TAXONOMY AND BIOGEOGRAPHY OF *GYMNOCARPOS* (CARYOPHYLLACEAE)

L. PETRUSSON* & M. THULIN*

The circumscription of *Gymnocarpos* (Caryophyllaceae) is extended to include the genus *Lochia*. Eight species are recognized: *G. decandrus* in the Canary Islands, northern Africa and southwestern Asia, *G. parvibractus* in Somalia, *G. argenteus* and *G. mahranus* in the mainland of Yemen, *G. dhofarensis* in Yemen and Oman, *G. rotundifolius* in Oman, *G. kuriensis* on Abd al-Kuri and Socotra, and *G. bracteatus* on Socotra. A phylogenetic analysis of *Gymnocarpos* is presented and the biogeography of the genus is discussed. The analysis suggests that *G. mahranus* and *G. parvibractus*, and *G. kuriensis* and *G. rotundifolius*, are pairs of vicarious sister species. *G. argenteus*, *G. dhofarensis*, *G. mahranus* and *G. rotundifolius* are species new to science. New combinations are *G. bracteatus*, *G. kuriensis* and *G. parvibractus*. *G. decandrus* is lectotypified. *G. przewalskii*, a species from China and Mongolia, is excluded from *Gymnocarpos* and would probably best be treated as a genus of its own.

Keywords. Arid regions, Illecebraceae, lectotypification, *Lochia*, new species.

INTRODUCTION

Gymnocarpos Forssk., as presently usually conceived, is a genus of small, perennial shrublets with succulent, mucronate leaves growing in arid regions in northern Africa, the Middle East, SW Asia, and C Asia. Two species are currently recognized: *G. decandrus* extending from the Canary Islands to West Pakistan, and *G. przewalskii* in WNW China and Mongolia.

Lochia Balf.f. has usually been regarded as closely related to *Gymnocarpos*. Three species have previously been described: *L. bracteata* and *L. kuriensis* on Socotra and Abd al-Kuri, and *L. parvibracta* from Somalia.

However, as will be shown below, the alleged differences between *Gymnocarpos* and *Lochia* are either false or untenable and the two genera are therefore united. Also, during recent fieldwork in the southern part of the Arabian Peninsula a number of obviously new taxa have been found that belong to *Gymnocarpos* in a wide sense.

The present paper aims at a revision of *Gymnocarpos* sensu lato, and also includes an analysis of the phylogeny and biogeography of this genus. Unless otherwise indicated, all specimens cited have been seen. In particular there are a few (temporarily) missing specimens previously known to have been in E. These are indicated with 'n.v.'.

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HISTORICAL REVIEW

The first described species of *Gymnocarpos*, *G. decandrus*, was discovered in Egypt by Forsskål during the expedition to 'Arabia Felix' in 1761–63 (Forsskål, 1775, 1776). A second species, *G. przewalskii*, was described by Maximowicz from central Asia in 1880. A third species, *G. salsoloides* described from the Canary Islands by Christ (1888), was reduced to a form of *G. decandrus* by Chaudhri (1968).

The first described species of *Lochia*, *L. bracteata*, was discovered by Balfour, Cockburn and Scott during their expedition to Socotra in 1880. Balfour (1884, 1888) named the genus after General Loch, Commandant at Aden at the time of the expedition. *L. bracteata* was also later reported from Abd al-Kuri (Balfour, 1903; Vierhapper, 1907).

Chaudhri (1968) recognized two subspecies of *L. bracteata*, subsp. *bracteata* and subsp. *abdulkuriana*. Subsp. *bracteata* was treated as an endemic of Socotra and included one new form, forma *ciliata*. Subsp. *abdulkuriana* was described from the adjacent island of Abd al-Kuri.

Radcliffe-Smith studied the genus in the field on both Socotra and Abd al-Kuri and came to the conclusion that it included two different species, one on each island. The previous subsp. *abdulkuriana* was redescribed as *L. kuriensis* (Radcliffe-Smith, 1971). The name *abdulkuriana* was not retained, as it represented a misspelling of the name of the island.

A third species, *L. parvibracta*, was described by Gilbert (1991) from material collected by Thulin and Abdi Dahir in central Somalia.

Material of *Lochia* has also been collected in the Dhofar Region of Oman and the Hadramaut and Mahra Regions of Yemen, particularly during recent years. Previously this has generally been called *L. bracteata* in a wide sense (King & Kay, 1984; Bittrich, 1993), but in the present work four new species are recognized from the southern part of the Arabian Peninsula.

TAXONOMIC REMARKS

Gymnocarpos and *Lochia* belong to subfamily Paronychioideae. This has often been regarded as a distinct family, Illecebraceae, differing from Caryophyllaceae by the presence of a cupular receptacle (perigonium), stipulate leaves, apetalous flowers with the inner whorl of stamens often replaced by staminodes (sometimes regarded as petals), and indehiscent one-seeded fruits (Gilbert, 1993).

Bittrich (1993) took a broader view of Paronychioideae, including also the tribes Polycarpeae and Corrigioleae, and placed *Lochia* in the tribe Paronychieae close to *Paronychia*. The genus *Gymnocarpos* sensu stricto was included by Bittrich (1993), without further explanation, in *Paronychia*. As *Paronychia* has a bicarpellary gynoecium as opposed to the tricarpellary gynoecium in *Gymnocarpos*, and as it also differs in several other morphological characters — such as the herbaceous, flat, non-mucronate, hairy leaves in *Paronychia* in contrast to the succulent, cylindrical,

mucronate and glabrous leaves in *Gymnocarpos* — we find the amalgamation of these genera unwarranted.

The main difference used by Chaudhri (1968) to distinguish between *Lochia* and *Gymnocarpos* was the number of carpels. According to Balfour (1884, 1888) *Lochia* has a bifid style indicating a bicarpellary gynoecium, while in *Gymnocarpos* the style is trifid. This statement, which has been repeated in all subsequent accounts of these genera up to now, is however erroneous. The number of carpels in *Lochia* is actually also three, and even in the illustration of *L. bracteata* in Balfour (1888) a clearly trifid style is shown.

Balfour (1888) also distinguished *Lochia* from *Gymnocarpos* by 'its large membranous bracts of the cymes, the short perianth-tube with connivent lobes, short stamens, and nonadherent ovary'. Chaudhri (1968) mentioned a number of differences between the two genera, principally characters of the inflorescence and flowers. However, with the additional species described in this paper, the difference between the genera is only a matter of degree as regards length of leaves, flowers, staminodes etc., as well as indumentum characters. Also, as regards the somewhat sunken ovary in *Gymnocarpos* as opposed to the free ovary in *Lochia* the difference is gradual. We therefore here propose an amalgamation of the two genera. For the status of *G. przewalskii*, see under 'Excluded species'.

ASPECTS OF MORPHOLOGY

Bracts

The large and scarious bracts are typical of most species in the genus (Fig. 1A). However, *G. parvibractus* and *G. mahranus* have similar but smaller and stipule-like bracts (Fig. 1B). In *G. decandrus* the bracts are leaf-like, i.e. they consist of a small, subulate lamina which is fused at the base with the stipules (Fig. 6B). However, similar types of leaf-like bracts may also be present in the species with large, scarious bracts, and then in the lowermost parts of the cyme. The lamina may in this case be strongly reduced and represented only by a green, fleshy tip between the two fused stipules (Fig. 1C). Only *G. rotundifolius*, among the species with large scarious bracts, seems to be entirely devoid of leaf-like bracts.

The bracts in the genus thus show a more or less gradual transformation between those that are similar to an ordinary leaf with its stipules (Fig. 1D) and an entirely scarious bract (Fig. 1A). On the assumption that this transformation series started with a bract similar to an ordinary leaf, the stipules have in most cases apparently increased in size and become fused, and the lamina has decreased and finally disappeared during this process. However, in *G. parvibractus* and *G. mahranus* there has been a loss of the lamina in the bracts, but almost no increase in size compared to the stipules.

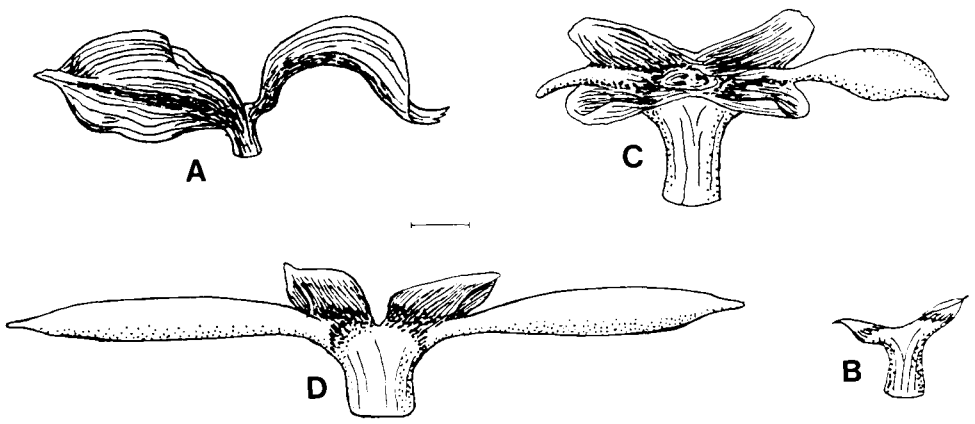

FIG. 1. Bracts and stipules in *Gymnocarpos*. A, large scarious bracts in *G. dhofarensis* (*Miller* 2524); B, small stipule-like bracts in *G. mahranus* (*Miller* 12131); C, leaf-like bracts with reduced laminae in *G. bracteatus* (*Smith & Lavranos* 594); D, leaves with stipules in *G. kuriensis* (*Simony* s.n.). For all, scale bar = 1mm.

Staminodes

Gymnocarpos, like many other genera in the subfamily Paronychioidae, has the inner whorl of stamens replaced by staminodes. In *G. parvibractus* and *G. mahranus* the staminodes are only 0.2–0.4mm long and broadly triangular, whereas in *G. decandrus* they are 1.25–1.5mm long and filiform from a broader base. All the other species have slender, lanceolate or narrowly triangular staminodes of an intermediate length (0.4–1mm).

Pollen

Gymnocarpos has Type II pollen according to Nowicke (1975), i.e. pantoporate, spinulose and tubuliferous/punctate ektexine pollen, which is a common pollen type in Paronychioideae (Nowicke, 1975; Nowicke & Skvarla, 1977).

