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Monograph of Orbea and Ballyanthus (Apocynaceae-Asclepiadoideae-Ceropegieae)

P. V. Bruyns

THE AMERICAN SOCIETY OF PLANT TAXONOMISTS
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MONOGRAPH OF ORBEA AND BALLYANTHUS (APOCYNACEAE–ASCLEPIADOIDEAE–CEROPEGIEAE)

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ABSTRACT. The genus *Orbea* Haw. (Apocynaceae) is revised and the formerly recognized genera *Orbeanthus* L. C. Leach, *Orbeopsis* L. C. Leach, *Pachycymbium* L. C. Leach, and *Angolluma* Munster are included in it. The revision is based on a detailed survey of morphological characters and a cladistic analysis, which demonstrated lack of support for the segregate genera. The much expanded genus *Orbea* is the only monophyletic entity that can be recognized in this complex. One species formerly assigned to *Orbea* is placed in a monotypic genus, *Ballyanthus*, which is more closely related to *Duvalia* Haw. and *Huernia* R. Br. *Orbea* comprises 56 species widely distributed in Africa and the southwestern part of the Arabian peninsula; one new species, *Orbea taitica*, is described. *Ballyanthus prognathus* occurs in northern Somalia.

INTRODUCTION

The stapeliads are a group of about 310 species of highly succulent plants. They belong to the tribe Ceropegieae of the Asclepiadoideae in the Apocynaceae and form a distinct, monophyletic entity within the Ceropegieae (Bruyns 2000a). They are found in the Old World throughout most of the drier parts of Africa and in Eurasia from southern Europe to India and Myanmar (Bruyns 2000b). Many of the genera have been revised in recent years and, in comparison to other parts of the Asclepiadoideae, they may be considered quite well studied. This is mostly due to their horticultural interest and their presence in many private, specialist collections.

The treatments of Leach (1985, 1988) of *Stapelia* and *Huernia* have dealt with many of the problems associated with these large genera. Leach (1978) also revised *Orbea* and, in the process, described several new genera. Nevertheless problems still remain among the taxa of the complex of genera surrounding *Orbea*, partly because Leach was mainly concerned with southern African taxa and did not deal conclusively with those from north of the equator, and partly because he left the position of certain species in southern Africa in abeyance. Members of the *Orbea*-complex all have mottled, glabrous, and smooth stems in which the tubercles taper gradually to a fine tip. Leach and other workers have recognized several genera within this complex, but many of these appear to be based on very insubstantial differences. Consequently a re-investigation of the generic limits among the members of the *Orbea*-complex was considered necessary and is presented here.

TAXONOMIC HISTORY

In Linnaeus's *Species plantarum* of 1753 and subsequent editions, all the stapeliads were included in the genus *Stapelia*. Robert Brown (1810) was the first to consider breaking this genus into smaller groupings, and he described the segregates *Caralluma*, *Huernia*,

and *Piaranthus*. Haworth (1812) appears to have welcomed this subdivision of what was already a somewhat cumbersome entity, and he moved species into several additional new genera, one of which was *Orbea*. Haworth's genus *Orbea* contains rather a miscellany of species and hybrids, which had arisen in cultivation (Bruyns 1998). This genus, along with many others that he described, did not meet with contemporary favor, and most of them were reduced to synonyms of *Stapelia* by Schultes (1820) and Endlicher (1838), remaining there in the subsequent treatment of botanists, such as Decaisne (1844). N. E. Brown (1890) again appears to have toyed with the idea of splitting off species from *Caralluma* and *Stapelia*, but ultimately abandoned this in favor of maintaining these larger genera and several other, mostly much smaller ones. By the time they were catalogued by White and Sloane (1937), *Caralluma* and *Stapelia* contained 105 and 99 species, respectively.

Leach (1975, 1978) investigated the problems of generic boundaries in the stapeliads and decided that it was necessary to resurrect several of Haworth's genera. In revising Haworth's genus *Orbea* and describing the new genera *Orbeanthus*, *Orbeopsis*, and *Pachycymbium*, Leach (1978) began his search for a new classification of the stapeliads and, in particular, he began to address the problems posed by the large and poorly defined genera *Caralluma* and *Stapelia*. In this new classification, where he moved several species out of these genera, he aimed to shift the emphasis from floral to vegetative characters (Leach 1978: 2) and so reflect better the "phyletic relationships" than had been the case in earlier classifications. In resurrecting *Orbea* and typifying it with *O. variegata*, Leach made some nomenclatural errors that were first pointed out by Mottram (1996). These were resolved by conserving *Orbea* Haw. against *Orbea* L. C. Leach (Bruyns 1998; Brummitt 2000).

In his second paper on this problem, Leach (1980) revised the resurrected genus *Tridentea* Haw. and again moved several species out of *Caralluma* and *Stapelia*; however, a recent re-assessment of the characters used by Leach and the consideration of some others that he did not use have not supported his arguments (Bruyns 1995). This has made it necessary to re-examine the situation in *Orbea* and its close relatives with the use of the same broader set of characters.

From Leach (1978) it is clear that such reconsideration must include the species of *Orbeanthus*, *Orbeopsis,* and *Pachycymbium*, as well as several other species whose generic placing he left in abeyance at that stage. From Gilbert (1990), it is evident that the four miscellaneous southern African species *Caralluma lugardii*, *C. rogersii*, *C. ubomboensis*, and *Stapelia miscella* as well as the more widely distributed *Caralluma schweinfurthii* must be brought into consideration in such an investigation. Gilbert's treatment of 1990 meant that the investigation would also have to include the so-called "*ango*"-group of *Caralluma*. This is an assemblage of species found in Africa north of the equator and in southern Arabia, which are supposed to be related to the imperfectly known *Caralluma ango* (Gilbert 1978) and have more recently been placed in a genus of their own, *Angolluma*.

At this stage it is appropriate to assess critically the various genera that have been recognized and are treated in this monograph.

ORBEANTHUS. In his discussion of *Orbeanthus*, Leach (1978: 72) emphasized (1) the "creeping stems with their very much smaller, often retrorse teeth, which are quite devoid of any trace of stipular denticles and which readily develop adventitious roots wherever touching the soil"; (2) "the general form of the corolla with its broad smooth annulus . . . also differs markedly from anything found in *Orbea*"; (3) the hairiness of the corona, which is "almost sufficient to distinguish *Orbeanthus* from all other genera."

We shall consider each of these points in turn:

(1) If one examines such genera as *Echidnopsis* Hook. f., *Huernia*, *Stapelia*, and *Stapeliopsis* Pillans, one will find that in most species the stems are decumbent but in each genus a few taxa have procumbent to creeping stems. In *Echidnopsis* this variation even occurs within the single species, *E. sharpei* A. C. White & B. Sloane (Bruyns 1988), and in *Huernia* in *H. verekeri* Stent (Leach 1988). Like the rhizomatous habit, the creeping habit has developed independently several times among the stapeliads. On its own, it is therefore not a good character with which to distinguish genera.

Leach (1978) claimed that the teeth on the stems in *Orbeanthus* are "very much smaller" than they are in related genera (*Orbea* and *Orbeopsis*). This is certainly true of *O. hardyi* where the teeth are a mere 1–3 mm long; however, it is not true of *O. conjuncta*, which was at that time rather lesser known. In *O. conjuncta* the teeth are 2–6 mm long and, while they cannot compete with, say, *Orbea maculata* (where they are up to 15 mm long), they easily fall within the range of more modest species, like *O. variegata*. Leach also claimed that the teeth on the stems were "often retrorse," but on the five collections of *O. conjuncta* that I have before me this is not true for any of the stems.

His statement that the stems are "devoid of any trace of stipular denticles" has been verified here; however, the survey presented below (character 7) shows that this character must be viewed with caution. Among *Orbea*, *Orbeopsis*, and *Orbeanthus* there is a cline from presence to absence of these denticles rather than a discontinuity. In particular, there are species that Leach placed in *Orbea* in which stipular denticles are also often missing (e.g., *O. namaquensis*).

The ability to "develop adventitious roots wherever touching the soil" is also cited as unique to *Orbeanthus*. Yet, it is one of the remarkable characteristics of the stapeliads that this ability is almost universal within the group: even an erect stem from such widely differing species as *Stapelia gigantea* N. E. Br., *Orbea maculata*, and *O. caudata*, if cut off near the tip (prevented from rotting and drying out) and laid flat upon the soil, will form adventitious roots all along its length. In *Orbeanthus* this occurs naturally as the stem is prostrate and consequently in contact with the soil for its entire length; the ability is, however, latent in most stapeliads.

(2) Since the corollas of *O. conjuncta* and *O. hardyi* are so very different in shape (the one deeply campanulate and the other ± flat), it is difficult to see what Leach meant by the "general form of the corolla" in *Orbeanthus*. In particular, he mentioned the "smooth annulus": while the annulus is mostly rugulose in *Orbea*, this is not true of all species (see character 21 below and, for example, *O. longidens*) and so cannot be used to separate the genera.

(3) Here it is important to note that pubescent corona lobes are also found in three species of *Stapelia* [*S. arenosa* C. A. Lückh., *S. rubiginosa* Nel, *S. rufa* Masson; Leach (1985)] as well as occasionally in *Caralluma* [e.g., *C. adenensis* (Deflers) K. Schum.; Bruyns & Jonkers (1994)] and intermittently in *C. stalagmifera* C. E. C. Fischer. Consequently this is not as unusual as Leach assumed and is not at all sufficient to separate *Orbeanthus* "from all other genera."

It follows that a careful analysis of the characters discussed does not support Leach's separation of *Orbeanthus* from *Orbea*.

ORBEOPSIS. The evidence provided by Leach (1978) for the establishment of *Orbeopsis* is rather more circumspect. From the key (Leach 1978: 4) one finds that *Orbeopsis* was separated from *Orbea* by the "inflorescence . . . of more or less simultaneously

opening flowers; corolla without an annulus." Further on, Leach (1978: 62) gives some additional information: "deeply lobed flowers . . . devoid of annulus and mostly rotate with the corolla surface finely granulate or granulate-rugulose . . . pollinia mostly a different shape, usually wider than long."

Clearly one may deduce from the key that the main criterion separating *Orbea* and *Orbeopsis* is the nature of the inflorescence, i.e., the "more or less simultaneously opening flowers." As indicated below (character 10), this is not true of *O. albocastanea*, *O. caudata*, and *O. knobelii*. In *Quaqua* N. E. Br. (Bruyns 1999) several species [e.g., *Q. armata* (N. E. Br.) Bruyns, *Q. mammillaris* (L.) Bruyns] bear clusters of more or less simultaneously opening flowers, whereas in the majority the inflorescences have fewer flowers and the flowers open in succession. In *Hoodia* Sweet, clusters of more or less simultaneously opening flowers are produced only in *H. ruschii* Dinter and *H. triebneri* (Nel) Bruyns, whereas in all the other species the flowers develop successively (Bruyns 1993). Thus, in the first place this character is not adhered to by all species of *Orbeopsis* and, second, this is another of those characters that is very variable in several other stapeliad genera. Consequently, it should not be used to separate *Orbea* and *Orbeopsis* unless such segregation is substantiated by other significant differences.

The other character that Leach (1978) mentions repeatedly is the lack of an annulus. As indicated below (character 15) the position in *Orbeopsis* is part of a cline across the *Orbea*-complex where the annulus varies from absent to very clearly present (even varying greatly in *Orbea* sensu Leach). The development of an annulus is variable in many stapeliad genera. In *Hoodia* only *H. pilifera* (L. f.) Plowes produces an annulus, whereas in all other species the corolla is thickened at least to some extent around the mouth of the tube (Bruyns 1993); in *Huernia* as well there is a wide range from flowers with an annulus to flowers without any trace of one; in *Quaqua* many species have the corolla distinctly thickened around the mouth of the tube but no "true annulus" is found.

Investigations with the SEM of corolla surfaces (characters 21 and 22, below) have shown that a "granulose-rugulose" texture on the inner surface is common in *Orbea* and is found in all species of *Orbeopsis* and *Pachycymbium* sensu Leach. Therefore, once again, this cannot be used to separate these genera.

As far as "deeply lobed flowers" are concerned one ought to note that they are rare in *Orbea* and are only found in *O. maculata*. Nevertheless, the flowers of *O. knobelii* are not particularly deeply lobed either.

The criterion "pollinia mostly a different shape, usually wider than long" is also not adequate to separate the genera. Within *Orbea* sensu Leach the pollinia vary from considerably longer than broad to as long as broad (character 36). Within *Orbeopsis* variation is even wider than in *Orbea*.

Thus there appears to be no character that can be used to separate *Orbea* and *Orbeopsis*. It is probably significant here also that Leach (1978: 3) admitted that "on the evidence of vegetative characters alone [*Orbeopsis*] could be accommodated in *Orbea*."

PACHYCYMBIUM sensu L. C. Leach (1978). This genus is separated from *Orbea* by "flowers . . . less than 3 cm diam . . . campanulate rigidly fleshy, arranged in small fascicles along the sides of the stems" (Leach 1978: 4). Leach (1978: 70) mentions other differences in the staminal column: deeply urceolate corona; inner corona lobes not at all produced above the anthers; "pollinia" far less accessible than in *Orbea*, and "the arrangement of the anther wings and nectarial cavity is entirely different from that in *Orbea*."

