO)	DQ916885	DQ916907	DQ916866
**Zygostelma benthamii* Baill.	Thailand, Phetchaburi	*Middleton 849* (A)	DQ916886	DQ916908	DQ916867