In this study pollen of six species, *G. argenteus*, *G. bracteatus*, *G. dhofarensis*, *G. kuriensis*, *G. mahranus* and *G. rotundifolius*, was acetolysed (Erdtman, 1969) and studied under the light microscope. The general description of the pollen grains made from this study is as follows:

Pollen grains spheroidal, 16.2–24.6μm diam., poly(12–)pantoporate with sunken pores, 2.4–6.3μm diam., and with distinct convex mesoporial exine; exine-1 spinulose and perforated.

No clear differences between the species could be detected. The smallest grains found are probably not completely mature and the majority of the grains range from 18 to 23μm.

Pollen grains of *G. argenteus* and *G. kuriensis* were also studied by scanning elec-

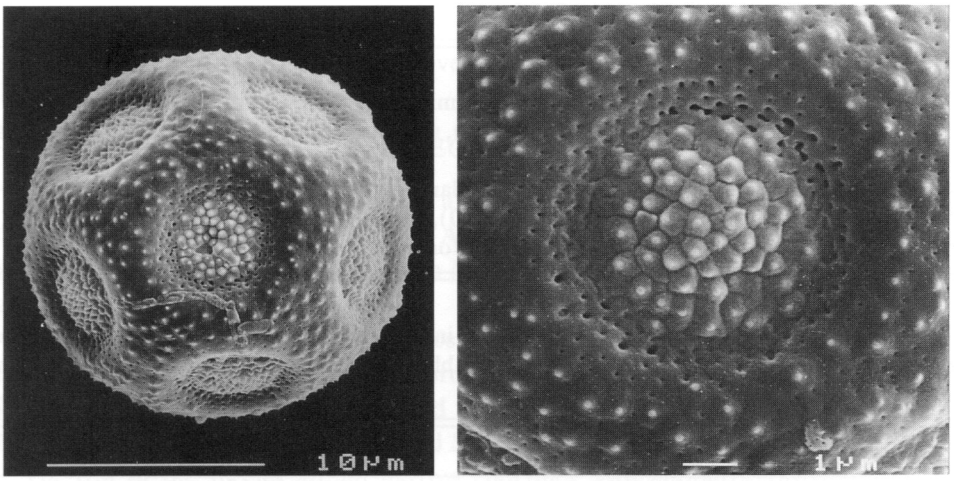

FIG. 2. SEM photographs of pollen of *Gymnocarpos argenteus* (*Thulin et al.* 8330). *Left*, pollen grain; *right*, pore of pollen grain.

tron microscopy (SEM). SEM photographs of pollen of *G. argenteus* are shown in Fig. 2.

POLLINATION AND DISPERSAL

The flowers of *Gymnocarpos* are probably to a large extent self-pollinated. The flowers are protandrous, and the stamens often cling to the stigma when the flower opens and the style lengthens (Chaudhri, 1968). No reports on insect visitors to any of the species now included in *Gymnocarpos* are available.

The fruit of *Gymnocarpos* remains enclosed in the receptacle at maturity. Apparently whole infructescences or parts of them become detached and are dispersed by the wind. This means that *Gymnocarpos* is characterized by synaptospermy, i.e. 'the keeping or even bringing together of many seeds until germination' (van der Pijl, 1969). The big bracts in most of the species then probably function as dispersal aids rather than as attractants for pollinators. Synaptospermy and wind dispersal of deciduous infructescences have also been reported in other genera of Paronychioideae, such as *Herniaria* and *Paronychia* (Bittrich, 1993).

PHYLOGENY

A cladistic analysis based on morphological characters was performed using the characters listed in Table 1. The corresponding data matrix is given in Table 2.

Since the relationship of *Gymnocarpos* with other genera in the Paronychieae is uncertain, *G. decandrus* was used as an outgroup for the rest of the species. *G. decandrus* has the 'simplest' type of bracts in the genus, consisting of a lamina with

TABLE 1. Characters used in the cladistic analysis of *Gymnocarpos*.

1. Petiole absent (0), present (1)
2. Stipules large (more than 0.8mm long) (0), small (less than 0.8mm long) (1)
3. Bracts all leaf-like with lamina and stipules (0), scarious, only the lowermost one sometimes with lamina (1)
4. Scarious bracts small and stipule-like (0), enlarged (1)
5. Staminodes filiform to narrowly triangular (0), broadly triangular (1)
6. Leaves predominantly linear (0), elliptic-fusiform (1), subglobose (2)

TABLE 2. Data matrix of the characters used in the cladistic analysis of *Gymnocarpos*. The numbers correspond to the characters listed in Table 1. ? = character inapplicable, – = character state variable.

	1	2	3	4	5	6
decandrus	0	0	0	?	0	0
argenteus	0	0	1	1	0	0
bracteatus	1	0	1	1	0	0
dhofarensis	0	0	1	1	0	–
kuriensis	1	0	1	1	0	2
mahranus	0	1	1	0	1	0
parvibractus	1	1	1	0	1	1
rotundifolius	1	0	1	1	0	2

stipules. Similar leaf-like bracts are also found in other species of the genus, but then always associated with transitional forms between leaf-like and scarious bracts.

The cladistic analysis was carried out using the computer program PAUP version 3.0r (Swofford, 1991) and resulted in four cladograms. The strict consensus tree is presented in Fig. 3.

The consensus tree is unresolved except for showing two pairs of sister species, *G. mahranus* and *G. parvibractus*, and *G. kuriensis* and *G. rotundifolius*. An alternative analysis using the same characters but with *Paronychia* as outgroup yielded exactly

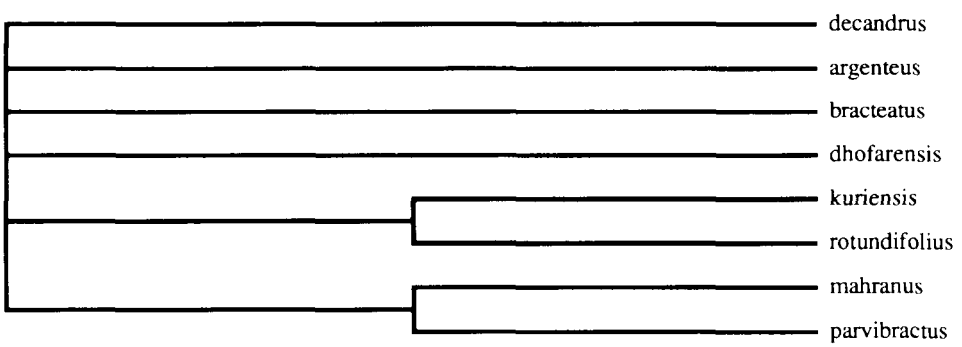

FIG. 3. Phylogenetic analysis of *Gymnocarpos*. Strict consensus tree (CI = 0.875, RI = 0.857).

the same result. Various analyses with more extensive sets of characters were also made, but did not result in any improved resolution.

BIOGEOGRAPHY

The genus *Gymnocarpos* has a tropical and subtropical distribution that includes the Canary Islands, the northern part of Africa, Somalia, the Arabian Peninsula, the islands Socotra and Abd al-Kuri in the Indian Ocean, the Middle East, Afghanistan and Pakistan.

Gymnocarpos decandrus has the most extensive distribution in the genus. It is found on the Canary Islands, in Morocco, N Algeria, N Tunisia, N Libya and N Egypt on the African mainland, and in Israel, Jordan, S Syria, W Saudi Arabia, N Oman, S Iran, SW Afghanistan and SW Pakistan in Asia (Fig. 4).

The rest of the species are all narrow endemics with allopatric distributions. *G. parvibractus* is known only from one locality near the coast of central Somalia (Fig. 5B). *G. kuriensis* grows in the eastern part of Abd al-Kuri and the western part of Socotra, while *G. bracteatus* grows only in the central part of Socotra (Fig. 5B). *G. rotundifolius* grows in south-central Oman and *G. dhofarensis* is distributed in the southern part of the Dhofar Region in Oman and the eastern part of the Mahra Region in Yemen (Fig. 5A). *G. argenteus* is known only from the Hadramaut Region

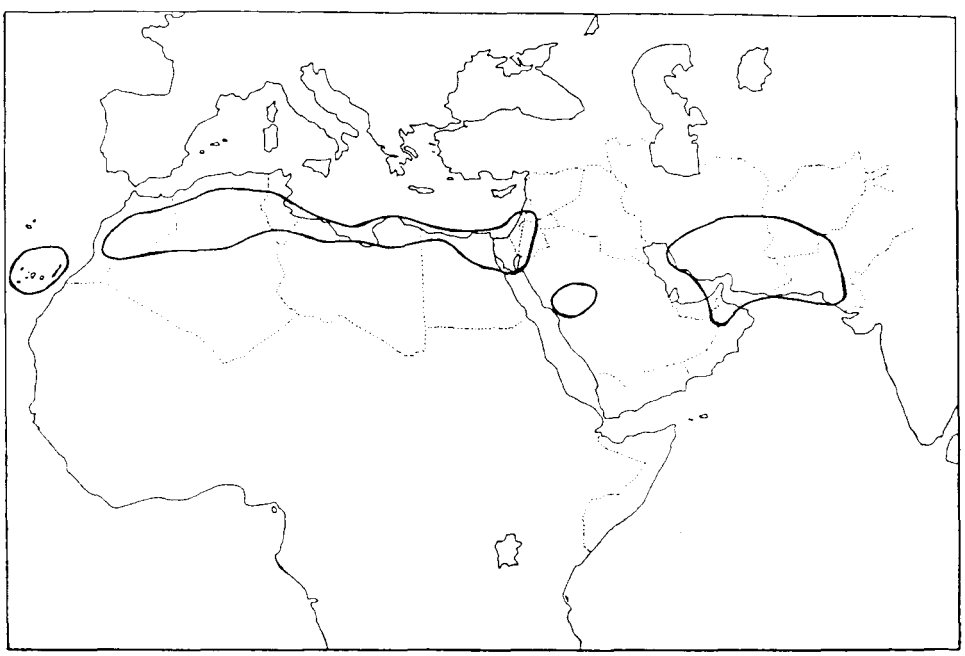

FIG. 4. Known distribution of *Gymnocarpos decandrus* (based mainly on collections listed by Chaudhri, 1968).