As to the main features distinguishing *Pachycymbium* from *Orbea* ("flowers less than

30 mm diam" and "arranged in small fascicles along the sides of the stems") the following two points need to be considered.

Within *Stapelia*, a genus whose "naturalness" one would be hard put to dispute, one finds flowers ranging from 8 mm to 400 mm in diameter (Leach 1985); in *Hoodia* they range from 8 mm to 170 mm (Bruyns 1993). Thus there seems little reason to exclude *Pachycymbium* from *Orbea* on this ground. One's confidence in this character is reduced if one considers the "somewhat intermediate position" between *Orbea* and *Pachycymbium* of *Orbea paradoxa* (Leach 1978: 70), where the flowers are also campanulate and fairly fleshy but, in particular, are 18–28 mm in diameter. In other words, in respect of most of the main characters separating the two genera *O. paradoxa* belongs to *Pachycymbium* rather than *Orbea*.

Returning once more to *Stapelia*, one will find remarkable variation in the position of the inflorescence on the stem. There may be a single inflorescence near the base of the stem (Leach 1985: 34, *S. gariepensis* Pillans), the inflorescences may develop "randomly along the sides of the stems, sometimes 2–3 from a single stem" (Leach 1985: 58, *S. baylissii* L. C. Leach), they may be "frequently towards the apex, often with a number of peduncles flowering at the same time" (Leach 1985: 118, *S. immelmaniae* Pillans) or even "from the sides of the stem near the apex" (Leach 1985: 85, *S. surrecta* N. E. Br.). The same variation in the position of the inflorescence (i.e., from near the base of the stem to near its apex) is found in *Tromotriche* Haw. (Bruyns 1995).

Here it is worth mentioning the case of *Orbea prognatha* (P. R. O. Bally) L. C. Leach, which is "somewhat anomalous" according to Leach (1978: 55). In this species the flowers are produced "usually near the apex of the stem, occasionally lower" (Bally 1962: 340), a fact which is not mentioned anywhere in Leach (1978). Thus even within Leach's concept of *Orbea* the inflorescence is found from the base of the stems to near the apex and there seem to be no grounds for the claim that this separates *Orbea* and *Pachycymbium*.

From the sketches presented here (Fig. 46) it can be seen that apart from the more erect outer coronal series, which restricts access to the pollinia and nectarial cavity (a pollination syndrome and unlikely to be of generic significance), there is no structural difference in the construction of the flower in *Pachycymbium*, which is as usual in the stapeliads. Similar restriction of access to the pollinia by the outer corona is to be seen elsewhere, for example in *Stapelia flavopurpurea* Marl. within *Stapelia*, and in *Tromotriche baylissii* (L. C. Leach) Bruyns and *T. choanantha* (Lavr. & H. Hall) Bruyns.

There appear, once again, to be no grounds for recognizing *Pachycymbium* sensu L. C. Leach and *Orbea* as distinct genera.

PACHYCYMBIUM sensu M. G. Gilbert. Gilbert (1990) modified Leach's concept of *Pachycymbium* to include all the species of the so-called "*ango*"-group from *Caralluma*. According to Gilbert (1990: 21) the main features that distinguish *Pachycymbium* from *Orbea* are the "small lateral fascicles of flowers" and the "relatively small very fleshy flowers that are often campanulate and sometimes also with an annulus."

The same two points that I have raised above as relevant to *Pachycymbium* sensu Leach apply to *Pachycymbium* sensu Gilbert. In addition, *P. miscellum* (N. E. Br.) Gilbert is problematic: here the "basal inflorescences and very long pedicels are very *Orbea*-like, as is the corona" (Gilbert 1990: 28). The rotate, not particularly fleshy corolla with annulus (Bruyns 1986) is also quite unlike that of *Pachycymbium* and more akin to that found

in *Orbea*. This species thus has a typical "*Orbea*" flower, which is just smaller than in any species included by Leach (1978) in *Orbea*.

Pachycymbium rogersii (L. Bolus) Gilbert and *P. lugardii* (N. E. Br.) Gilbert also do not fit "relatively small very fleshy flowers that are often campanulate and sometimes also with an annulus" for Gilbert's *Pachycymbium*. Thus it appears from Gilbert (1990) that the "small lateral fascicles of flowers," i.e., the position of the inflorescence, is the only way to separate *Pachycymbium* sensu Gilbert and *Orbea*. Again, as pointed out above, the presence of exactly this variation within *Stapelia* and *Tromotriche* and its variability within *Orbea* undermines its value as a character with which to separate *Pachycymbium* and *Orbea*.

ANGOLLUMA (Munster 1990; Newton 1993; Plowes 1994). Munster (1990) published the name *Angolluma* for the "*ango*"-group in *Caralluma*. Newton (1993) added to Munster's account by correcting some errors and omissions, and also added his opinions on why *Angolluma* should be recognized.

In Newton's (1993) view *Pachycymbium* was well defined by Leach (1978), and its distinctness as a generic entity was reinforced by the fact that the additional species of Lavranos (1984) "fits comfortably into it." Since it is likely that Lavranos's new species is conspecific with *P. carnosum* (Stent) L. C. Leach, the latter part of this argument is not instructive and does not change the weaknesses of Leach's definition of *Pachycymbium* (see above).

Newton (1993) disagreed with Gilbert's placing of the "*ango*"-group in *Pachycymbium* mainly on four points:

(1) The presence of stipular denticles ("stipels") in the "*ango*"-group is extremely rare. Newton mentions that he has rarely seen them in *Caralluma subterranea*, but it is perhaps noteworthy that they are present intermittently in clonotype material of his *Angolluma semitubiflora* from Tanzania and in the more recently described *A. lenewtonii*, as well as intermittently in such species as *O. denboefii*, *O. distincta*, and *O. dummeri*. Even more noteworthy is the fact that in *Duvalia* Haw., which also occurs both north and south of the equator, the species growing south of the equator all have stipular denticles and the northern ones lack them entirely. In addition, stipels are of variable occurrence in *O. carnosa*; Newton apparently assumed that they are always present. This suggests that their relative rarity in the "*ango*"-group (which mainly occurs north of the equator) is not significant. Another example is provided by *Orbea* itself: of the two species from around and north of the equator included in *Orbea* by Leach, one of them (*O. semota*) usually lacks stipular denticles, whereas its closest southern African relatives usually have them (though in *O. namaquensis* their occurrence is also intermittent).

(2) Newton challenged Gilbert's claim that *Caralluma schweinfurthii* approached the "sculptured corolla" of *Pachycymbium*; he regarded the surface of the corolla of *C. schweinfurthii* as "finely tuberculate." SEM views (as in Fig. 3C, D, of the corolla of *O. ubomboensis*, which is very similar to that of *O. schweinfurthii*) show that the corolla surface is covered with comparatively large compound papillae, which themselves are finely papillate: "finely tuberculate" is too vague and Gilbert's description is closer to the truth.

(3) Newton disagreed with Gilbert's claim that there is an annulus in *Caralluma decaisneana*. He had not observed this to be prominent, though it is not clear on what material his conclusion was based. As discussed below, the degree of prominence is largely irrelevant, and there are plenty of examples in the "*ango*"-group where there is an annular thickening of the corolla.

(4) Newton stated that only a few species of the "*ango*"-group have rhizomatous stems. As Gilbert (1978) observed, this phenomenon is found at least to some extent in five of the eight species he found in Ethiopia, so that it is more common than Newton thought. Again, Newton does not explain on what material his conclusion was based.

Newton added as well that the "almost equilateral triangular stem-teeth of *Pachycymbium* s.s. look quite different from the rounded tapering teeth of the "*ango*"-group." This is true (mostly) of *P. keithii* but not of *P. carnosum,* where the teeth are narrowly triangular and not equilateral at all. Newton continued that "genera should be distinguished by consistent combinations of characters," that the members of the "*ango*"-group have "similarities in other floral and inflorescence characters and are easily recognized from vegetative characters." He did not say what these "consistent combinations of characters" might be and what other characters might be useful to characterize the "*ango*"-group. None of the four points he raised against Gilbert's treatment actually succeed in contradicting Gilbert's statement that all the distinguishing features of *Pachycymbium* s.s. "can be matched by species within the "*ango*"-group" (Gilbert 1990: 20). One is therefore left without any distinguishing characters for *Angolluma* relative to *Pachycymbium*, i.e., in exactly the position in which Gilbert found himself and which convinced him to modify the concept of *Pachycymbium* to include the "*ango*"-group.

Plowes (1994) moved the species of the "*ango*"-group of *Caralluma* from *Pachycymbium* to *Angolluma*. In justification for this he listed four differences between *Pachycymbium* and *Angolluma*.

(1) *Pachycymbium*: "small campanulate flowers (usually under 18 mm) with an unusually thick fleshy corolla fabric, a conspicuous thickened narrow annulus around the mouth of the tube and a very irregularly rugose upper surface with a *variety of spiculate papillae*." In *Angolluma hairs,* if present, "*differ in structure* from those of *Pachycymbium*"; in two species "there is a slight annulus," which is "*not really comparable* to that in *Pachycymbium s.s.*"

(2) In *Pachycymbium* the outer corona is deeply urceolate.

(3) *Pachycymbium* "has laterally flattened deltoid teeth, with prominent denticles near the tip"; *Angolluma* has "conical tubercles that normally lack denticles," though they are present "in some juvenile *Angolluma subterranea* tubercles" but "*do not usually persist once the tubercle is mature.*"

(4) *Pachycymbium* is "profusely rhizomatous," a feature "*not normally present* in" *Angolluma*.

That this arrangement is deeply flawed is adequately demonstrated by the above quotes (with my emphasis) and none of these characters can be used to distinguish between *Pachycymbium* and *Angolluma*. There is no evidence for "a very adequate case to maintain the previous separation of these two groups of species."

Several other statements made by Plowes in the same article show that there is no real definition of *Angolluma*. Some of these are quoted here: (1) (p. 120) that he has entertained "misgivings" about placing *Stapelia miscella* N. E. Br. in *Angolluma*; (2) that the placing of *Caralluma ubomboensis* Verdoorn and *Stapelia miscella* together in *Angolluma* "is only possible by taking a very wide view of *Angolluma*, which in any case has had to be done in order to accommodate many diverse species"; (3) that he has "shoe-horned" *Caralluma rogersii* (L. Bolus) E. A. Bruce & R. A. Dyer into *Angolluma*; (4) that the placing of these three and *Caralluma lugardii* N. E. Br. in *Angolluma* is "largely a matter of expediency" and (5) (p. 106) that, in the case of *Caralluma vibratilis* E. A. Bruce & P. R. O. Bally, "despite these various anomalies that do not accord with the balance of

species in *Angolluma*, this genus appears to be the best fit for it and it is accordingly now placed there."

It is clear from these quotes that there is no point in examining whether the criteria given are satisfied by all the species concerned and whether they really separate the genera involved.

MATERIALS AND METHODS

The descriptions, illustrations, and distribution maps are based on living plants and herbarium collections (see Acknowledgments). Living material and some that was preserved in alcohol was used for the examination of the surface of the stems, the stipular structures, and the inner surface of the flower. For SEM, the material was prepared as described by Bruyns (1993) and examined with a Cambridge S200 SEM. The line drawings were all made with a camera lucida attached to a Nikon SMZ 10 dissecting microscope.

As part of each species treatment, collections are cited according to the quarter-degree system of Edwards and Leistner (1971). In this system each one-degree by one-degree square is divided into four equal parts. The upper two of these parts are labelled A and B and the lower two C and D. Each of these squares is further divided into four equal parts, which are labelled in the same way. Thus, the surface is divided into squares one sixteenth of a degree in size, and each square can be characterized by four digits and two letters. This system is extended to localities north of the equator by adding "N," and here the square is subdivided in the order C D / A B as opposed to A B / C D in the southern hemisphere. Latitude and longitude readings, when available, are listed after the locality. This system has not been extended to west of the Greenwich meridian.

Species are generally taken here as groups of populations that differ in at least two persistent, "good" characters (Stebbins 1950; Hedberg 1957; Wiley 1981; Cronquist 1988); however, in a few cases (in northeast Africa and Arabia) the paucity of material is such that no reliable decision could be taken, and taxa are kept as distinct species when they show discontinuities in only one character or only very weak discontinuities at all. In general, in this account the rank of subspecies is applied to geographically complementary taxa that differ in only one "reasonably reliable" character. The rank of variety is used for taxa that occur together but differ in a single character, and here intermediates are often found.

For the cladistic analysis all the taxa recognized in the "*Orbea*-complex" were considered, except *O. taitica*. The outgroups used were *Quaqua inversa* (N. E. Br.) Bruyns, *Q. mammillaris* (L.) Bruyns, *Duvalia caespitosa* (Masson) Haw., *D. sulcata* N. E. Br., *Duvaliandra dioscoridis* (Lavranos) M. G. Gilbert, *Huernia barbata* (Masson) Haw. and *H. transvaalensis* Stent. The two species of *Quaqua* were included, because they belong to a considerably more basal genus than *Orbea* but are nevertheless not too far removed from *Orbea* (Bruyns 2000a). *Duvaliandra* M. G. Gilbert is included, since it has been postulated to be closely related to *Duvalia* and *Huernia* (Gilbert 1980; Bruyns 2000a). The species of *Duvalia* and *Huernia* are included, because they share many vegetative characters with the "*Orbea*-complex," and it is important to show that none of these taxa are nested within *Orbea*. The data were analysed with the program Hennig86 with the heuristic branch-and-bound routine (procedure "mh*; bb*;"), after which the consensus tree was plotted (procedure "n; tpl;"). The support for clades was determined by performing 10,000

replications of parsimony jack-knifing using PAUP* version 4.0b4a (PPE) (Swofford 2000) with options selected so as to emulate the conditions discussed by Farris et al. (1996) (collapse branches if minimum length is zero, jackknife with 36,79 % deletion, emulate "Jac" resampling, "Fast" stepwise-addition). Only groups or nodes with frequency >50% were retained in the jackknife consensus tree.