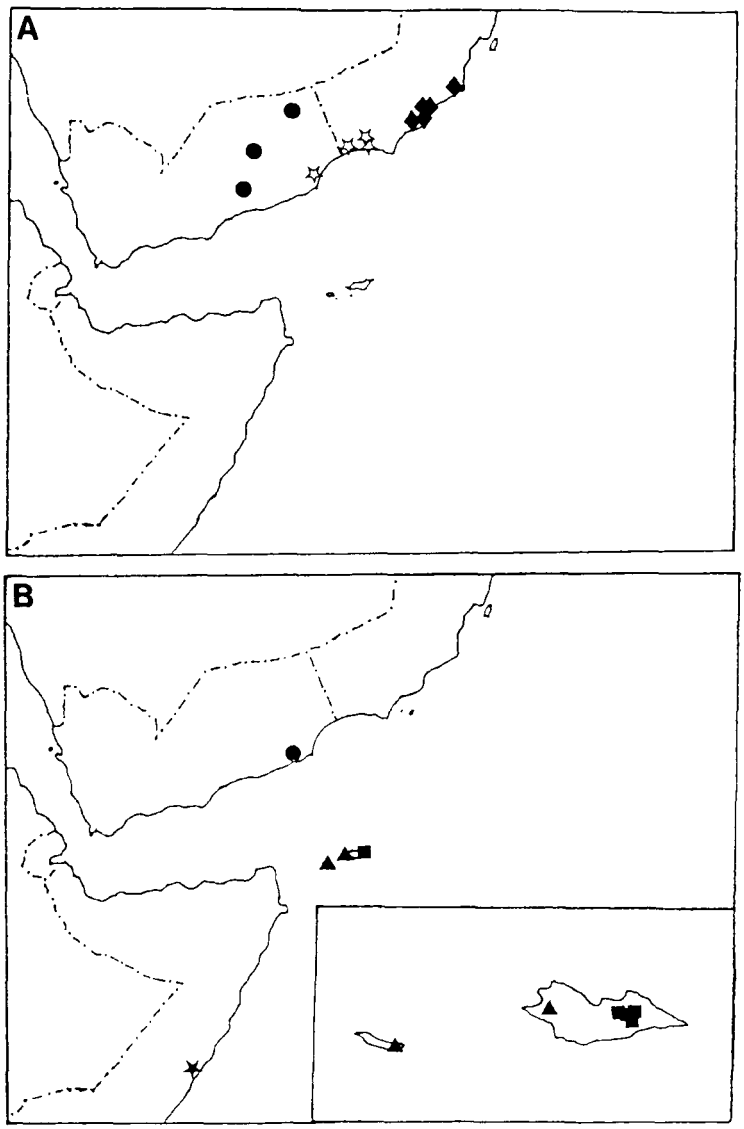

FIG. 5. A, Known distribution of *Gymnocarpos argenteus* (●), *G. dhofarensis* (☆) and *G. rotundifolius* (◆); B, known distribution of *G. parvibractus* (★), *G. mahranus* (●), *G. bracteatus* (■) and *G. kuriensis* (▲); inset: Abd al-Kuri and Socotra.

in Yemen (Fig. 5A) and *G. mahranus* from one locality near the coast of the Mahra Region in Yemen (Fig. 5B). The centre of diversity of *Gymnocarpos* is thus located in the southern part of the Arabian Peninsula and the adjacent islands in the Indian Ocean.

All species of *Gymnocarpos*, except *G. decandrus*, belong to the Somalia-Masai Region that also extends into the southern part of the Arabian Peninsula (White &

Léonard, 1991). *G. decandrus*, on the other hand, is distributed mainly in the Saharo-Sindian Region. In the north of Africa the species is also marginally distributed in the Mediterranean-Sahara regional transition zone and the Mediterranean Region (White & Léonard, 1991), and it also extends to the Macaronesian Region.

The species pair *G. mahranus* on the Arabian mainland and *G. parvibractus* on the African mainland is an example of vicariance between the southern part of the Arabian Peninsula and NE Africa. Other such cases have been discussed by Thulin (1993, 1994). *G. kuriensis* and *G. rotundifolius*, another species pair according to the cladistic analysis (Fig. 3), also show a vicarious distribution, but in this case between the islands Abd al-Kuri and Socotra and the Arabian Peninsula.

In the study of endemism on the Arabian Peninsula by Miller & Nyberg (1991), eight areas of endemism are recognized in this region. In three of these areas species of *Gymnocarpos* are found: *G. argenteus* and *G. mahranus* in the Jol area, *G. dhofarensis* in the Dhofar Region area, and *G. rotundifolius* in the Central Oman area. On Socotra and Abd al-Kuri, famous for their high degree of endemism (Takhtajan, 1986; Miller & Nyberg, 1991), two endemic species of *Gymnocarpos*, *G. bracteatus* and *G. kuriensis*, are found. In Somalia *G. parvibractus* is found in the Hobiyo (Obbia) area, which is one of two major areas of endemism in Somalia pointed out by Thulin (1994).

A number of plant groups, such as *Aeonium* and *Campylanthus*, show a marked disjunction between the Macaronesian Region on the one hand and the Horn of Africa and southern Arabia on the other, and are obviously relics surviving in opposite corners of the African continent (Thulin, 1994). It is quite possible that *Gymnocarpos* basically falls into this pattern as well, but in this case *G. decandrus* has managed to extend its distribution almost throughout the comparatively recent arid lands of the Saharo-Sindian Region.

TAXONOMY

Gymnocarpos Forssk., Fl. Aegypt.-Arab.: 65 (1775).
Type: *G. decandrus* Forssk.
Juss., Gen. Pl.: 314 (1789) as '*Gymnocarpus*'; Pers., Syn. 1: 262 (1805) as '*Gymnocarpon*'; Steud., Nom.: 385 (1821) as '*Gymnocarpum*'; DC., Prodr. 3: 369 (1828) as '*Gymnocarpum*'; Endl., Gen. Pl.: 958 (1839); Webb & Berthelot, Phytogr. Canar. 1: 165 (1840); Boiss., Fl. Or. 1: 747 (1867); Benth. & Hook., Gen. Pl. 3(1): 17 (1880); Pax & Hoffm. in Pflanzenfam., ed. 2, 16c: 299 (1934); Maire, Fl. Afr. Nord 9: 35, f. 9 (1963).
Syn.: *Lochia* Balf.f. in Proc. Roy. Soc. Edinb. 12: 409 (1884), and in Trans. Roy. Soc. Edinb. 31: 251, tab. 84 (1888); Pax & Hoffm. in Pflanzenfam., ed. 2, 16c: 299 (1934); Chaudhri in Med. Bot. Mus. Rijksuniv. Utrecht 285: 58, figs 7–12 (1968); Bittrich in Kubitzki, Fam. and Gen. of Vasc. Pl. 2: 223 (1993). Type: *L. bracteata* Balf.f.

Shrublets with glabrous, much-branched, erect or prostrate, woody and knotty stems and ± tortuously spreading branches; bark often densely furrowed. *Leaves* opposite, often fascicled on younger branches, sessile or shortly petiolate, fleshy, terete, linear-oblanceolate to subcircular in outline, acute to obtuse, mucronate, entire. *Stipules* interpetiolar, scarious, ovate-triangular with two keels, acute at the apex, hyaline, entire and soon partly frayed at the margin, first connate, later splitting lengthwise into two. *Inflorescence* dichasial or sometimes partly monochasial, terminal or subterminal, shortly pedunculate, glabrous or villous; bracts scarious, glabrous or minutely puberulous, ovate to suborbicular, small stipule-like to conspicuous and equalling or exceeding the flowers, or leaf-like with well-developed to vestigial laminae fused at base with stipules. *Flowers* sessile or sometimes the middle ones pedicelled, trullate, with a distinct obconical receptacle shorter than the sepals, glabrous or hairy at the base. *Sepals* 5, narrowly triangular to oblong-lanceolate with a membranous margin, shortly hooded, mucronate, glabrous or sometimes with pubescent mucro and ciliate base; petals absent. *Stamens* 5, alternating with 5 filiform to triangular staminodes; filaments filiform from a broad base; anthers oblong. *Ovary* obovate, papillose above, free or slightly sunken into receptacle; style long, slender; stigma 3-lobed; ovule single, with basal placentation. *Fruit* oblong, obtuse, brown, papillose above; pericarp membranous, rupturing irregularly in the middle or near the base. *Seed* ovate in outline, somewhat compressed, with a membranous, smooth, brown testa, hanging from the tip of funicle. *Embryo* horseshoe-shaped surrounding a mealy endosperm; cotyledons narrow, flattened; radicle superior.

Distribution and habitat. Genus of eight species distributed from the Canary Islands in the west to Pakistan in the east with a centre of diversity in the southern part of the Arabian Peninsula and the Horn of Africa. The species of *Gymnocarpos* generally grow in arid, rocky places, often on limestone, at altitudes up to about 1000m.

Key to the species

1a. Bracts small, stipule-like ——— 2
1b. Bracts large, equalling or exceeding the flowers, or bracts leaf-like with stipules and lamina ——— 3

2a. Bracts mostly brown, except for a white margin, glabrous; leaves sessile, linear-oblanceolate in outline ——— **7. G. mahranus**
2b. Bracts mostly white, except for a brown base, minutely puberulent; leaves petiolate, globose-ovoid to fusiform ——— **8. G. parvibractus**

3a. Bracts leaf-like, with small stipules and 2–4mm long lamina **1. G. decandrus**
3b. Bracts large, scarious, only the lowermost sometimes with a vestigial to well-developed lamina ——— 4

4a. Leaves sessile — 5
4b. Leaves with a 0.25–1.5mm long petiole — 6

5a. Sepals with long hairs at the base; bracts puberulous, white with a brown base only; leaves always linear-oblanceolate in outline — **2. G. argenteus**
5b. Sepals glabrous or with some short hairs only at the base; bracts glabrous, brown with a ± broad white margin; leaves linear-oblanceolate to fusiform or almost globose — **3. G. dhofarensis**

6a. Leaves narrowly linear-oblanceolate in outline; bracts brown throughout or with narrow white margin in upper part only — **4. G. bracteatus**
6b. Leaves broadly linear-oblanceolate in outline to almost globose — 7

7a. Bracts white with a brown base only; staminodes 0.8–1mm long — **5. G. rotundifolius**
7b. Bracts mainly brown with a ± narrow white margin; staminodes 0.4–0.6mm long — **6. G. kuriensis**

1. G. decandrus Forssk., Fl. Aegypt.-Arab.: 65 (1775) as '*G. decandrum*'. **Fig. 6.**
Type: Egypt, Cairo, 'In desertis Káhirinis orient', 1762, *Forsskål* 537 (lecto. C, selected here).
Forssk., Ic. Rer. Nat. 4, tab. 10 (1776); Desf., Fl. Atl. 1: 203 (1798); Viv., Fl. Lib. 13, tab. 10, fig. 1 (1824); Webb & Berthelot, Phytogr. Canar. 1: 166 (1840); Aschers. & Schweinf., Illust. Fl. Egypt 1: 354 (1912); Ozenda, Fl. Sahara: 209, fig. 51 (1958); Quezel & Santa, Nouv. Fl. Alger. 1: 316 (1962); Maire, Fl. Afr. Nord 9: 36 (1963); Zohary, Fl. Palaest. 1: 130, pl. 183 (1966); Chaudhri in Med. Bot. Mus. Rijksuniv. Utrecht 285: 53 (1968) as '*G. decander*'; Täckholm, Stud. Fl. Egypt, ed. 2: 101 (1974).
Syn.: *Trianthema fruticosa* Vahl, Symb. 1: 32 (1790); *G. fruticosus* (Vahl) Pers., Syn. 1: 262 (1805) as '*Gymnocarpon fruticosum*'; DC., Prodr. 3: 369 (1828); Boiss., Fl. Or. 1: 748 (1867); Batt. & Trab., Fl. Alg. (Dicot.): 167 (1888). Type as for *G. decandrus.*

G. salsoloides Webb ex Christ in Engl. Bot. Jahrb. 9: 104 (1888); *G. decandrus* f. *salsoloides* (Webb ex Christ) Chaudhri in Med. Bot. Mus. Rijksuniv. Utrecht 285: 57 (1968). Type: Canary Islands, *Bourgeau & Bolle* (syntypes, n.v.).

Shrublet; *tap root* long, woody, 10–12mm diam. *Stem* erect, up to c.45cm tall, 1–1.5cm diam. at the base; bark greyish or light brown, densely furrowed; internodes 0.5–3cm long, glabrous. *Leaves* sessile, linear-terete, 5–18 × 0.5–1.5(–2)mm, slightly narrowed to the base, obtuse to subacute at the apex; mucro 0.2–0.6mm long, light green to light brown. *Stipules* 1.5–2 × 1.25mm, with indistinct keels, white, sometimes with a reddish base, ciliate at the margin and on the keels, cilia red or white. *Inflorescence* composed of terminal, densely congested, (3–)7–15-flowered dichasia; peduncles 5–10mm, usually densely villous or densely covered with short, soft crisped hairs; bracts leaf-like, subulate, 2–4mm long, strongly mucronate, fused at base with

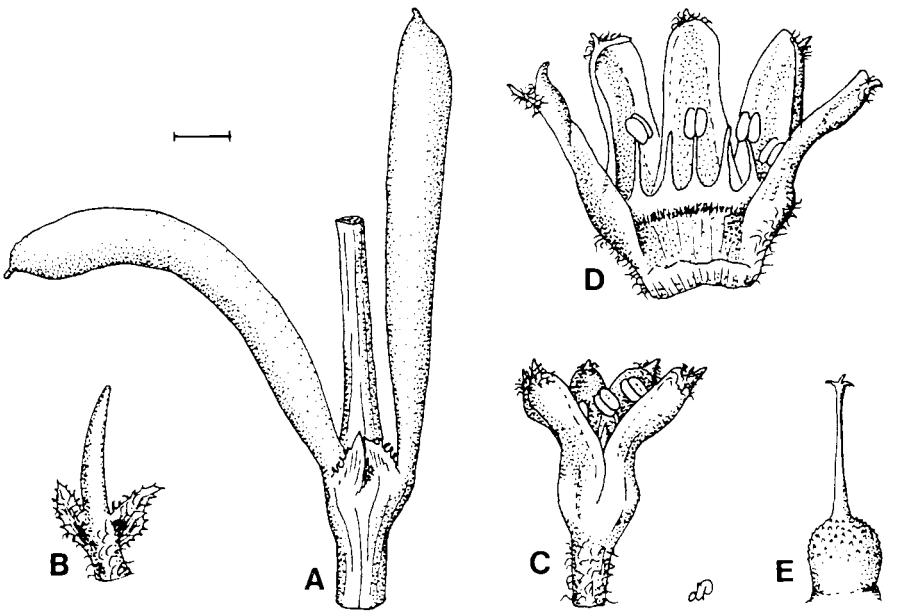

FIG. 6. *Gymnocarpos decandrus*. A, part of stem with stipules and leaves; B, bract; C, flower; D, perianth opened up; E, pistil. For all, scale bar = 1mm. (A & B from *Linder* s.n.; C–E from *Lundqvist* 5748).

stipules. *Flowers* 5–7mm long, fleshy, sessile; receptacle 2–3mm long, obconical, reddish, 10-ribbed, papillose or densely pilose. *Sepals* light green to light reddish-brown, tubular when young, but spreading with age, narrowly oblong, 3–4.5 × 1mm, with a broad white, membranous margin, pilose at base; mucro 0.25–0.5mm, pale yellowish, hairy at base. *Stamens* with 1.4–2mm long filaments; anthers c.0.4 × 0.25mm; staminodes linear-lanceolate, 1.25–1.5mm long, brownish, somewhat shorter than the stamens. *Ovary* ovoid-oblong, 1.5 × 1.2mm, densely papillose, slightly sunken into and fused at the base with the receptacle; style 2–2.75mm, shortly trilobate at the tip, equalling or exceeding the stamens. *Fruit* 2–2.5 × 1.5mm, narrowly ellipsoid, orange-brown, densely papillose, rupturing irregularly at the base. *Seed* 2–2.25 × 1.1mm, ellipsoid, dark brown.

Notes on nomenclature. Forsskål's original spelling of the name of this species was *G. decandrum*, i.e. *Gymnocarpos* was treated as neuter, and this has been retained by practically all authors, a marked exception being the monographer of the genus, Chaudhri, who used the enigmatic '*G. decander*'. According to the International Code of Botanical Nomenclature names ending in *-carpos* are to be treated as masculine (Art. 62.2), hence the correct spelling of the name must be *G. decandrus*.

According to Hepper & Friis (1994) the type material of *G. decandrus* includes three sheets collected by Forsskål: no. 537 in herb. Forsskål in C, a sheet ex herb. Schumacher in C, and a sheet ex herb. Banks in BM. These sheets are most probably

duplicates of the same original collection. *Forsskål* 537 is here selected as the lectotype.

Distribution and habitat. *G. decandrus* is known from the Canary Islands, Morocco, N Algeria, N Tunisia, N Libya, NE Egypt, Israel, Jordan, S Syria, N Oman, W Saudi Arabia, S Iran, SW Afghanistan and SW Pakistan (Fig. 4). It grows on dry limestone hills and sandy places up to c.1500m altitude. For an extensive list of collections of *G. decandrus*, see Chaudhri (1968).

Vernacular names. Syrr, Djarad (Arabic) (Forsskål, 1775; Hepper & Friis, 1994).

Taxonomic remarks. This species includes, according to Chaudhri (1968), one distinguishable form, forma *salsoloides*. This was formerly treated as a distinct species, *G. salsoloides*, on the Canary Islands, and is characterized by rather short and congested shoots. However, plants with short and congested shoots are also found in other areas, while plants with longer shoots are also found on the Canary Islands. As forma *salsoloides* therefore seems to be no more than an environmentally induced modification, we prefer not to recognize it.

2. G. argenteus Petruss. & Thulin, **sp. nov. Fig. 7.**
Species nova a *G. bracteato* (Balf.f.) Petruss. & Thulin foliis sessilibus, bracteis albis, et basibus et apicibus sepalorum pilosis differt.
Type: Yemen, Hadramaut, 26km along the pipeline route from the crossing with the Ressib road, 15°18′N 49°11′E, 13 x 1992, *Thulin, Eriksson, Gifri & Långström* 8330 (holo. UPS; iso. Aden Univ., E, K).

Shrublet; *stem* erect, up to 40cm tall; bark white, later grey, olive green in young shoots; internodes up to 17mm long. *Leaves* sessile, linear-oblanceolate, almost cylindrical, 5–20 × 1–1.4(–1.8)mm, attenuate at the base, acute and sharply mucronate at the apex; mucro (0.25–)0.4–0.8mm long. *Stipules* 1.25–1.5mm long, with ciliate keels, slightly denticulate at the margin, chestnut-brown with broad hyaline margin. *Inflorescence* composed of terminal, densely congested, many-flowered dichasia up to 30mm diam.; peduncle up to 20mm long; bracts equalling or exceeding the flowers, broadly ovate to suborbicular, 5–6 × 5–6mm, acute at the apex, white, often chestnut-brown at the base and/or along the midnerve, minutely puberulent, denticulate at the margin; lower flowers surrounded by two smaller bracts (c.2mm long, chestnut-brown with broad white margin, partly puberulent) or leaf-like bracts, fused at the base with stipules. *Flowers* c.4 × 1.5–2mm, sessile; receptacle c.1mm long, lower flowers often with longer, pedicel-like base, green ± tinged with purple, pilose at the base with up to 0.8mm long hairs. *Sepals* 2.5–2.75 × 1.1–1.5mm, with distinct membranous margin, light green with purple spots, densely ciliate at the base with up to 0.8mm long hairs and near the apex with 0.3mm long hairs; mucro 0.5–0.8mm long, brownish. *Stamens* with 1–1.2mm long filaments; anthers oblong (0.6–)1 × (0.25–)0.5mm, yellow-orange; staminodes narrowly triangular with concave sides, 0.6–0.8mm long. *Ovary* obovate, 0.8–1.5 × 0.6–1mm, strongly papillose;