MORPHOLOGY

HABIT. The species of *Orbea* are mat- to clump-forming succulents. Plants vary from as little as 20 mm in diameter in *O. miscella* to 3 m in diameter in *O. huillensis*, but generally specimens are between 5 to 30 cm in diameter. Clumps vary from dense (e.g., in *O. rogersii*) to very laxly and loosely clustered in *O. distincta* or *O. schweinfurthii*.

The stems vary greatly from erect with a short, horizontal base to entirely prostrate in two species (*O. conjuncta*, *O. hardyi* – character 1).

Ten species from south of the equator and eight from the Northern Hemisphere have stems that spread underground by means of cylindrical, horizontal rhizomes (character 2). On these rhizomes the angles are obscure, and the tubercles are reduced or even obsolete. On rising to the surface these stems become markedly thicker and erect, and bear much-enlarged tubercles. Where such a stem rises to the surface it tends to branch at or above ground level and a "new" plant forms, from where further rhizomes may develop. In *O. sprengeri* some subspecies have a rhizomatous habit and others not (Gilbert 1978), and this is coded as "?"

In *Orbea* the stems are almost always brightly marked with purple on a grey to green background (character 3). The only exceptions to this are *O. miscella* and *O. ubomboensis*; in the latter mottling is rarely found and in the former it has not been noted at all. In most species the stems are ca. 10 mm in diameter, excluding the teeth, but in *O. miscella* and *O. ubomboensis* they are especially slender (often 5 mm thick or less). On the other hand, stems are generally stouter in *O. albocastanea*, *O. gerstneri*, *O. huillensis*, *O. knobelii*, *O. lutea*, *O. melanantha*, and *O. valida*, and are particularly so in *O. huillensis*, *O. melanantha*, and *O. valida*. They are mostly less than 15 cm tall.

In all species of *Orbea* the surface of the stems is smooth (Fig. 1) and they share this character-state with the basal species *Caralluma adscendens* R. Br. (character 4). Surface aspects tend to vary a little on the leaf-rudiment, where some epidermal cells have their outer walls raised into distinct papillae (Fig. 1C).

In all stapeliads the leaf-rudiments are borne on raised podaria, which are here termed tubercles. Such a tubercle is not a modified petiole but is the much expanded, succulent base of the leaf-rudiment (Troll 1937). These tubercles are mostly conical but can become strongly laterally flattened (character 5), and then they are usually joined into wings longitudinally along the stem, giving a characteristic angled appearance. In all species of *Orbea* the tubercle narrows gradually from its base towards the tip.

In all species in *Orbea* the tip of the tubercle, which constitutes the leaf-rudiment, is indistinguishable from the rest of the tubercle, except sometimes for a slightly paler color. The base of the leaf-rudiment is indicated by the location of two small stipular denticles, if these are present. It may also be slightly flattened above (adaxially) and slightly laterally inflated (as is the case in Fig. 1C), but no midrib and no blade can be located. In general the leaf-rudiment wears off with time to leave a rounded tip on the tubercle. In a few species (especially *O. huillensis*, *O. lutea*, *O. melanantha*, and *O. valida*) the tubercle may become hardened with age and covered partly with a suberized layer.

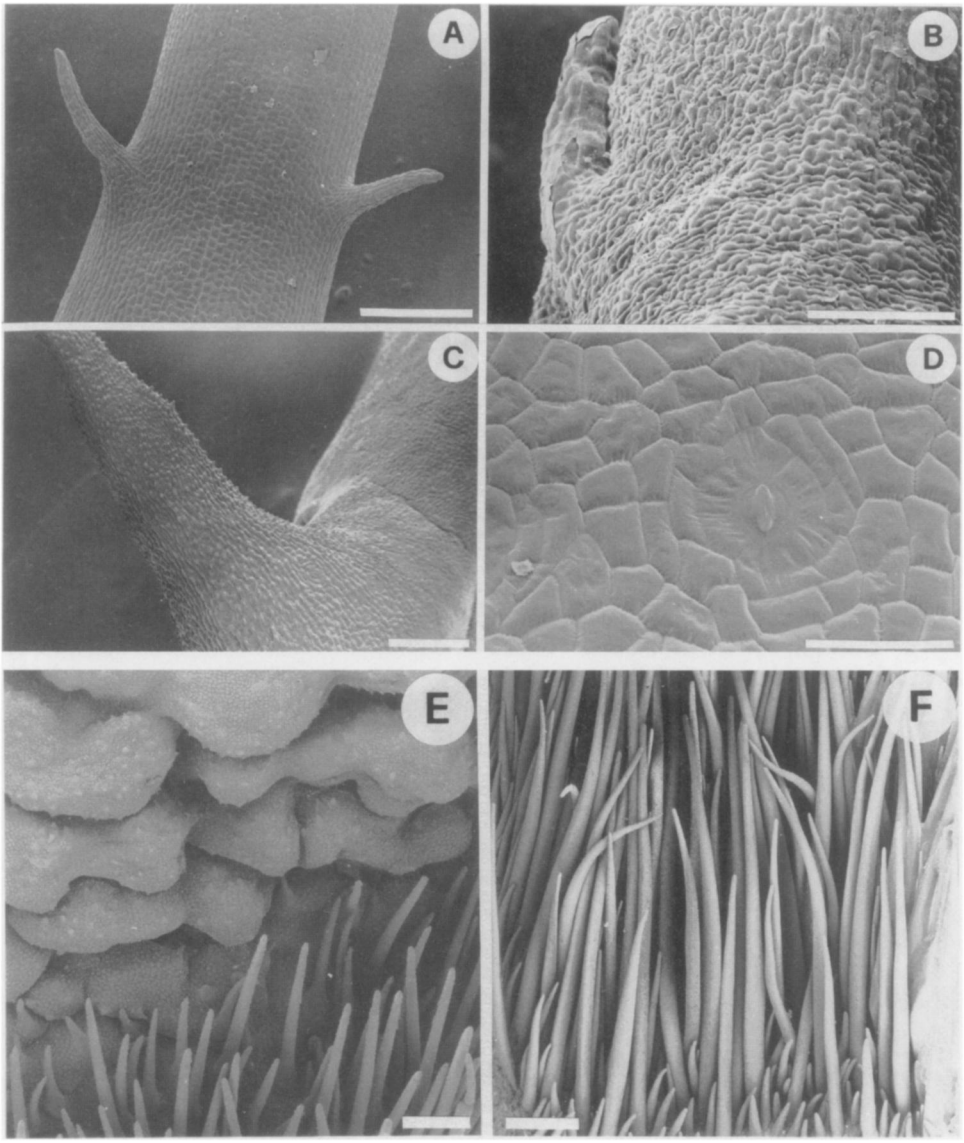

FIG. 1. Surface of stems and stipular denticles in *Orbea* (A–D) and hairs borne inside corolla near base (E–F). A. *O. longidens*, relatively long, slender stipular denticles. B. *O. schweinfurthii*, small stipular denticles adpressed to surface. C. *O. lugardii*, slightly papillate ridge along edge of tubercle; stipular denticles absent. D. *O. ubomboensis*, outer walls of cells hardly raised above surface. E. *O. verrucosa*, rugulose surface of tube with few outstanding papillae giving way to dense ring of bristles in base. F. *O. ciliata*, bristles in base of tube. In E and F, the mouth of the tube lies at the top of the picture. Scale bars: A, C, 500 µm; B, E–F, 200 µm; D, 50 µm. [Based on: A, *Bruyns 4449*; B, *Bruyns 2293*; C, *Bruyns 4158*; D, *Bruyns 4455*; E, *Bruyns 5388*; F, *Bruyns 5388*.]

In several species the length of the tubercles greatly exceeds the thickness of the internodes (character 6). In these cases the presence of a small pair of stipular denticles quite close to the tip indicates that such a long tubercle is mostly part of the stem and is not derived from the leaves or from the petiole. This phenomenon is particularly noticeable in species in the southern hemisphere, like *O. caudata* subsp. *rhodesiaca* or *O. longidens*, where the stems are relatively slender, but it is also found among several in the northern hemisphere. Certainly in the case of *O. longidens* it has the effect of breaking up the outline of the plant and making it appear very grass-like; this is also the case in species from north of the equator, which frequently grow quite well concealed among small tufts of grass.

In many species of *Orbea* a pair of small, cylindrical to conical, stipular denticles is present on the adaxial (upper) surface of the tubercle, usually quite close to the tip (character 7, Fig. 1A). Very occasionally these are flattened and pressed to the surface of the leaf rudiment (Fig. 1B), and in some cases they form a horny ridge along the edge at the base of the leaf rudiment. Stipular denticles are generally far more prevalent in species occurring south of the equator, but in several of these they are absent. North of and around the equator they are found regularly in *O. semitubiflora* and *O. subterranea* but only intermittently in several other species, such as *O. denboefii*, *O. distincta*, and *O. dummeri*. It is important to note that even in species where stipular denticles are regularly present (such as *O. carnosa*, for example), there are invariably tubercles that lack them entirely; sometimes entire plants are without them. The minute marginal hairs that have been observed in *Tridentea* (Bruyns 1995) are entirely missing in *Orbea*.

INFLORESCENCE. In *Orbea* the inflorescences develop in a wide variety of positions along the stem (character 8). There is also much variation in the number of inflorescences per stem (character 9), but it is generally the case that when the inflorescence develops basally there is only one per stem, and when it develops towards the apex of the stem there are several per stem. Generally it is also true that species with larger flowers bear few of them in a single inflorescence towards the base of the stem, whereas in smaller-flowered species flowers may arise at the base, may be grouped in a single inflorescence, or may be borne distally in several inflorescences.

The presence of dense umbels bearing more or less simultaneously opening flowers (character 10) is now known in several genera, e.g., *Hoodia* (Bruyns 1993) and *Quaqua* (Bruyns 1999), and is also found elsewhere in the Asclepiadoideae (e.g., Smith 1988; some species of *Pachycarpus* E. Mey.). Leach (1978) used this phenomenon to define his genus *Orbeopsis*, but there is considerable variation even among the species that he included there. In *O. caudata* the flowers open in rapid succession but are relatively few per inflorescence. In the other species, they are in dense clusters of up to 40 per inflorescence. According to White and Sloane (1937: 524, 366), the flowers of *O. albocastanea* open "in succession" and those of *O. knobelii* "in rapid succession." In the case of *O. albocastanea* their Fig. 466 shows an inflorescence with flowers at all stages of development; I have observed the same. In the other species of "*Orbeopsis*" the flowers on an inflorescence open ± simultaneously. In fact, within *Orbea*, as in *Quaqua*, there is a cline from successively opening flowers to all opening simultaneously on an inflorescence.

COROLLA. The flower in *Orbea* varies from 10 mm to 100 mm in diameter (character 14), but this range is much exceeded in *Stapelia*, where flowers are found anywhere between 6 mm and 400 mm in diameter (Leach 1985).

In the majority of species of *Orbea* the corolla is divided into lobes inserted on the

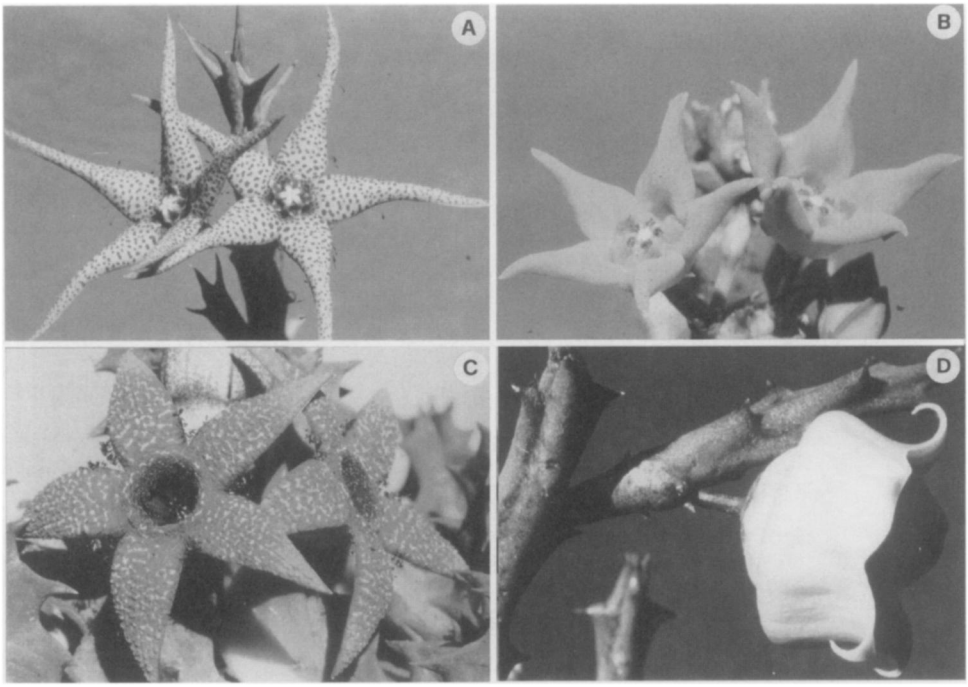

FIG. 2. Transitional series from flat to tubular flowers in *Orbea*. A. *O. caudata* subsp. *rhodesiaca*, corolla ± flat. B. *O. semitubiflora*, corolla with a small tube in center just containing corona. C. *O. gerstneri* subsp. *elongata*, corolla with an obvious tube in center. D. *O. conjuncta*, corolla bicampanulate; the tube forming most of the length of the corolla. [Based on: A, *Bruyns 6936*; B, *Newton 3419*; C, *Bruyns 6605*; D, *Bruyns 4477*.]

edge of an obvious corolla tube that surrounds the gynostegium in the center. This tube is very variable in depth (character 12), but it does not become more than twice as deep as it is broad, in contrast to the situation in genera like *Echidnopsis*, where the length may greatly exceed the breadth (Bruyns 1988). A series of different shapes of the flower is shown in Fig. 2, ranging from the almost flat flowers of *O. caudata* to the deeply bell-shaped flowers of *O. conjuncta*.