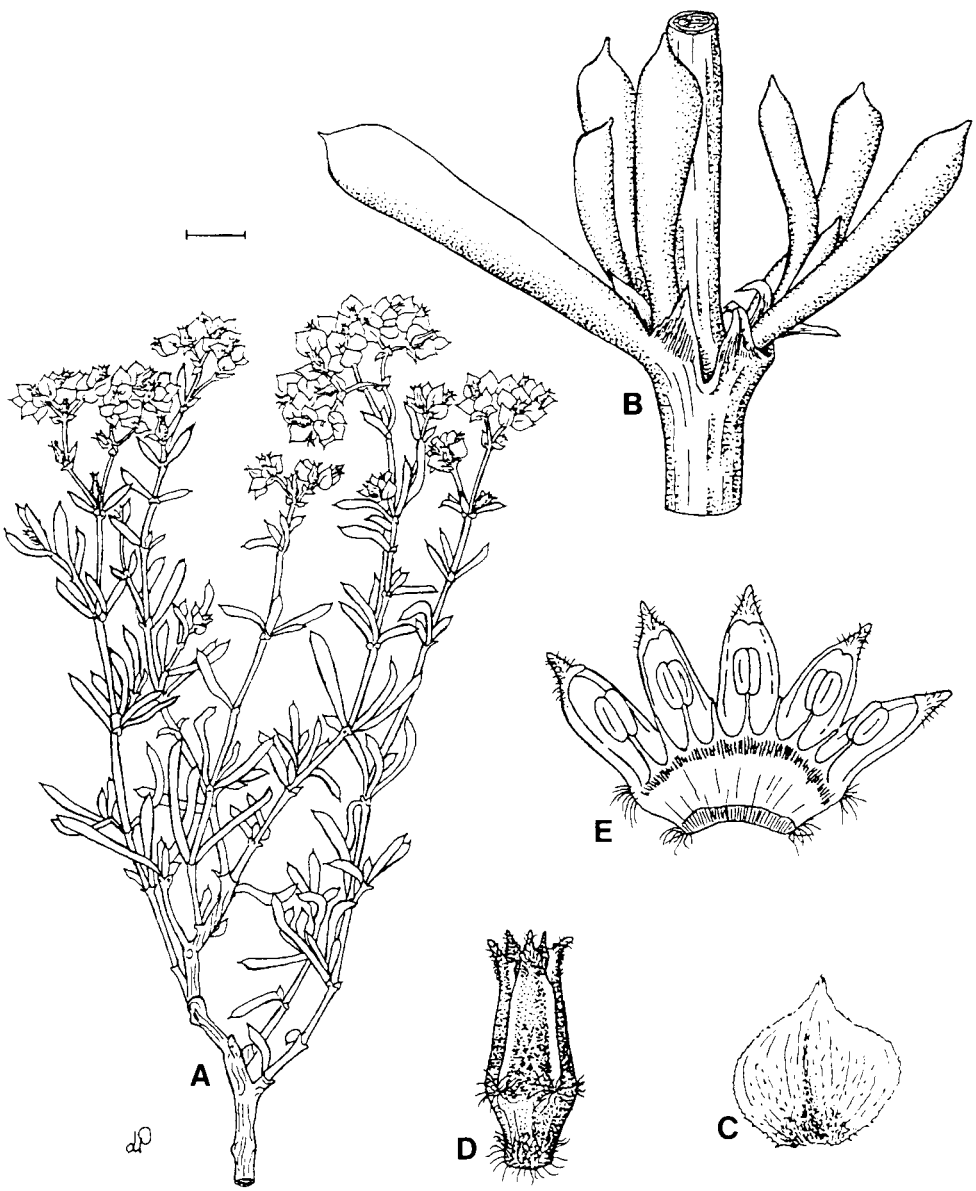

FIG. 7. *Gymnocarpos argenteus*. A, habit; B, part of stem showing stipular splitting and leaves; C, bract; D, flower; E, perianth opened up. A, scale bar = 10cm; B–E, scale bar = 1mm. (All from *Thulin et al.* 8330).

style 1.6–1.9mm, tapering from a broad base; stigma 3-lobed. *Fruits* and *seeds* not seen.

Additional specimens examined. YEMEN. Mahra: Sanau, 17°50′N 51°05′E, 7 ii 1946, *Thesiger* s.n. (BM); Hadramaut: near Thomud, 6 v 1953, *Popov* GP/H/617 (BM).

Distribution and habitat. The species is known only from three localities in Yemen (Fig. 5A), where it grows on arid hills above 500m altitude. The type collection was made on gypsum at 1020m altitude. Associated species at the type locality included *Schweinfurthia spinosa*, *Salsola rubescens*, *Zygophyllum album*, *Forsskaolea tenacissima*, *Launea bornmuelleri*, *Corallocarpus glomeruliflorus*, *Lavandula macra*, *Gypsophila montana* subsp. *somalensis* and *Commicarpus reniformis*.

Taxonomic remarks. Some of the material of *G. argenteus* has previously been identified as *G. bracteatus*. However, *G. argenteus* is easily distinguished from *G. bracteatus* by its sessile leaves, puberulous white bracts that are brown at the very base only, and its pilose base of the receptacle as well as its densely pilose base and apex of the sepals. In *G. bracteatus* the leaves are petiolate, the bracts are glabrous and brown throughout or almost so, and the receptacle and sepals are glabrous or almost so.

The closest relative of *G. argenteus* seems rather to be *G. dhofarensis*, another species with sessile leaves. For differences between these two species, see under *G. dhofarensis*.

3. G. dhofarensis Petruss. & Thulin, **sp. nov. Fig. 8.**
Species nova a *G. argenteo* Petruss. & Thulin basibus sepalorum subglabris et bracteis glabris brunneis margine albo lato differt.
Type: Oman, Dhofar, main Salalah to Thamrait road, 7km N of Raven's Roost, 4 x 1979, *Miller* 2524 (holo. E, iso. K).

Shrublet; *stem* erect, up to 30cm high, branches straight to somewhat tortuously spreading; bark white to light grey, light green to brownish in young shoots; internodes up to 15mm long. *Leaves* sessile, linear-oblanceolate to fusiform or almost globose, 3–12.5 × 1.2–3mm, attenuate at the base; mucro (0.25–)0.5–0.75mm long, pale brown. *Stipules* c.1.25mm long, chestnut-brown with white margin and apex, entire, soon frayed at the apex. *Inflorescence* composed of terminal or subterminal, densely congested dichasia, peduncle up to 4mm long; bracts equalling or exceeding the flower, ovate, 4–5 × 2.5–3.5mm, acute at the apex, ± brown with white ± broad margin; lower flowers surrounded by smaller bracts (c.1.5mm long, glabrous), or leaf-like bracts fused at the base with stipules. *Flowers* c.5 × 2mm, sessile; receptacle c.1.5mm long, usually ciliate at the base, green. *Sepals* 2.3–2.75 × 1–1.7mm, green, glabrous, or practically so, at the base, usually ± puberulent at the apex; mucro (0.35–)0.5–1mm long. *Stamens* with c.0.8mm long filaments; anthers c.0.6 × 0.4mm; staminodes 0.5–0.7mm long, narrowly triangular with concave sides. *Ovary* obovate, 0.75–1.5 × 0.7–1.2mm, papillose all over; style slender, 1–1.9mm long; stigma 3-lobed, the lobes c.0.2mm long, recurved. *Fruits* and *seeds* not seen.

Additional specimens examined. YEMEN. Mahra: pass above Ras Fartak, 15°49′N 51°57′E, 3 x 1993, *Miller* 12160 (E, UPS). OMAN. Dhofar: 7.5km from Ayun turnoff, 17°20′N 54°02′E, 9 xii 1984, *McLeish* 416 (E, n.v.); Jebel Qamar, NE of Sarfait, 11 ix 1989, *Miller & Nyberg* 9315 (E, n.v.).

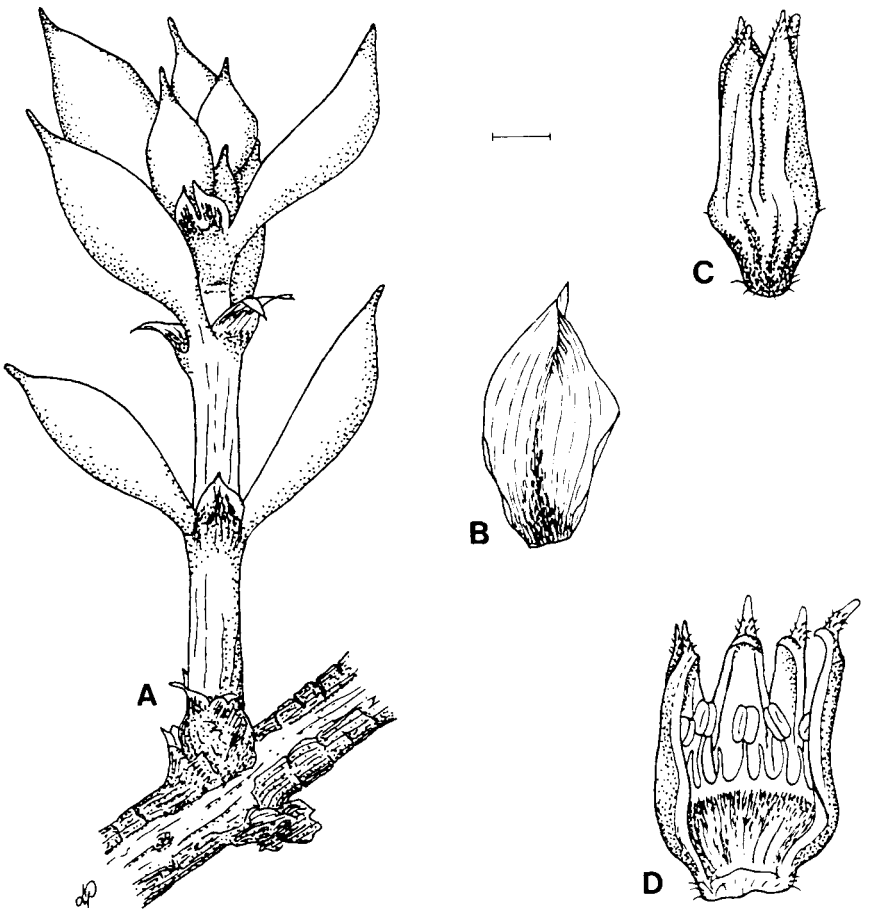

FIG. 8. *Gymnocarpos dhofarensis*. A, young shoot with stipules and leaves; B, bract; C, flower; D, perianth opened up. For all, scale bar = 1mm. (All from *Miller* 2524).

Distribution and habitat. The species is known from a few localities in the southern part of the Arabian Peninsula (Fig. 5A), where it grows on sparsely vegetated, rocky slopes above 600m altitude.

Taxonomic remarks. G. dhofarensis has sessile, generally linear-oblanceolate to fusiform leaves, similar to the leaves of the obviously closely related *G. argenteus*. *G. dhofarensis* differs from *G. argenteus* by its glabrous bracts that are brown with a more or less broad white margin, and its glabrous or practically glabrous sepals. In *G. argenteus*, on the other hand, the bracts are puberulous and white with a brown base only and the sepals are densely pilose at the base and near the tip.

Also, the leaves are more variable in shape in *G. dhofarensis* than in *G. argenteus*, and in *Miller* 2524 (K) the leaves are subglobose in one of the branches present on the sheet. Such leaves may resemble the leaves of *G. rotundifolius* and *G. kuriensis*,

but differ in being sessile and by having a long mucro. In *G. rotundifolius* and *G. kuriensis* the leaves are petiolate with a short mucro.

4. G. bracteatus (Balf.f.) Petruss. & Thulin, **comb. nov. Fig. 9.**
Type: Yemen, Socotra, on the slopes of Haghier Mts, ii–iv 1880, *Balfour, Cockburn & Scott* 429 (lecto. K, selected here; iso. BM, E).
Syn.: *Lochia bracteata* Balf.f. in Trans. Roy. Soc. Edinb. 12: 409 (1884), in Trans. Roy. Soc. Edinb. 31: 252, tab. 84 (1888), and in Forbes (ed.), Flowering Plants of Socotra and Abd-el-Kuri: 501 (1903); Vierhapper in Denkschr. Akad. Wiss. Wien, Math.-Nat. Kl. 71: 352 (1907), pro parte; Chaudhri in Med. Bot. Mus. Rijksuniv. Utrecht 285: 59, pl. 2, figs 7–11 (1968), pro parte; King & Kay in Arab. Gulf J. Sci. Res. 2: 399 (1984), pro parte.

Shrublet; *stem* erect, up to 35cm tall, bark grey to dark grey-brown, pale brown in young shoots; internodes up to 20mm long. *Leaves* narrowly linear-oblanceolate, 7–13 × 1–1.5mm, olive green, acute at the apex, attenuate at the base, petiole 0.5–1(–1.5)mm long; mucro 0.4–0.8mm long, pale brown. *Stipules* narrowly triangular, 1.5–2mm long, with distinct, ciliate keels, slightly denticulate at margin and soon frayed at apex, chestnut-brown, margin and apex white. *Inflorescence* composed of terminal or subterminal, densely congested, many-flowered dichasia up to 20mm

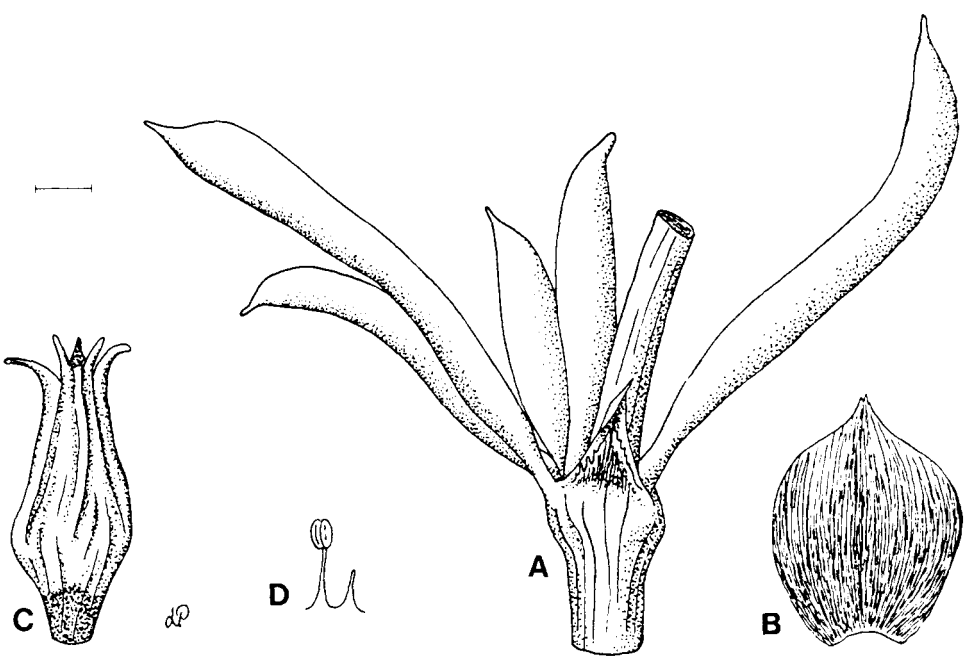

FIG. 9. *Gymnocarpos bracteatus*. A, part of stem with stipules and leaves; B, bract; C, flower; D, stamen and staminode. For all, scale bar = 1mm. (All from *Smith & Lavranos* 594).

diam., peduncle up to 10mm long; bracts equalling or exceeding, but not fully concealing, the flowers, broadly ovate to suborbicular, 4.5–5.75 × 5mm, brown or streaked with brown, without or only in upper part with white margin; lower flowers surrounded by smaller but similar bracts (1.5–2mm long), or leaf-like bracts fused at base with stipules. *Flowers* 4–6 × 1.75–2mm, sessile but the lower flower sometimes with 0.5–1mm long pedicel; receptacle 1–2mm long, usually chestnut-brown in the basal part, sometimes slightly ciliate at the base. *Sepals* 2–2.75 × 1.25mm, with distinct, sometimes papillose, hyaline margin, sometimes slightly ciliate at the base, light green, tinged with brown; mucro 0.8–1mm long, usually glabrous but sometimes minutely puberulent. *Stamens* with 1.2–1.5mm long filaments; anthers 0.35–0.6 × 0.25–0.3mm; staminodes narrowly triangular with concave sides, 0.5–0.75mm long, brownish. *Ovary* 1.5 × 1mm, narrowly ellipsoid, papillose above; style 1mm long, usually bent at top, 3-lobed; stigma lobes 0.25–0.4mm long, recurved. *Fruit* 2.25–2.4 × 1.25mm, narrowly ellipsoid with obtuse-rounded and papillose top, rupturing irregularly at the base, chestnut-brown. *Seed* 1.75–2.3 × 0.8–1.4mm, ellipsoid, dark brown, glabrous.

Notes on nomenclature. In the protologue of *Lochia bracteata* the only cited specimen was *Balfour, Cockburn & Scott* 429, but Chaudhri (1968) also cited *Balfour* 84 from 'Glato' in E. A study of the material in E has now revealed that this was a mistake. What was interpreted as 'Glato 84' is actually 'Plate 84', i.e. the plate number in Balfour's 'Botany of Socotra'. Therefore, there is no locality called 'Glato' and there is no specimen with the collection number 84. The two Balfour sheets in E must both be duplicates of *Balfour, Cockburn & Scott* 429.

Chaudri (1968) cited *Balfour* 429 in E as the holotype of *L. bracteata*, with a duplicate in K as isotype. However, we do not regard this as a lectotypification as Chaudhri apparently just presumed that the holotypes of Balfour's names must be in E. The four duplicates now known of *Balfour, Cockburn & Scott* 429 must all be available for lectotypification and we here select the material in K as a lectotype. The first set of Balfour's botanical collections is housed in K (Balfour, 1888). In this case this is also better material than that in E, and it is the material that was the basis for the plate in Balfour's work.

Additional specimens examined. YEMEN. Socotra: Jebel Rughid, by path leading up to Muqadrihun, on a steep slope by side of track, 12°37′N 53°58′E, 30 iv 1967, *Smith & Lavranos* 594 (K); Wadi Lubani, 1km S of Muqadrion Pass, 12°37′N 54°00′E, 27 i 1992, *Miller & Nyberg et al.* 11148 (E, UPS); Muqadrihon Pass, 12°37′N 54°01′E, 28 i 1994, *Thulin & Gifri* 8795 (UPS).

Distribution and habitat. G. bracteatus is endemic to Socotra, where it grows on the rocky slopes of the Haghier Mountains (Fig. 5B), on shattered and decomposing granite at an altitude of c.450m.

Vernacular name. Kalkaho (Balfour, 1888; Chaudhri, 1968).

Taxonomic remarks. *G. bracteatus* has been used by recent authors in a broad sense to include all the plants of the genus found on Socotra and Abd al-Kuri and in Oman (King & Kay, 1984; Bittrich, 1993). Here, however, *G. bracteatus* is used strictly for the collections from the central part of Socotra. The previously described forma *ciliata* from the western side of the island is included in *G. kuriensis*. *G. bracteatus* sensu stricto is characterized by its practically entirely brown, large bracts and its petiolate, narrow, linear-oblanceolate, olive green leaves.

5. G. rotundifolius Petruss. & Thulin, **sp. nov. Fig. 10.**
Species nova a *G. kuriensi* (Radcl.-Sm.) Petruss. & Thulin bracteis albis basi brunnea et staminodiis longioribus differt.
Type: Oman, Dhofar, gravel plain W of Sawqirah, 29 iv 1984, *Miller* 6476 (holo. E; iso. K, UPS).

Shrublet; *stem* erect, up to 25cm high, up to 8mm thick at the base; bark light grey to dark grey-brown, reddish in young shoots; internodes up to 10mm long. *Leaves* elliptic-obovate to circular in outline, 2–5 × 1.5–3.5mm, attenuate at the base into 0.25–0.5mm long petiole, obtuse at the apex and with 0.1–0.4mm long mucro. *Stipules* 0.8–1.1(–1.5)mm long, with indistinct keels, white with chestnut-brown base, margin entire, soon frayed at the apex. *Inflorescence* composed of terminal or subterminal, densely congested, many-flowered dichasia, up to 22mm diam., peduncle up to 4mm long; bracts broadly ovate, equalling or exceeding the flowers, 4–5 × 2.5–3mm, acute at the apex, white with brown base; lower flowers surrounded by smaller bracts that are 1.5–2mm long, chestnut-brown with a white margin. *Flowers* 4.5–5.5 × 2–2.5mm, sessile; receptacle c.1.5mm long, ± tinged with purple,

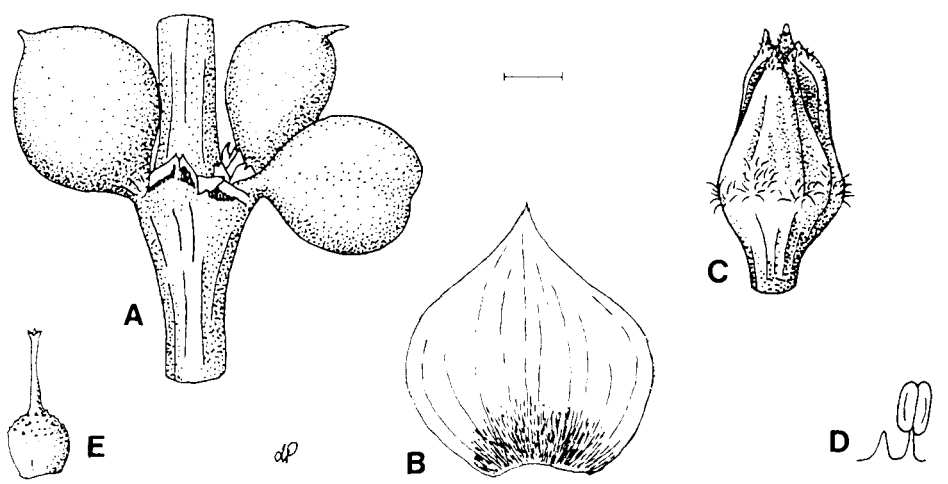

FIG. 10. *Gymnocarpos rotundifolius*. A, part of stem with stipules and leaves; B, bract; C, flower; D, stamen and staminode; E, pistil. For all, scale bar = 1mm. (All from *Miller* 6476).

usually glabrous. *Sepals* c.2.5 × 1mm, green or ± purple with a broad, white margin, ciliate at the base with c.0.25mm long hairs; mucro 0.4–0.6mm long, papillose or sometimes puberulent. *Stamens* with 0.8–1.2mm long filaments; anthers (0.4–)0.8–1 × (0.25–)0.5mm; staminodes narrowly triangular with concave sides, 0.8–1mm long. *Ovary* rounded-obovate, 0.75–1.5 × 0.7–1.25mm, papillose above; style 1.5–1.8mm long; stigma 3-lobed, lobes 0.2mm long, recurved. *Fruits* and *seeds* not seen.