In the stapeliads the corolla tube often consists of two parts. The "primary" tube encloses the gynostegium and has the tissues distinctly thickened at the mouth; the "secondary" tube extends beyond this thickening (character 16) and below the base of the corolla lobes (Bruyns 2000a). The thickening at the mouth of the primary tube, which is interpreted as a corolline corona (Endress & Bruyns 2000; Bruyns 2000a), can become substantial and much swollen; it is often referred to as an "annulus."

In most of the southern African taxa an annulus of variable prominence is present. This reaches its most prominent and highly developed state in *Orbea ciliata*, and all stages between this form and complete absence exist. In the northern taxa the annulus is generally only poorly developed and mostly takes the form of a thickened ring of tissue around the mouth of the tube, which is only clearly detectable on dissection of the corolla. In many species from north of the equator it is absent, but this is true of some southern ones, too, like *O. albocastanea* and *O. caudata*. Further variation is found in the extent to which the annulus actually forms the corolla tube (character 13); there are several cases in which the base of the corolla is flat, and the small corolla tube surrounding the stipe is formed

entirely by the annulus (e.g., *O. umbracula* in Fig. 4E and *B. prognathus* in Fig. 4D). It is considered that in such instances the basal tubular part of the corolla (i.e., that below the thickening or annulus) has been almost or completely lost.

Where a secondary corolla tube is present it seems likely that it is formed by fusion of the lobes beyond the annulus. There are two cases in *Orbea* (*O. conjuncta* and *O. hardyi*) where the zone of fusion is still clear in the mature flower, and these two are unique in this respect in the stapeliads.

In many species of *Orbea* the surface of the corolla is covered with furrows and ridges (character 21), i.e., it is irregularly rugulose, with or without certain cells projecting from the surfaces of these furrows or ridges. In others the surface is flat, again with or without certain cells projecting from it. Having the epidermal cells raised into discrete papillae (Fig. 3C, D), which is very prevalent in the genera *Huernia* and *Stapelianthus* Choux, is found in most genera but is relatively rare in *Orbea*. More common in *Orbea* is the situation where certain cells of a verrucose epidermis project from the surface. These cells can be very oddly shaped; some of them are shown in Fig. 3. The peculiar ring of thick, short bristles (character 18, Fig. 1E) around the base of the corolla tube that is present in several species of *Orbea* sensu L. C. Leach is a modification of this situation. This is clear from Fig. 1E where, in the left-hand corner, a gradual change can be seen from tiny projecting cells to these bristles. Such bristles were first noted by N. E. Brown (1878) in *Orbea ciliata*. He drew them as if they arose on and near the base of the "staminal column," and this is how Berger (1910) also interpreted them; however, they are actually on the surface of the corolla, but very close to the base of the tube.

Further modified epidermal cells on the inside of the corolla are the vibratile cilia that are sometimes present just inside the margin of the corolla lobes (character 20). These are enormously elongated and initially inflated cells that soon lose their contents through evaporation (Vogel 1961; Bruyns 2000a) and are widely present in the Ceropegieae. Such cilia are quite frequently found in southern African taxa, but north of the equator they are only known in *Ballyanthus prognathus*, *O. semota*, and in *O. vibratilis*. Small, rigid hairs are present along the margins in some species (e.g., *O. umbracula*, *O. namaquensis*, *O. carnosa*); these rigid hairs are not considered as vibratile cilia.

GYNOSTEGIUM. The staminal tube in *Orbea* always bears two series of corona lobes, an outer series and an inner series. The outer appears first (as seen in Fig. 11A, Fig. 96A) as a small lip beneath the guide-rails, and somewhat later (Fig. 11B) the inner lobes appear behind the anthers and usually a little above the outer lobes. At later stages the outer and inner lobes often become very much intergrown, and it may be difficult to determine to which series a given lobule belongs. Some of the problematic cases in this respect have been investigated by following their ontogeny and two such instances are illustrated here for *O. schweinfurthii* (Fig. 11) and *Ballyanthus prognathus* (Fig. 96).

In all species of *Orbea* the two coronal series are at least partly fused towards their base (character 25) and sometimes fused into various cupular structures or a ringlike structure in *O. maculata* and *O. schweinfurthii*. In *Ballyanthus prognathus*, careful dissection shows that the two series are quite clearly separated on the staminal tube (Fig. 4D), although the separation is much more clear in *Duvalia* and *Huernia*.

In many species of *Orbea* the gynostegium is raised above the base of the corolla tube on a stipe (character 23). Since this structure is absent in *Caralluma adscendens* this is taken as the plesiomorphic state. The stipe varies greatly in length in the genus, with the longest occurring in certain species with small but tall annuli in the center of the flower

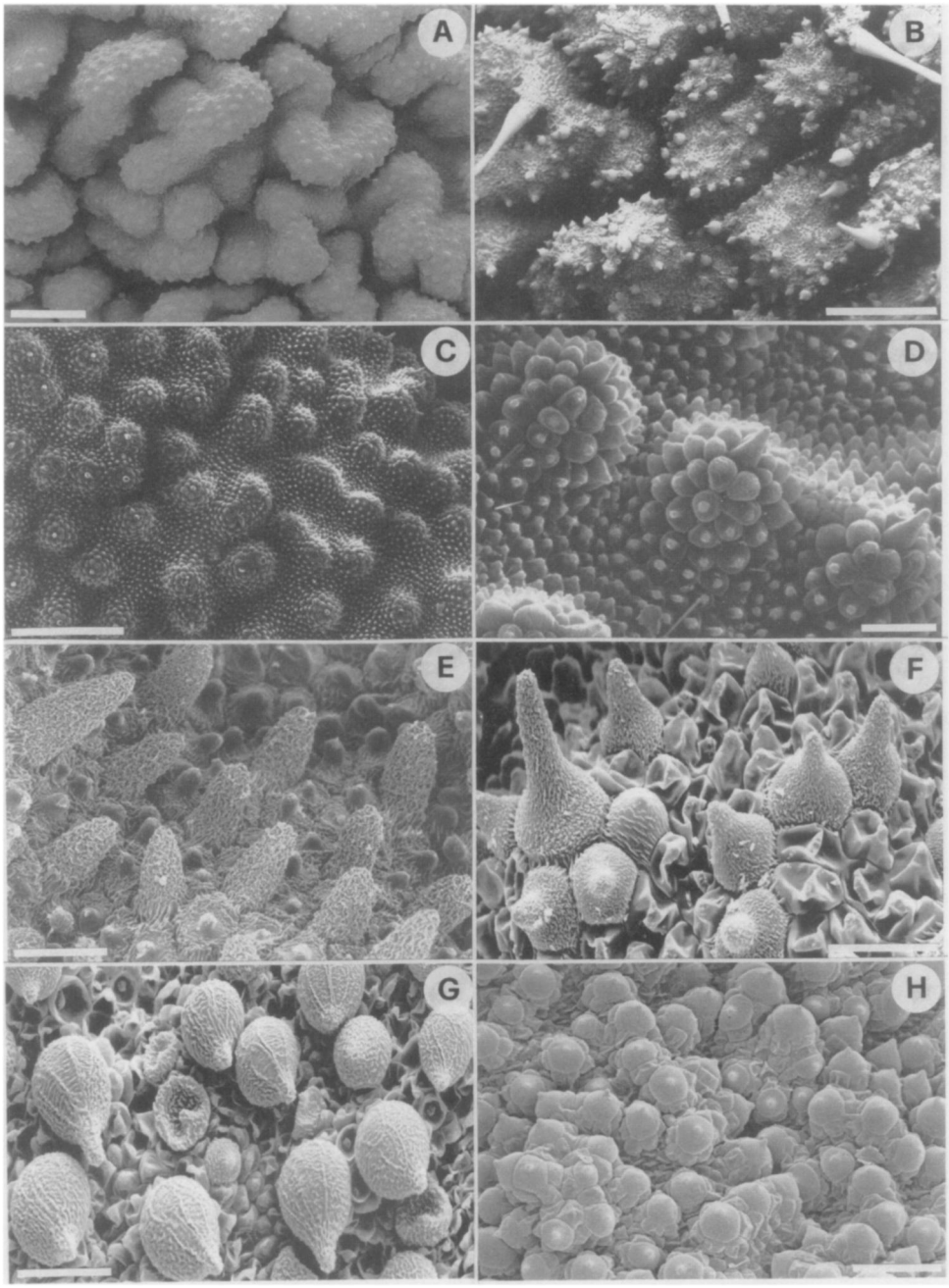

FIG. 3. Papillae and surfaces of inside of corolla in *Orbea*. A–B. Rugulose surface. A. *O. variegata*. B. *O. carnosa* subsp. *keithii*. C–D. Discrete papillae in *O. ubomboensis*. E–H. Different shapes of individual cells on surface. E. *O. ciliata*, ± cylindrical cells. F. *O. melanantha*, cells with a very broad base. G. *O. carnosa* subsp. *carnosa*, skittle-shaped cells. H. *O. rogersii*, mammose cells. Scale bars: A, B, 500 µm; C, 400 µm; D-G, 50 µm; H, 100 µm. [Based on: A, *Bruyns s.n.*, Elands Bay; B, *Bruyns 6590*; C, D, *Hardy 5409*; E, *Bruyns 6050*; F, *Bruyns 6536*; G, *Bruyns 6542*; H, *Bruyns 6504*.]