Additional specimens examined. OMAN. Dhofar: c.5km W of Sawqirah, 19 iv 1989, *Miller & Nyberg* 9456 (E); plateau above Miji, c.15km W of Sharbithat, 19 iv 1989, *Miller & Nyberg* 9438 (E); limestone cliff above Sharbithat, 18°00′N 56°27′E, 29 iv 1984, *Miller* 6462 (E, K); Sahel al Jazir: Rima to Ras Madraka road, Khor Dirrif, 18°56′N 57°20′E, 1 x 1984, *Miller* 6503 (E).

Distribution and habitat. G. rotundifolius is known only from Oman, where it grows on open, sparsely vegetated dry rocks or sand dunes from sea level up to c.100m altitude (Fig. 5A).

Taxonomic remarks. G. rotundifolius is closely related to *G. kuriensis* and differs mainly in its white bracts with a brown base only, whereas in *G. kuriensis* the bracts are mainly brown. Also, the staminodes in *G. rotundifolius* are longer (0.8–1 vs. 0.4–0.6mm), the leaves are generally smaller (2–5 vs. 4–12mm long) with a more olive green (not pale glaucous) colour, and the bark of the stem is generally more or less grey (not whitish).

6. G. kuriensis(Radcl.-Sm.) Petruss. & Thulin, **comb. nov. Fig. 11.**

Syn.: *Lochia kuriensis* Radcl.-Sm. in Hook. Ic. Pl. 7(4): t. 3674 (1971); *L. bracteata* Balf.f. subsp. *abdulkuriana* Chaudhri in Med. Bot. Mus. Rijksuniv. Utrecht 258: 60, pl. 2, fig. 12 (1968). Type: Yemen, Abd al-Kuri, 12°14′N 52°15′E, 4 xii 1898, *Forbes & Ogilvie-Grant* 84 (holo. E).

L. bracteata Balf.f. subsp. *bracteata* forma *ciliata* Chaudhri in Med. Bot. Mus. Rijksuniv. Utrecht 285: 60 (1968). Type: Yemen, Socotra, Jebel Rahmen, near Ras Shoab, 10 i 1899, *Simony* s.n. (holo. WU).

L. bracteata sensu Balf.f. in Forbes (ed.), Natural History of Socotra and Abd-el-Kuri: 526 (1903), pro parte quoad specim. *Forbes & Ogilvie-Grant*; sensu Vierhapper in Denkschr. Akad. Wiss. Wien, Math. Nat. Kl. 71: 352 (1907), pro parte quoad specim. *Paulay* et *Simony*.

Shrublet; *stem* erect, up to 30cm tall; bark first white, later grey, pale green in young shoots; internodes up to 25mm long. *Leaves* (linear-)oblanceolate to subglobose, terete, 4–12 × 1.5–3(–5)mm, pale glaucous, obtuse at the apex, attenuate or rounded at base; mucro 0.2–0.5mm long, pale brown; petiole 0.5–1mm long, almost white. *Stipules* 0.8–1mm long, with indistinct keels, slightly denticulate at the margin, chestnut-brown with white apex and margin, apex soon partly frayed. *Inflorescence* composed of terminal, densely congested dichasia, up to five or six times dichotomously branched, up to 40mm diam., peduncle up to 12mm long; bracts broadly ovate to

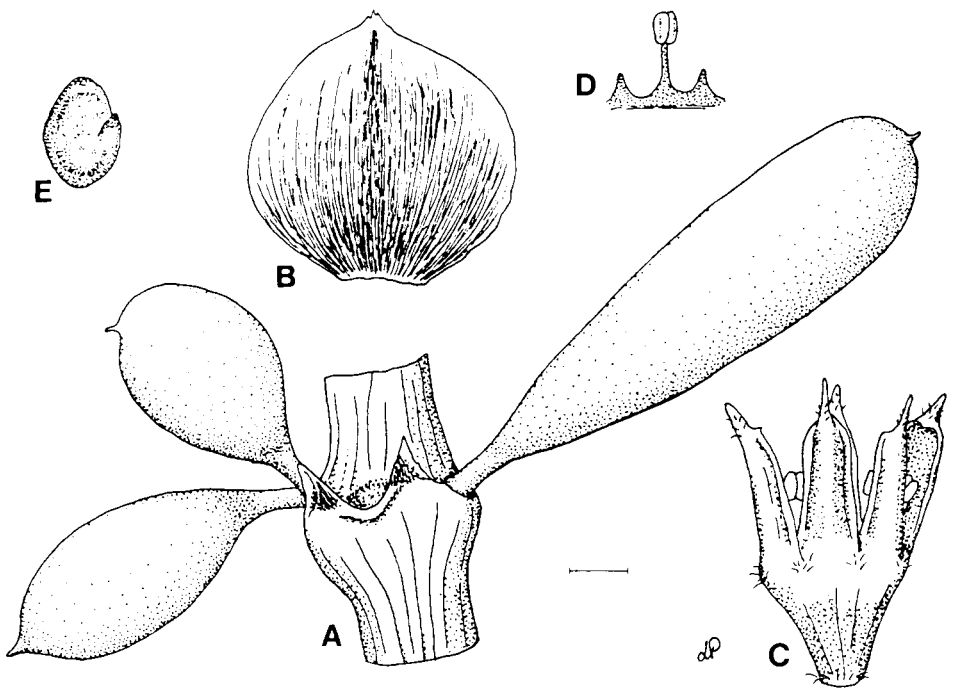

FIG. 11. *Gymnocarpos kuriensis.* A, part of stem with stipules and leaves; B, bract; C, flower; D, stamen and staminodes; E, seed. For all, scale bar = 1mm. (A & B from *Smith & Lavranos* 650; C–E from *Simony* s.n.).

suborbicular, equalling, but not fully concealing, the flowers, 4–5.5 × 2.5–5mm, acute at the apex, margin entire or slightly denticulate, ± chestnut-brown or streaked with brown at the base and middle part, apex and margin always white; lower flowers surrounded by smaller but similar bracts (c.2mm long), or leaf-like bracts fused at base with stipules. *Flowers* 4.5–5 × 2mm, sessile; receptacle 1.5–2mm long, sometimes ciliate at the base, pale green when young, later brown. *Sepals* c.2.5 × 1–1.4mm, with broad papillose, hyaline margin, occasionally minutely ciliate at the base, pale glaucous, light brown inside; mucro 0.5–0.8mm long, papillose or minutely puberulent. *Stamens* with 0.8–1.4mm long filaments, anthers 0.5–0.6 × 0.3–0.4mm, brown; staminodes narrowly triangular with concave sides, 0.4–0.6mm long, brown. *Ovary* ovate, c.1.5mm long, papillose; style 1.2–1.75mm long, 3-lobed; stigma lobes 0.3–0.4mm, recurved. *Fruit* 2.25–2.5 × 1.5mm, brown, ovate with obtuse-rounded, papillose top, rupturing irregularly in the middle or near the base. *Seed* c.2 × 1.25mm, elliptic, glabrous, brown.

Additional specimens examined. YEMEN. Abd al-Kuri: 12°14′N 52°15′E, 4 xii 1898, *Forbes & Ogilvie-Grant* 41 (E), 54 (E); W and SW slopes of Jebel Saleh, near the harbour, 17–21 i 1899, *Paulay* s.n. (WU); central plain NE of the harbour, 17–21 i 1899, *Paulay* s.n. (WU); spread over the entire N side of Jebel Saleh, 17–21 i 1899, *Paulay* s.n. (WU); near the N

coast at Base Camp Bay which is due N of Jebel Hassala (Qarat Salih), 6 v 1967, *Smith & Lavranos* 650 (FT, K), (PRE, n.v.); N slope of Jebel Hassala, 9 ii 1992, *Miller & Nyberg et al.* 11384 (E, UPS).

Distribution and habitat. G. kuriensis is endemic to Abd al-Kuri and Socotra. It grows on the slopes of Jebel Saleh, and on the coastal plain and amphibolite hillocks in the northeastern part of Abd al-Kuri and is also known from Jebel Rahmen on the western part of Socotra (Fig. 5B).

Taxonomic remarks. This species was first included in *L. bracteata* by Balfour (1903) and Vierhapper (1907), but was later distinguished as *L. bracteata* subsp. *abdulkuriana* by Chaudhri (1968). Radcliffe-Smith (1971) treated it as a species of its own due to the smaller bracts, which are not chestnut-brown all over as in *G. bracteatus* sensu stricto, the whitish bark in contrast to the dark greyish-brown in *G. bracteatus*, and the elliptic-obovate, glaucous, fleshy leaves, as opposed to the linear and dark green ones in *G. bracteatus*. King & Kay (1984), however, again included *L. kuriensis* in *L. bracteata* due to some collections from Dhofar, Oman, which they thought were somewhat intermediate between the two species. However, the differences between *G. kuriensis* and *G. bracteatus* are obvious and the populations from Dhofar are here placed in *G. dhofarensis* and *G. rotundifolius*.

Simony's gathering from Jebel Rahmen in the western part of Socotra was treated as *L. bracteata* forma *ciliata* by Chaudhri (1968), who thought this collection was somewhat intermediate between *L. bracteata* and *L. kuriensis*. However, with its obovate-oblanceolate, pale glaucous leaves, bracts with a white margin all around, and short staminodes this collection agrees very well with *G. kuriensis*, and we are convinced that it should be included in this species without any separate taxonomic recognition.

7. G. mahranus Petruss. & Thulin, **sp. nov. Fig. 12.**
Species nova a *G. parvibracto* (M. Gilbert) Petruss. & Thulin foliis sessilibus linearibus vel oblanceolatis et bracteis praecipue brunneis glabris differt.
Type: Yemen, Mahra, top of pass W of Qishn, 15°23′N 51°34′E, 1 x 1993, *Miller* 12131 (holo. E, iso. UPS).