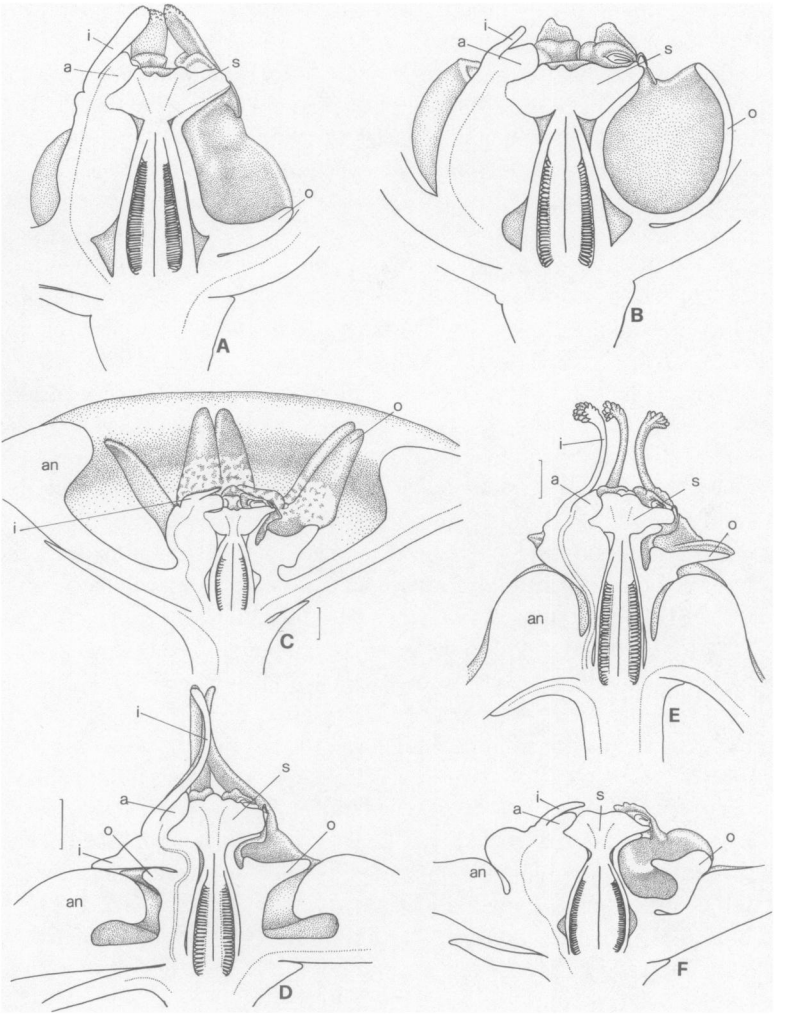

FIG. 4. Flowers of *Orbea* and *Ballyanthus* in vertical section. Only the center of the flower is shown, and the extent of the corolla tube is not illustrated; dotted lines indicate vascular traces. A. *O. deflersiana*. Corolla with a considerable tube barely thickened around mouth; outer corona laterally extensively fused to base of inner corona to form a shallow pouch, not extending behind anthers at all, without any flap closing off nectarial cavity. B. *O. tubiformis*. Corolla with a considerable tube barely thickened around mouth; outer corona extensively fused to inner corona to form a deep pouch, not extending behind anthers at all, without any flap closing off nectarial cavity. C. *O. conjuncta*. Corolla with a considerable tube, a much thickened annulus, and a primary tube below annulus; outer corona with discrete lobes (deeply bifid) and very slight protrusion behind anthers, with a small lip beginning to close off nectarial cavity. D. *B. prognathus*. Corolla ± flat in center with a thick annulus enclosing a small primary tube around base of gynostegium; outer corona forming ± continuous ring around gynostegium (slightly shorter under dorsal projection of inner lobes), with a small lip beginning to close off nectarial cavity. E. *O. umbracula*. Corolla ± flat in center with a thick annulus but without a primary tube; outer corona with discrete lobes partly fused laterally to inner corona and giving rise to a slight ridge behind them, with small lip beginning to close off nectarial cavity. F. *O. laticorona*. Corolla ± flat with a small annular thickening around gynostegium but without a primary tube; outer corona forming ± continuous ring around gynostegium, with a considerable lip closing up nectarial cavity except beneath guide-rails and giving a "false bottom" to the pouch of outer corona (for another example see Fig. 23, *O. huernioides*). an = swollen annulus in corolla, o = outer corona, i = inner corona lobe, a = anther, s = style-head. Scale bars: A, E, F, 1 mm (at E); B, D, 1 mm (at D); C, 1 mm. [Based on: A, *Lavranos 1788*; B, ex hort. De Boer; C, *Bruyns 4477*; D, ex hort. de Kock; E, *Bruyns 7418*; F, *Darvall 4*.]

and more or less without a real corolla tube (e.g., *O. umbracula*, Fig. 4E). Many of the northern taxa lack an obvious stipe (scored as 0 here), but traces of it can still be detected in the form of ridges of tissue running from the side or floor of the corolla tube up between the outer corona lobes. This stipe, if present, is always noticeably pentagonal (even when it is extremely short), with five swollen ridges extending between the outer corona lobes (character 24). In *Ballyanthus prognathus*, *Duvalia*, and in the species of *Huernia* where a stipe is present, this pentagonal outline is absent even though the stipe still expands towards the apex and the base.

The outer corona is very variable in *Orbea* and appears to show three main trends (character 26). In many cases (especially in the southern taxa of *Orbea*) there are five spreading lobes beneath the guide-rails. These exceed the part of the outer corona behind the anthers, which usually takes the form of a transverse ridge or rounded boss. One trend is for the part behind the anther to disappear entirely. A second trend is for the part behind the anther to become much larger than that between the anthers (this is rare and is only known in *O. maculata*, though it does also happen in *Duvaliandra dioscoridis*). The third trend, unique to this group, is the tendency to form a pouch around each guide-rail, which reaches extreme forms in the deeply campanulate-flowered species, such as *O. tubiformis*. This tendency is also found in *O. carnosa*, where the outer corona rises up steeply rather than spreading, as in the remaining southern species, and the corona has a more or less urceolate outline (from the outside). In the northern taxa there is a progressive loss of the free part of the lobes together with increasing lateral fusion to the inner lobes, and this leads to comparatively deep pouches in some species (character 27).

Associated with the lower part of the outer corona is the so-called "nectarial cavity." This is formed by a secondary lip of the outer corona that rises up towards the guide-rail to enclose a cavity (character 30). There is considerable variation in the presence of this lip, and in many species there is no trace of it at all. In those species with deeply pouch-like outer coronas it is often absent (Fig. 4A, B), but in *O. huernioides* it is the largest found in any member of *Orbea* and completely closes off the nectarial cavity (Fig. 23E). In several of the northern taxa (especially *O. gemugofana*, *O. sprengeri*, and *O. wissmannii*; shown in Fig. 4F) this lip is conspicuous and forms a platform beneath the guide-rail, which gives the impression that the outer corona is solid beneath this platform. Careful dissection reveals that this is not the case, and that there is invariably a hollow cavity beneath it, though there is sometimes a small hole visible beneath the guide-rail, which provides an entrance to this cavity.

In many of the southern African taxa there are several radial ridges on the adaxial (upper) surface of each outer corona lobe. Often the surface between the innermost of these ridges is differently colored or covered with a nectarial secretion (character 28).

The inner corona lobes are always adpressed to the backs of the anthers and many do not even exceed them (character 31); however, in many other cases (e.g., *O. umbracula*, Fig. 4E; *B. prognathus*, Fig. 4D) they greatly exceed the anthers and rise up into a small column in the center, often with somewhat tuberculate and clavate apices. On their abaxial or dorsal surface they often have various appendages. Many of the transverse structures seen behind the inner corona lobes belong to the outer series (character 26), and it is often only by ontogenetic investigations that it can be determined to which series they belong. In some genera, such as *Duvalia* and *Huernia*, and in *B. prognathus* there is a small transverse boss near the base of the inner lobes, and these bosses have been established as belonging to the inner series (Meve 1997, for *Duvalia*; see Fig. 96 for *B. prognathus*). These structures are not known anywhere in *Orbea* (character 32).

Several species of *Orbea* have a dorsal horn on the inner lobe. This is not to be confused with the lateral spreading of the outer corona, especially since the latter may be present together with such a dorsal horn on the inner lobes (as is sometimes seen on *O. carnosa,* Fig. 46H, I). These dorsal horns are always laterally flattened and may be somewhat fin-shaped. This is found, for example, in *O. variegata*, and it is also common in *Stapelia*. In *O. albocastanea*, *O. knobelii*, *O. lutea*, and *O. melanantha* the whole inner corona is laterally flattened above the base. In the cases of *O. lutea* and *O. melanantha* there is a slightly broader part immediately above the back of the anther, so that here the lobe itself is much reduced and most of the visible structure is the dorsal appendage. The position in *O. albocastanea* and *O. knobelii* remains unclear in this respect.

In all stapeliads the pollinia are hidden within the anthers until the process of dehiscence begins well before anthesis (Kunze 1996). In early stages the anthers are roughly semicircular when viewed from above. During dehiscence the lateral margins of the anthers shrink back to expose the pollinia, and in many stapeliads (including *B. prognathus*) the anthers are finally almost rectangular in outline at anthesis. In many species of *Orbea* sensu L. C. Leach the anther does not shrink back fully at anthesis and continues to cover the pollinia at least partly.

POLLINIUM. In most taxa of *Orbea* the pollinium is comparatively large, (0.27–) 0.37–0.78 mm long and (0.12–) 0.20–0.55 wide. The side of the pollinium on which the insertion-crest is located is more or less straight or even slightly concave. This leads to a distinctly "D-shaped" pollinium (character 37). As in all stapeliads the corpuscle has transparent lateral wings to which the pollinia are attached via caudicles. Each caudicle broadens out considerably just beneath the pollinium to become somewhat spathulate. In most cases the insertion-crest is located along the outer margin of the pollinium only at the top and then twists onto the dorsal surface. In *B. prognathus* the insertion-crest lies exactly along the outer edge of the pollinium. In fact the pollinaria of this species are very similar to those in *Duvalia* (less so to those of *Huernia* where the wings on the corpuscle are generally much shorter), except that the corpuscle in *B. prognathus* is longer than wide.

FOLLICLES, SEEDS, AND SEEDLINGS. In all stapeliads the follicles are paired and they are mostly erect, with the horns in a pair diverging at 30–60°. Those that are known in *Orbea* (they remain unknown in many species and in *B. prognathus*) are always glabrous, smooth, and brightly longitudinally mottled with narrow broken purple stripes on a pale background. They are very variable in length, from 5 cm in such species as *O. miscella* to at least 15 cm in *O. huillensis*.

Seeds have not been seen in all species but where known are almost completely flat, pear-shaped to round in outline, 5–9 mm long, and mat pale brown to red-brown with a paler and shiny margin. They are particularly large and circular in *O. longidens*.

Seedlings in stapeliads generally have a comparatively large, wedge-shaped, photosynthetic hypocotyl with small cotyledons on its extremities (Bruyns 2000a), and some of these are illustrated here for *Orbea* in Fig. 5 (those of *B. prognathus* are unknown). In several species the cotyledons are much larger than in any other stapeliads, except *Frerea indica* Dalz. (Bruyns 2000a: Fig. 6), but one finds the same tendency of reduction in the cotyledons within *Orbea* (compare Fig. 5A and E) that has been observed in *Hoodia* (Bruyns 1993). *Orbea* taxa, such as *O. caudata* subsp. *rhodesiaca*, *O. halipedicola*, *O. longidens*, and *O. rogersii*, which inhabit somewhat wetter parts of the southern African subcontinent and have relatively long and slender tubercles; all have relatively large cotyledons (as in Fig. 5A). On

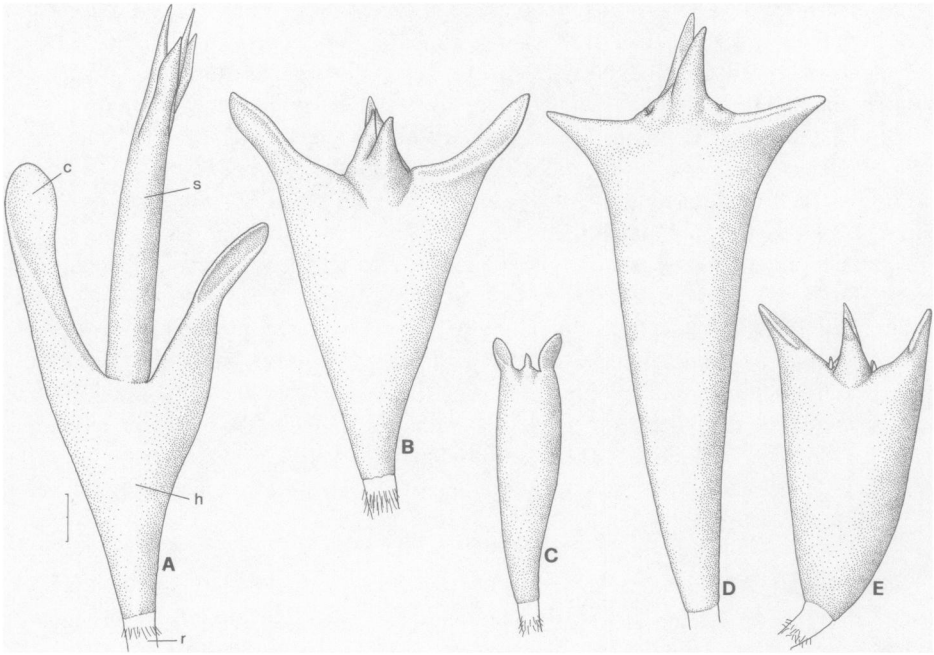

FIG. 5. Seedlings in *Orbea*, 20–30 days old, showing variation in shape of hypocotyl and size of cotyledons (cotyledons wide in A–C; reduced in D, E). A. *O. longidens*. B. *O. albocastanea*. C. *O. miscella*. D. *O. namaquensis*. E. *O. verrucosa*. r = radicle, h = hypocotyl, c = cotyledon, s = young shoot (lettering only in A). Scale bar: A–E, 2 mm (at A). [Based on: A, *Bruyns 4449*; B, *Bruyns 3543*; C, *Bruyns 4250*; D, *Bruyns 4602*; E, *Bruyns 3066*.]

the other hand, species from the drier parts further west tend to have much smaller cotyledons and shorter tubercles, as can be seen here for *O. namaquensis* (Fig. 5D).

POLLINATORS

It is now fairly well established that flies pollinate the flowers in the stapeliads (Bruyns 2000a), and the species of *Orbea* are not exceptional in this respect, although relatively few observations of pollinators have been reported. It has been noted (often on cultivated plants) that many species are visited by larger flies, such as blow-flies of the genus *Lucilia* (*O. sprengeri* subsp. *foetida*; Gilbert 1978), blue-bottle flies of the genus *Calliphora* (*O. gemugofana*; Gilbert 1978), or the common house-fly *Musca domestica* and carrion-flies of the genus *Sarcophaga* (for *O. variegata* around Cape Town, *O. namaquensis* in Namaqualand; pers. obs.). Quite different flies are involved in some of the very small-flowered species. Thus, in the widespread *O. schweinfurthii* and in the southern African *O. ubomboensis* very much smaller drosophilid flies are the only visitors to the flowers (Agnew 1976; pers. obs.).

To attract these insects, the flowers of species of *Orbea* emit a wide range of odors. Many of these odors are foul and excrement-like, and such evil odors generally attract the larger flies. In others fruity and sometimes somewhat sweetish odors are given off, as in *O. schweinfurthii* and *O. ubomboensis*.