Shrublet; *stem* prostrate, up to at least 10cm long, branches erect and very tortuously spreading; bark light grey, olive-green in young shoots; internodes short, less than 10mm long. *Leaves* sessile, linear-oblanceolate, almost cylindrical, 4–8 × 1–1.5(–1.9)mm, attenuate at the base, acute and mucronate at the apex; mucro 0.2–0.4mm long. *Stipules* 0.5mm long, chestnut-brown with a broad hyaline margin, first entire, soon partly frayed. *Inflorescence* composed of small terminal dichasia with 3–7 flowers; peduncle 1–2mm long; bracts small and stipule-like, 0.6–1mm long, acute at apex, chestnut-brown or occasionally purple with broad white margin or sometimes almost white, first entire, soon partly frayed. *Flowers* 4–6 × 1.5–2mm, the middle flowers often with receptacle attenuate into c.1.5mm long pedicel, the other flowers sessile; receptacle 1–2mm long, usually light green, sometimes ± tinged

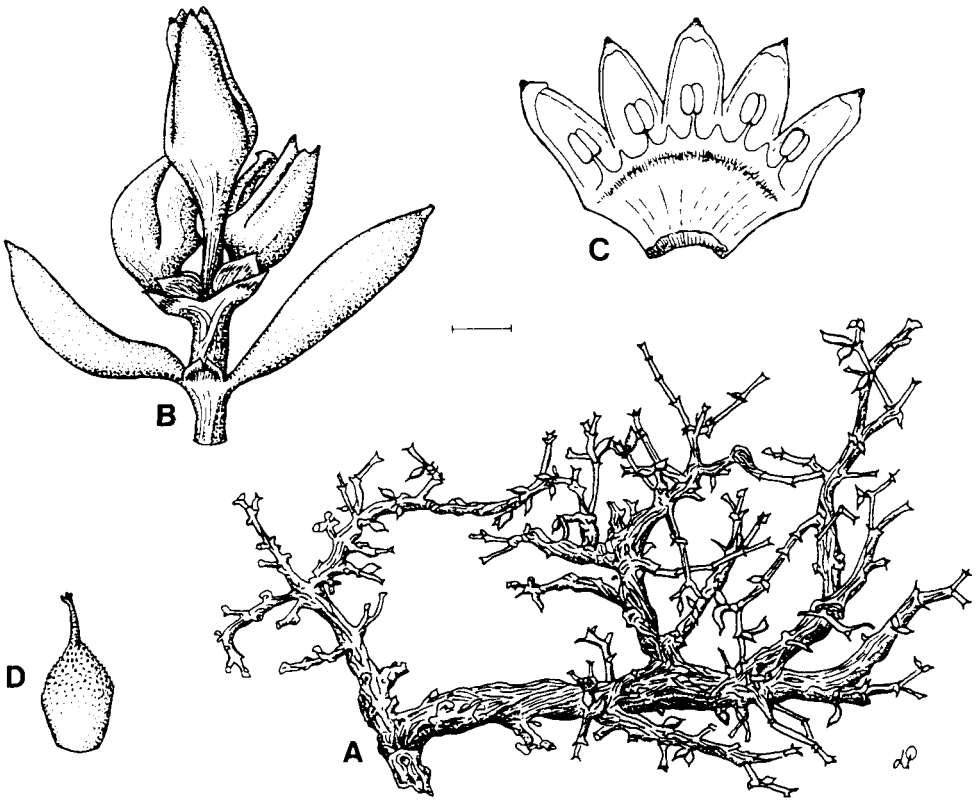

FIG. 12. *Gymnocarpos mahranus*. A, habit; B, part of stem with leaves, stipules and inflorescence; C, perianth opened up; D, pistil. A, scale bar = 10cm; B–D, scale bar = 1mm. (All from *Miller* 12131).

with purple. *Sepals* 2.5 × 1.5mm, with usually involute membranous margin, glabrous, green, sometimes ± tinged with purple, shortly mucronate (mucro 0.1–0.2mm long). *Stamens* with 0.6mm long filaments; anthers oblong 0.6 × 0.5mm, yellow; staminodes triangular, c.0.3mm long. *Ovary* ovate to obovate, 2 × 1.25mm, papillose above; style 1mm long, tapering from a broad base, chestnut-brown; stigma 3-lobed. *Fruits* and *seeds* not seen.

Distribution and habitat. *G. mahranus* is known only from the type locality, where it grows on open rocky slopes with low cushion vegetation at about 550m altitude (Fig. 5B).

Taxonomic remarks. *G. mahranus* in Yemen and *G. parvibractus* in Somalia constitute an obvious species pair differing from all other species of *Gymnocarpos* in their small, stipule-like bracts and the triangular staminodes. However, *G. mahranus* has mostly brown and glabrous bracts, whereas they are mainly white and minutely puberulent in *G. parvibractus*. The leaves are sessile and have a 0.2–0.4mm long mucro in *G.*

mahranus, whereas in *G. parvibractus* they are petiolate and have a 0.5–0.8mm long mucro. The mucro of the sepals is only 0.1–0.2mm long and glabrous in *G. mahranus*, but is 0.3–0.5mm long and minutely puberulent in *G. parvibractus*.

8. G. parvibractus (M. Gilbert) Petruss. & Thulin, **comb. nov. Fig. 13.**
Syn.: *Lochia parvibracta* M. Gilbert in Nord. J. Bot. 11(4): 453 (1991), and in Thulin (ed.), Fl. of Somalia 1: 96 (1993). Type: Somalia, Mudug, 20km N of Hobyo (Obbia) on road to Jirriiban, 5°29′N 48°32′E, 28 v 1989, *Thulin & Abdi Dahir* 6663 (holo. K; iso. MOG, UPS).

Shrublet; *stems* up to c.10cm high, up to 6mm thick at the base; bark white to light grey, pale brown in young shoots; internodes up to 8mm long. *Leaves* circular-ovoid to fusiform, 4–6.5(–10) × (1–)1.8–2.5mm, ± attenuate at the base into (0.25–)0.5–1mm long petiole; mucro 0.5–0.8(–1)mm long, pale brown to almost white, very minutely papillate. *Stipules* 0.8–1.1mm long, with distinct keels, white with brown base, margin and keels soon partly frayed. *Inflorescence* slightly congested, dichasial or partly monochasial, up to 14mm diam.; peduncle up to 4mm long; bracts stipule-like, c.1.2mm long, white with brown base or sometimes almost brown, very minutely puberulent. *Flowers* 4–4.5 × 1.5–2mm; receptacle, 1–2mm long, obconical, narrowing below into a pedicel-like base, light green to almost white, sometimes ± tinged with purple. *Sepals* c.2.5 × 1mm, with involute membranous margin, light green; mucro 0.3–0.5mm long, minutely puberulent. *Stamens* with 0.5–1mm long filaments, brownish; anthers 0.4–0.5 × 0.25mm, dark brown; staminodes triangular, 0.2–0.4mm long, brown. *Ovary* elliptic-ovate, 1.2–1.5 × 0.9–1.1mm, papillose above; style 0.4–0.8mm long, slender; stigma 3-lobed with 0.2–0.3mm long, recurved lobes. *Fruit* ovate, 1.25–1.5 × 1mm, papillose above, free from surrounding perigonium. *Seed* c.1.4 × 0.5mm, elliptic, glabrous, brown.

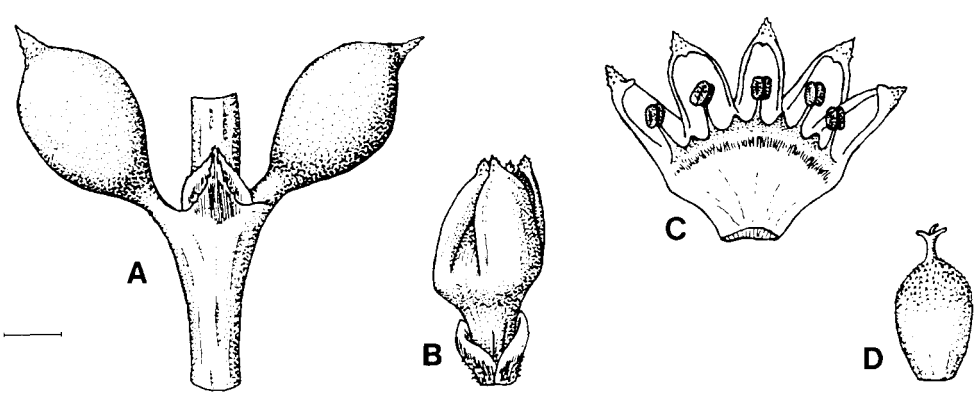

FIG. 13. *Gymnocarpos parvibractus*. A, part of stem with stipules and leaves; B, flower with bracts; C, perianth opened up; D, pistil. For all, scale bar = 1mm. (All from *Thulin & Abdi Dahir* 6663).

Distribution and habitat. *G. parvibractus* is known only from the type locality in the coastal part of central Somalia (Fig. 5B). It forms cushions in crevices of gently sloping, open limestone rocks at c.70m altitude.

Taxonomic remarks. *G. parvibractus* is the only species of the genus known from Somalia. It is closely related to *G. mahranus* in Yemen; for the differences between these two species, see under *G. mahranus*.

EXCLUDED SPECIES

G. przewalskii Bunge ex Maxim. in Bull. Acad. Imp. Sci. St.-Petersb. 26: 502 (1880); Chaudhri in Med. Bot. Mus. Rijksuniv. Utrecht 258: 57, pl. 2, figs 1–6 (1968).

This species, distributed in China and Mongolia, differs markedly from *Gymnocarpos* in at least two fundamental characters.

Firstly, *G. przewalskii* has a different arrangement of the bracts, with an outer pair of large, scarious, white bracts and an inner pair of lateral narrower bracts. The inner, narrower bracts obviously represent the bracts of an aborted lateral flower. No structures similar to the inner bracts of *G. przewalskii* are known in *Gymnocarpos*.

Secondly, the leaves in *G. przewalskii* are totally different from those in *Gymnocarpos*. The leaves are described by Chaudhri (1968) as 'linear-terete or subcylindrical, mucronate ... occasionally slightly grooved on one side'. The 'grooved' leaf is in fact a flattened, though succulent, leaf with revolute margins. No species of *Gymnocarpos* has anything like this type of leaves.

These differences in our opinion make it impossible to retain *G. przewalskii* in *Gymnocarpos*, but no other genus in the subfamily Paronychioideae seems to agree with it either. Probably it would best be treated as a genus of its own.

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