CLADISTIC ANALYSIS

CHARACTERS

The following characters were used in the analysis. They were coded with respect to the putatively more basal species *Caralluma adscendens* (Roxb.) Haw. (Bruyns 2000a). The full matrix of data is shown in Table 1.

Vegetative Characters.

1. Stems: ascending to erect with horizontal base = 0; wholly horizontal = 1.
2. Stems: not rhizomatous = 0; rhizomatous = 1.
3. Stems: brightly mottled with purple on green to grey (when grown in strong light) = 0; uniformly colored (even in strong light) = 1.
4. Outer walls of epidermal cells on stem-surface: ± flat = 0; raised into papillae = 1.
5. Tubercles: conical = 0; laterally flattened = 1.
6. Tubercles: shorter than or equal to diameter of internodes = 0; long and attenuated and often much exceeding the thickness of the internodes = 1.
7. Stipular denticles: present as small tooth (even if intermittently) = 0; present as ridge along apex of tubercle = 1; absent = 2.

Reproductive Characters.

8. Inflorescences: randomly distributed along stem or towards apex = 0; basal = 1.
9. Inflorescences: several per stem = 0; 1 (2) per stem = 1.
10. Flowers developing: in succession on inflorescence = 0; opening simultaneously on inflorescence = 1.
11. Flowers: few per inflorescence = 0; many (> 5) per inflorescence = 1.
12. Corolla tube: small to absent and at most surrounding base of gynostegium = 0; containing at least most of gynostegium = 1.
13. Corolla tube: entirely absent = 0; secondary corolla tube present but primary tube in base absent = 1; tube in center of flower formed entirely by annulus = 2.
14. Corolla: generally <30 mm in diameter = 0; corolla generally > 30 mm in diameter = 1.
15. Corolla: without prominent annulus and not noticeably thickened around mouth of tube = 0; with prominent annulus or corolla thickened around mouth of tube = 1.
16. Corolla: divided into lobes right to annular thickening = 0; fused beyond annular thickening = 1.
17. Corolla lobes: not visibly fused along side of tube = 0; zone of fusion clearly visible = 1.
18. Ring of thick, short bristles around the stipe at the base of the corolla tube: absent = 0; present = 1.
19. Corolla lobes: erect to spreading so that corolla rotate or campanulate = 0; reflexed so that whole structure strongly convex = 1.
20. Vibratile cilia just inside margins of corolla lobes: often present (usually along lower half of lobe only) = 0; absent = 1.
21. Inside of corolla: smooth = 0; irregularly (mostly transversely) rugulose = 1.
22. Epidermal cells inside corolla: verrucose cells (long and hair-like to cylindrical to skittle-shaped to mammose) projecting at intervals from surface but cells between them ± flat to not projecting from surface = 0; cells raised into discrete, mound-like multicellular papillae, with a verrucose, slightly larger, apical cell = 1.

TABLE 1. Matrix of character-states for all the taxa in the *Orbea*-complex (except *O. taitica*); see text.

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Quaqua inversa	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Q. mammillaris	0	0	1	1	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	1
Duvalia caespitosa	0	?	1	0	0	0	0	1	1	0	0	0	2	0	1	0	0	0	0	0
D. sulcata	0	0	0	0	0	0	2	1	1	0	0	0	2	1	1	0	0	0	0	0
Duvaliandra dioscoridis	0	0	1	0	1	0	2	1	1	0	0	1	1	1	0	1	0	0	0	0
Huernia barbata	0	0	1	0	1	0	2	1	1	0	0	1	1	1	0	1	0	0	0	1
H. transvaalensis	0	0	1	0	1	0	2	1	1	0	0	1	1	1	1	1	0	0	0	1
Orbea abayensis	0	0	0	0	0	1	2	0	0	0	0	0	2	?	1	1	0	0	0	1
O. albocastanea	0	1	0	0	1	0	0	1	1	0	1	0	2	0	1	0	0	0	0	0
O. araysiana	0	0	0	0	0	0	2	0	0	0	0	0	2	1	1	1	0	0	0	1
O. baldratii	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1
O. carnosa	0	1	0	0	1	?	0	0	0	0	0	1	1	0	1	1	0	0	0	1
O. caudata	0	0	0	0	0	1	2	0	1	0	1	0	2	1	1	0	0	0	0	0
O. chrysostephana	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1
O. ciliata	0	0	0	0	0	0	0	1	1	0	0	1	2	1	1	1	0	1	0	0
O. circes	0	0	0	0	0	1	2	0	0	0	0	1	1	?	0	0	0	0	0	1
O. conjuncta	1	0	0	0	0	0	2	1	1	0	0	1	2	?	1	1	1	0	0	1
O. cooperi	0	0	0	0	0	0	0	1	1	0	0	0	2	?	1	1	0	0	0	0
O. decaisneana	0	?	0	0	0	0	2	0	0	0	0	1	1	0	1	0	0	0	0	1
O. deflersiana	0	0	0	0	0	?	2	0	1	0	0	1	1	?	0	0	0	0	0	1
O. denboefii	0	0	0	0	0	1	0	0	0	0	0	1	1	?	0	0	0	0	0	1
O. distincta	0	0	0	0	0	1	0	0	1	0	0	1	1	1	0	0	0	0	0	1
O. dummeri	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1
O. gemugofana	0	0	0	0	0	1	2	0	0	0	0	1	1	?	0	0	0	0	0	1
O. gerstneri	0	1	?	0	?	?	0	?	1	1	1	1	1	1	?	0	0	0	0	0
O. gilbertii	0	0	0	0	0	0	2	0	0	0	0	0	2	?	1	1	0	0	0	1
O. halipedicola	0	1	0	0	0	0	0	1	1	0	0	0	2	1	1	1	0	1	0	0
O. hardyi	1	0	0	0	0	0	2	1	1	0	0	1	2	1	1	1	1	0	0	1
O. huernioides	0	0	0	0	0	0	2	0	0	0	0	1	1	0	0	0	0	0	0	1
O. huillensis	0	?	0	0	1	0	0	?	1	1	1	1	1	1	?	0	0	0	0	?
O. knobelii	0	1	0	0	1	0	0	1	1	?	1	0	2	?	1	0	0	0	0	0
O. laikipiensis	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1
O. laticorona	0	0	0	0	0	?	2	0	0	0	0	0	2	?	1	1	0	0	0	1
O. longidens	0	?	0	0	0	1	0	1	1	0	0	1	2	1	1	1	0	0	0	0
O. lugardii	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	1
O. luntii	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1
O. lutea	0	?	0	0	1	0	0	1	1	1	1	0	2	1	1	0	0	0	0	0
O. macloughlinii	0	0	0	0	0	0	0	1	1	0	0	0	2	1	1	1	0	0	0	0
O. maculata	0	1	0	0	1	1	0	1	1	0	0	0	2	1	1	1	0	0	0	0
O. melanantha	0	0	0	0	1	0	0	?	1	1	1	0	2	1	1	0	0	0	0	0
O. miscella	0	1	1	0	0	0	2	1	1	0	0	0	2	0	1	0	0	0	0	1
O. namaquensis	0	0	0	0	0	0	0	1	1	0	0	0	2	1	1	1	0	1	0	1
O. paradoxa	0	1	0	0	0	1	1	1	1	0	0	1	1	0	1	1	0	1	0	0
O. prognatha	0	0	1	0	0	0	0	0	0	0	0	0	2	0	1	1	0	0	1	0
O. pulchella	0	0	0	0	0	0	0	1	1	0	0	1	?	1	1	1	0	0	0	1
O. rogersii	0	0	0	0	0	1	0	0	0	0	0	0	2	?	1	0	0	1	0	1
O. sacculata	0	1	0	0	0	0	2	0	1	0	0	1	1	0	0	0	0	0	0	1
O. schweinfurthii	0	0	0	0	0	1	0	0	0	0	0	0	2	0	1	0	0	0	0	1
O. semitubiflora	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1
O. semota	0	0	0	0	0	0	0	1	1	0	0	0	2	?	1	1	0	1	0	0
O. sprengeri	0	?	0	0	0	0	2	0	0	0	0	0	2	?	1	1	0	0	0	1
O. subterranea	0	1	0	0	1	?	0	0	0	0	0	0	?	0	0	0	0	0	0	1
O. tapscottii	0	0	0	0	0	1	0	1	1	0	0	0	2	?	1	1	0	0	0	0
O. tubiformis	0	0	0	0	0	1	2	0	1	0	0	1	1	0	0	0	0	0	0	1
O. ubomboensis	0	1	?	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1
O. umbracula	0	0	0	0	0	1	0	1	1	0	0	0	2	1	1	1	0	0	1	1
O. valida	0	?	0	0	1	0	0	?	1	1	1	1	1	1	0	0	0	0	0	0
O. variegata	0	0	0	0	0	0	0	1	1	0	0	0	2	1	1	1	0	1	0	1
O. verrucosa	0	0	0	0	0	0	0	1	1	0	0	1	?	1	1	1	0	1	0	1
O. vibratilis	0	1	0	0	0	0	1	0	0	0	0	1	1	0	1	0	0	0	0	0
O. wilsonii	0	1	0	0	1	1	0	0	0	0	0	1	1	0	?	0	0	0	0	1
O. wissmannii	0	?	0	0	0	0	2	0	0	0	0	0	0	?	0	0	0	0	0	1
O. woodii	0	0	0	0	0	0	0	1	1	0	0	0	2	1	1	1	0	0	0	0

TABLE 1 continued.

Character	2 1	2	3	4	5	6	7	8	9	3 0	1	2	3	4	5	6	7	8	9	4 0	1	2
Quaqua inversa	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Q. mammillaris	0	1	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1
Duvalia caespitosa	0	0	1	1	1	2	0	0	0	1	0	1	0	1	0	1	0	0	1	1	1	0
D. sulcata	0	0	1	1	1	2	0	0	0	1	0	1	0	1	0	1	0	0	1	1	1	0
Duvaliandra dioscoridis	0	0	1	1	0	2	0	0	1	1	0	0	0	0	0	1	0	0	1	1	1	?
Huernia barbata	0	1	0	-	1	1	0	0	0	1	1	1	0	1	0	1	0	0	0	1	1	1
H. transvaalensis	0	1	0	-	1	1	0	0	0	1	1	1	0	1	0	1	0	0	0	1	1	1
Orbea abayensis	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	?	1	1	0	1	0	?
O. albocastanea	1	0	?	0	0	0	0	1	0	?	0	0	1	0	0	0	1	1	0	1	0	0
O. araysiana	0	0	1	0	0	2	0	0	0	2	1	0	0	0	0	?	1	1	0	1	0	?
O. baldratii	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	1	1	1	0	1	0	?
O. carnosa	1	0	0	0	0	1	1	0	0	0	0	0	?	0	0	?	1	1	0	1	0	1
O. caudata	1	0	1	0	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	1	0	0
O. chrysostephana	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	?	1	1	0	1	0	?
O. ciliata	1	0	0	-	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	0
O. circes	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	1	1	1	0	1	0	?
O. conjuncta	0	0	1	0	0	1	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	0
O. cooperi	1	0	1	0	0	1	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	0
O. decaisneana	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	?
O. deflersiana	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	1	1	0	1	0	?
O. denboefii	0	?	0	0	0	0	1	0	0	0	0	0	?	0	0	?	1	1	0	1	0	?
O. distincta	0	0	0	0	0	?	1	0	0	0	0	0	1	0	0	1	1	1	0	1	0	?
O. dummeri	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	?
O. gemugofana	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	1	1	1	0	1	0	?
O. gerstneri	1	0	?	0	0	0	0	1	0	0	1	0	1	0	0	?	1	1	0	1	0	?
O. gilbertii	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	?	1	1	0	1	0	?
O. halipedicola	0	0	1	0	0	1	0	1	0	1	1	0	0	0	1	?	1	1	0	1	0	0
O. hardyi	0	0	1	0	0	1	0	0	0	1	1	0	0	0	0	1	1	1	0	1	0	?
O. huernioides	0	0	0	0	0	1	1	0	1	2	1	0	0	0	0	?	0	1	?	1	0	?
O. huillensis	1	0	1	0	0	?	0	1	0	1	1	0	0	0	0	?	1	1	0	1	0	0
O. knobelii	1	0	1	0	0	0	0	1	0	?	0	0	1	0	0	0	1	1	0	1	0	?
O. laikipiensis	0	0	0	0	0	1	1	0	0	?	0	0	0	0	0	1	1	1	0	1	0	?
O. laticorona	0	0	1	0	0	2	0	0	0	2	0	0	0	0	0	?	1	1	0	1	0	?
O. longidens	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	0	0
O. lugardii	0	1	1	0	0	1	0	0	0	?	1	0	0	0	0	1	1	1	0	1	0	?
O. luntii	0	0	1	0	0	0	1	0	0	2	0	0	0	0	0	1	1	1	0	1	0	?
O. lutea	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0	1	0	?
O. macloughlinii	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	1	1	0	1	0	?
O. maculata	0	0	1	0	0	2	0	0	1	1	0	0	0	0	1	?	1	1	0	1	0	?
O. melanantha	1	0	1	0	0	1	0	1	0	1	0	0	1	0	0	0	1	1	0	1	0	?
O. miscella	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0
O. namaquensis	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	0	1	0	1
O. paradoxa	0	0	1	0	0	0	0	0	0	?	0	0	0	0	1	1	1	1	0	1	0	0
O. prognatha	0	0	1	1	1	2	0	0	0	1	1	1	0	0	0	1	0	0	0	1	0	?
O. pulchella	1	0	1	0	0	0	0	0	0	?	1	1	0	0	1	?	1	1	0	1	0	1
O. rogersii	0	0	1	0	0	0	0	0	0	1	1	0	1	0	1	1	1	1	0	1	0	0
O. sacculata	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	?	1	1	0	1	0	?
O. schweinfurthii	0	1	1	?	0	2	0	0	0	1	0	0	0	0	0	0	1	1	0	1	0	0
O. semitubiflora	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	?
O. semota	1	0	1	0	0	0	0	1	0	?	0	0	0	0	1	?	1	1	0	1	0	?
O. sprengeri	?	?	0	0	0	2	0	0	0	2	0	0	0	0	0	?	1	1	0	1	0	?
O. subterranea	0	1	0	0	0	0	1	0	0	?	0	0	0	0	0	1	1	1	0	1	0	?
O. tapscottii	1	0	1	0	0	1	0	0	0	1	1	0	1	0	1	1	1	1	0	1	0	?
O. tubiformis	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	1	0	1	0	?
O. ubomboensis	1	1	1	0	0	1	0	0	0	?	0	0	0	0	0	1	1	1	0	1	0	?
O. umbracula	1	0	1	0	0	1	0	1	0	1	1	0	0	0	1	?	1	1	0	1	0	?
O. valida	1	0	1	0	0	?	0	1	0	1	1	0	0	0	0	1	1	1	0	1	0	0
O. variegata	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1	1	1	1	0	1	0	1
O. verrucosa	1	0	1	0	0	0	0	0	0	1	0	1	0	0	1	?	1	1	0	1	0	1
O. vibratilis	?	0	0	0	0	0	1	0	0	0	?	0	0	0	0	?	1	1	0	1	0	?
O. wilsonii	0	0	0	0	0	0	1	0	0	?	0	0	0	0	0	?	1	1	0	1	0	?
O. wissmannii	0	0	0	0	0	1	1	0	0	2	0	0	0	0	0	1	1	1	0	1	0	?
O. woodii	1	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1	1	1	0	1	0	?

23. Basal stipe of gynostegium: absent beneath corona = 0; present = 1.
24. Basal stipe of gynostegium beneath corona: pentagonal = 0; cylindrical = 1.
25. Outer and inner coronas: at least partly fused around bases = 0; not fused around bases and usually well separated on staminal tube = 1. [In all species in the *Orbea*-complex the two coronal series are closely linked on the staminal tube.]
26. Outer corona: consisting of discrete lobes beneath guide-rails without part behind anthers = 0; with small boss or ridge behind anthers and inner lobes = 1; spreading to form ± continuous structure around gynostegium = 2.
27. Outer corona lobes: not forming deep pouch beneath guide-rail = 0; forming deep cupular pouch beneath each guide-rail = 1.
28. Outer corona: without radial ridges = 0; with radial ridges = 1.
29. Outer corona: not reduced below guide-rail = 0; much reduced below guide-rail = 1.
30. Outer corona: consisting only of a spreading to ascending lobe, without any secondary lip rising up towards the guide-rail to form a nectarial cavity = 0; with small lip forming nectarial cavity = 1; with lip almost completely closing off nectarial cavity, usually more than twice as long as thick = 2.
31. Inner corona: shorter than to ± equalling anthers = 0; much exceeding anthers = 1.
32. Inner corona: without swollen transverse boss near base = 0; with transverse boss = 1.
33. Inner corona: without laterally flattened dorsal appendage = 0; with laterally flattened dorsal appendage = 1.
34. Guide-rails: projecting from tissue below style-head, suspended over open area and not embedded in tissue of corona = 0; embedded in tissue of corona and not suspended over open area = 1.
35. Anthers: ± rectangular without thin flap covering pollinia at anthesis = 0; extended laterally by thin, often undulating flap covering pollinia at least partly at anthesis = 1.
36. Pollinia: broader than long = 0; longer than broad = 1.
37. Pollinia: ellipsoidal = 0; D-shaped = 1.
38. Insertion-crest: located exactly along outer margin of pollinium = 0; along outer margin at top only then twisting onto dorsal surface = 1.
39. Insertion-crest: more than half as long as pollinium = 0; at most half as long as pollinium = 1.
40. Caudicle: not broadened below pollinium = 0; broadened (often very much so) and ± spathulate below pollinium = 1.
41. Corpuscle: significantly longer than broad = 0; ± as long as broad = 1.
42. Seedling: with comparatively broad "leaflike" cotyledon = 0; with narrow, undifferentiated cotyledon = 1.

Results and Discussion

The cladistic analysis yielded 168 trees, each of length (L) 202, consistency index (CI) 22, and retention index (RI) 72. The strict consensus tree from these is shown here as Fig. 6. The values resulting from the jackknife analysis are plotted on this tree (those less than 50% are not shown).

In this analysis the following can be observed:

(1) The two species of *Quaqua* occupy a position that is basal to all the others.

(2) The species above *Quaqua* are divided into two major groups: a smaller clade consisting of *Duvalia*, *Duvaliandra*, *Huernia*, and *Ballyanthus*, and a larger clade containing all the remaining species of the "*Orbea*-complex" (the "*Orbea*-clade"). The

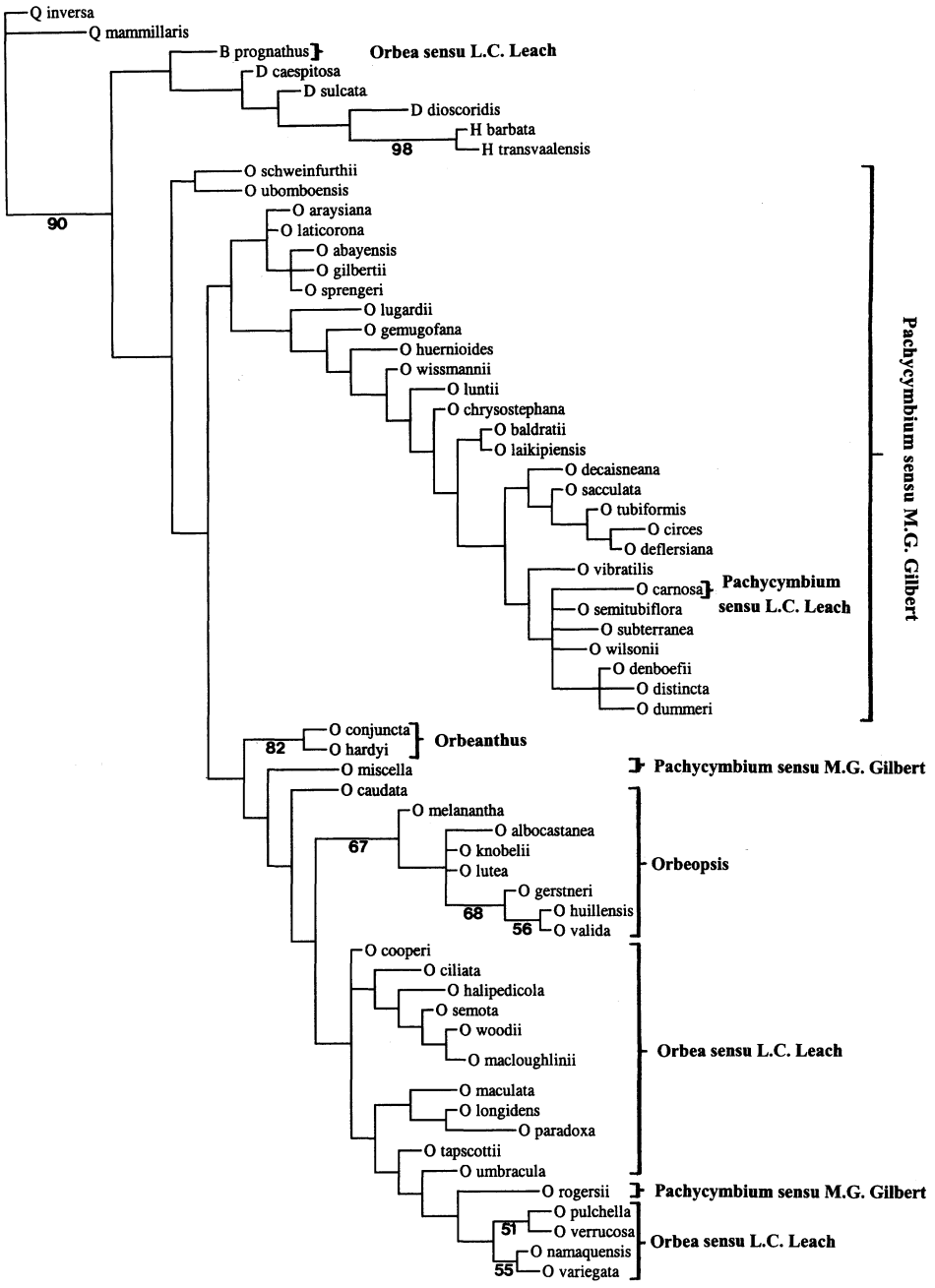

FIG. 6. Strict consensus tree showing relationships among all the taxa in the *Orbea*-complex (except *O.* taitica). Numbers below some branches indicate the jackknife support of that branch (below 50% not indicated). Previous groupings of species into genera are shown at right. Abbreviations for genera are as follows: B = *Ballyanthus*; D = *Duvalia* for *D. caespitosa* and *D. sulcata*, and *Duvaliandra* for *D. dioscoridis*; H = *Huernia*; O = *Orbea*; Q = *Quaqua*.

"*Orbea*-clade" is supported by the synapomorphy "pollinia with insertion-crest twisted onto dorsal surface" (character 38). Neither of these groups enjoys significant jackknife support, but together they are well supported against the species of *Quaqua*. The "*Orbea*-clade" is further subdivided into two major parts. The one contains mainly species of *Orbea* from the northern part of the range with *O. carnosa* and *O. lugardii* (from southern Africa) nested within it. The other consists only of species of southern Africa from the genera *Orbeanthus*, *Orbeopsis*, and *Orbea* sensu L. C. Leach, with *O. rogersii* deeply nested within the clade. Neither of these clades is supported by any known synapomorphies.

(3) *Orbea* sensu L. C. Leach is polyphyletic, with *B. prognathus* (*Orbea prognatha* of L. C. Leach) lying within the "*Duvalia-Huernia*-clade" and the remainder forming a paraphyletic assemblage within the "*Orbea*-clade." *Orbea rogersii* is also deeply nested within *Orbea* sensu L. C. Leach.

(4) *Orbeanthus* is monophyletic with fairly high bootstrap-support. It is nested within the "*Orbea*-clade" and is sister to a large group comprising mainly species of *Orbea* sensu L. C. Leach and of *Orbeopsis*.

(5) *Orbeopsis* (which included *O. caudata*) is not monophyletic, since *O. caudata* is basal to it and a larger group. That part, without *O. caudata*, has low but significant jackknife-support.

(6) *Pachycymbium* sensu L. C. Leach is nested within a larger monophyletic group within *Pachycymbium* sensu M. G. Gilbert.

(7) *Pachycymbium* sensu M. G. Gilbert is a relatively large, polyphyletic assemblage of taxa. It consists of one monophyletic group (composed mainly of "northern" species) and several miscellaneous species from southern Africa that are not clearly attached to this main group. The southern African species *O. carnosa* and *O. lugardii* fall within this main group, but *O. miscella* and *O. rogersii* fall within the *Orbea-Orbeopsis* part. On the other hand, *O. ubomboensis* and the more widely distributed *O. schweinfurthii* are basal to the whole *Orbea* [s. l.] clade.

Although this cladogram demonstrates that *Orbea* in the broad sense is monophyletic, it must be pointed out that there is a notable lack of statistical support for this arrangement. The relatively low number of characters relative to the number of taxa studied is probably mainly responsible for this. Homoplasy within several of the characters is also significant. A particularly good example of the high level of homoplasy is provided by the rhizomatous habit of the stems (character 2). Several authors (Leach 1978; Gilbert 1978, 1990; Newton 1993) have commented on the rhizomatous nature of many taxa in this complex, and this phenomenon is also known in many other genera (Bruyns 1995, for *Tromotriche*; Meve 1997, for *Duvalia*). Rhizomatous stems are found in the basal *O. ubomboensis*, in many species in the first subclade of *Orbea*, and in the second subclade as well. Its value for defining taxa at most levels is very doubtful and Leach's use of it for *Pachycymbium* is therefore of little significance.

From the above it becomes clear that the separation of *Orbeanthus*, *Orbeopsis*, *Pachycymbium*, and *Angolluma* from *Orbea* is not supported by morphological characters nor by the cladistic analysis. In the case of *Orbeanthus*, *Orbeopsis*, and *Pachycymbium*, it was already noted independently by Müller (1993) that these are not distinct from *Orbea*. From a consideration of morphological variation within these groups, it is clear that the only satisfactory solution is to recognize a single, large genus *Orbea*.

In the cladistic analyses one synapomorphy (character 38) defines *Orbea*: pollinia

with insertion-crest twisted onto the dorsal surface; however, this is true only among the taxa considered in this analysis.

There are, in fact, several vegetative characters that characterize *Orbea*. These are the generally brightly mottled stems, the flat outer walls of the epidermal cells on the stems, the tubercles that taper from the base to a slender tooth without differentiation into a leaf rudiment, and the frequent presence of (non-glandular) stipules at the base of the otherwise more or less indistinguishable leaf.

Many of these characters are shared with *Duvalia* and *Huernia*, but *Orbea* s.l. is distinguished from these two genera by the different corona. In *Orbea* the outer and inner series are not clearly separated on the staminal column, whereas this is the case in *Duvalia* and *Huernia*. Furthermore, the pollinaria are different. In *Orbea* the corpuscle is longer, and the pollinia are generally D-shaped and have the insertion-crest twisting from the outer margin onto the dorsal surface. *Orbea* also differs from *Duvalia* and *Huernia* in that the guide-rails are not embedded in the coronal tissue.

Stapelia prognatha P. R. O. Bally was placed in *Orbea* by Leach (1975), but the analysis conducted here shows that it should be excluded from *Orbea*, and that its affinities lie with *Duvalia* and *Huernia*. It is therefore placed in a separate genus, *Ballyanthus*.

DISTRIBUTION OF ORBEA

Orbea contains 56 species. The genus is very widely distributed in Africa from 30°N to 34°S, and it also includes six species in southwestern Arabia, which occur from Saudi Arabia to Dhofar in Oman (Fig. 7). Only one species, *O. sprengeri*, is common to southwestern Arabia and northeastern Africa, although the close similarity between *O. wissmannii* and *O. baldratii* suggests that these perhaps are conspecific; if so, the inclusive species would also be common to both regions (Gilbert 1990: 23). Within Africa the stapeliads have been found to be concentrated in two regions, a northeastern center extending from Tanzania to Arabia and a southern center in southern Africa, Zimbabwe, and Mozambique (Bruyns 2000b). *Orbea* is one of only four genera of stapeliads with species that are common to both of these centers, with 31 species in the southern center and 26 in the northern one. *Orbea* is unique among the stapeliads in having one species common to both regions. This is *O. schweinfurthii*, which is found from Namibia and Botswana northwards to Uganda. *Orbea caudata* is also, to some extent, common to both areas but only marginally so, since it only reaches from Namibia to southern Tanzania.

Orbea schweinfurthii is one of the two basalmost species in the genus. Since much of east Africa was considerably drier during the last ice age than it is now (Hamilton 1982), one may hypothesize that the genus originated in this region and radiated northwards and southwards at much the same time. With increasing wetness of the Kenya-Malawi gap (Jürgens 1997), the northern taxa became steadily more isolated from those further south, and today only a single species, which is tolerant of relatively high levels of moisture, remains common to both areas.

Orbea is unusual in the extent to which the species have spread into western Africa; the only other genus of stapeliads whose species reach the Moroccan coast is *Caralluma*. In *Orbea* only a single species (*O. decaisneana*) is found in this region, from Morocco and Senegal to Sudan. Similarly wide distributions in an east-west direction are known in several species: *Caralluma acutangula* (Decne.) N. E. Br. (Gilbert 1990), *C. adscendens* (Bruyns 1992), *C. edulis* (Edgew.) Benth. & Hook.f. (Bruyns 1989), and

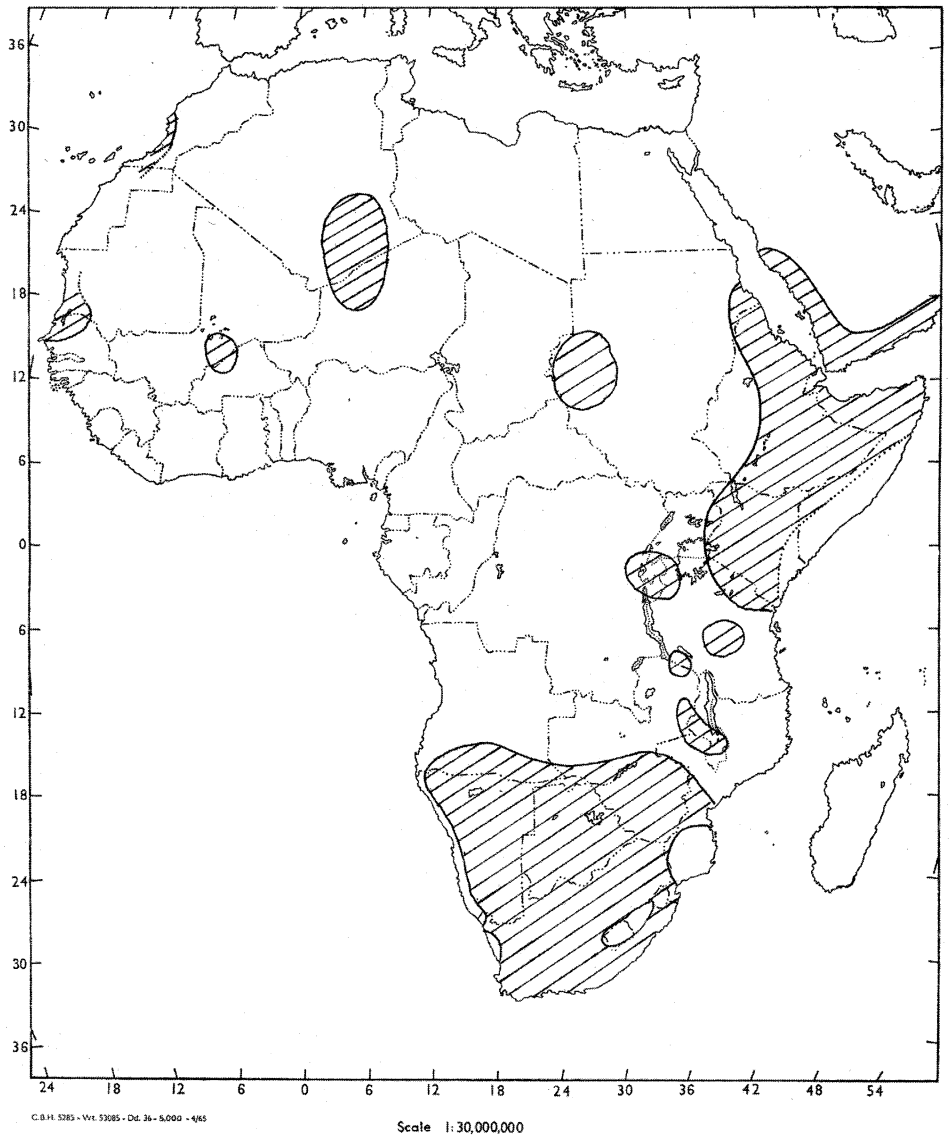

FIG. 7. Distribution of *Orbea*.

in the complex surrounding *Huernia lodarensis* Lavr. (Leach 1988). This phenomenon is known in several other succulent groups (see, for example, Bally 1965, Holland 1978, Thiede 1994).

Documentation of the distribution of *Orbea* in the northeastern center is extremely poor, and many species are known from only a few collections. In this region the numbers of species are as follows: Ethiopia 10, Kenya 12, Somalia 3, Tanzania 9. This means that the area of highest diversity of stapeliads in the northeastern center, the northern part of Somalia (Bruyns 2000b), is relatively poor in species of *Orbea*.

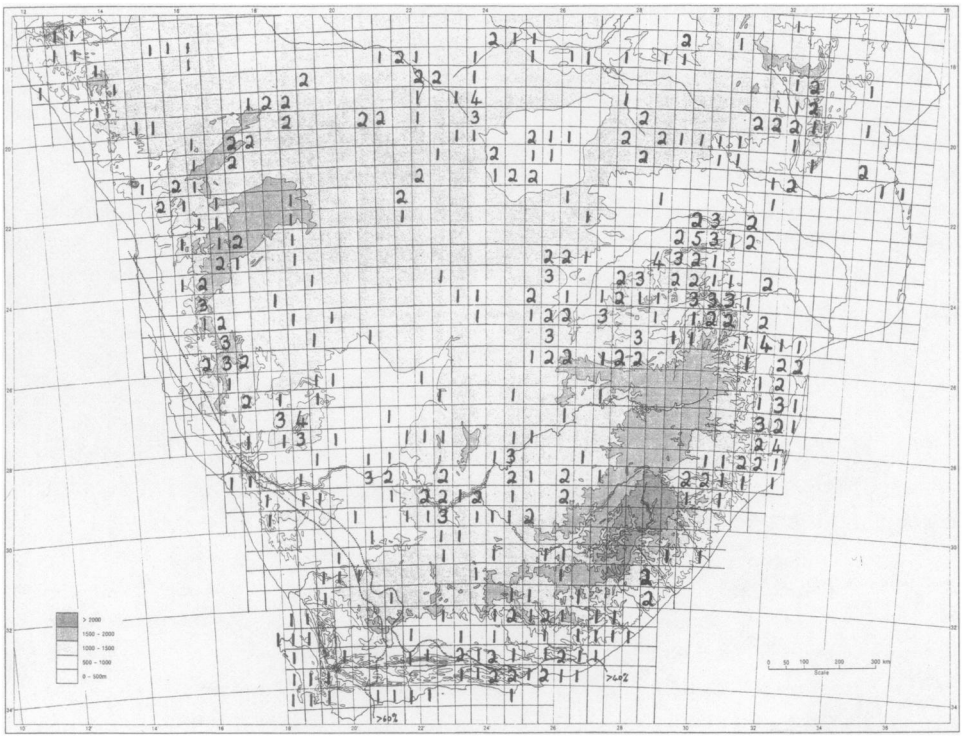

FIG. 8. Patterns of species diversity in *Orbea* in southern Africa. The number of species recorded in each half-degree square (30′ × 30′) is shown; empty squares indicate lack of records. The dotted lines indicate seasonality of rainfall: west of the 60% line receives more than 60% of the annual rainfall in winter, east of the 40% line receives less than 40% in winter.

In the southern center the distribution of most of the species is reasonably well documented. It therefore makes sense to plot these on a single map and try to obtain a picture of the patterns of diversity in *Orbea* in southern Africa (Fig. 8). Here most of the species have relatively diffuse distributions (the only exceptions are *O. conjuncta* and *O. hardyi*) and the same is true for the genus as a whole. Thus, over much of the region only 0, 1 or 2 species have been recorded per half-degree square. The blank squares over much of Namibia and Botswana in Fig. 8 probably mostly harbor at least one species and are blank only because the region is under-collected; however, those blank spaces in the Drakenberg and adjoining northern Orange Free State and in southern Mozambique are probably really devoid of *Orbea* (as they are of the stapeliads generally). For the stapeliads as a whole it was shown that the highest density is found along the eastern margin of the winter-rainfall region, and the southern and western escarpment (Bruyns 2000b). *Orbea* exhibits the opposite tendency, with higher concentrations predominating along the eastern side of the subcontinent. For the stapeliads as a whole, high density was also detected in and around several mountain chains well away from the areas of highest diversity. This pattern is repeated in *Orbea* in the following areas: the Tiras Mountains and the Great and Little Karas Mountains of Namibia; the Blouberg and Soutpansberg of the northern Transvaal; the mountains along the Olifants River of the eastern Transvaal; along the Lebombo

Mountains, which form the border between South Africa, Swaziland, and Mozambique. For *Orbea* the highest number of species per half-degree square is along the northern flank of the Soutpansberg, where five species have been recorded. In contrast to several other genera (e.g., *Quaqua*, Bruyns 1999; *Tromotriche*, Bruyns 1995), *Orbea* shows a marked lack of diversification in the arid parts of the winter-rainfall region of the western Cape. Nowhere in this area is more than one species found per half-degree square and only three species are recorded there. These are *O. ciliata*, *O. namaquensis*, and *O. variegata*; all of them are derived taxa belonging to a single clade, which suggests that diversification in this region was relatively recent. It is also noteworthy that no species are found in locally arid areas within the sandstone mountains of the western Cape.

TAXONOMY

[Note: In each species treatment, collections are cited according to the quarter-degree system of Edwards and Leistner (1971); see Materials and Methods. For each entry, the relevant digits and letters are placed in brackets.]

I. Orbea Haworth, Syn. pl. succ. 37. 1812, nom. cons. *Stapelia* [unranked] *Orbeae* Schultes in Roemer & Schultes, Syst. veg. 6: 36. 1820. *Stapelia* sect. *Orbea* (Haworth) Decaisne in DC., Prodr. 8: 658. 1844. *Orbea* sect. *Orbea* subsect. *Exstantes* L. C. Leach, Excelsa, Taxon. Ser. 1: 6. 1978, nom. superfl.—LECTOTYPE, designated by Bruyns, 1998: *Orbea variegata* (L.) Haworth.

Podanthes Haworth, Syn. pl. succ. 32. 1812. *Stapelia* [unranked] *Podanthae* Schultes in Roemer & Schultes, Syst. veg. 6: 28. 1820. *Stapelia* sect. *Podanthes* (Haworth) Decaisne in DC., Prodr. 8: 655. 1844.—LECTOTYPE, here designated: *Podanthes verrucosa* (Masson) Haworth [=*Orbea verrucosa* (Masson) L. C. Leach].

Diplocyatha N. E. Brown, J. Linn. Soc. Bot. 17: 167. 1878.—TYPE: *Diplocyatha ciliata* (Thunberg) N. E. Brown [=*Orbea ciliata* (Thunberg) L. C. Leach].

Stapeliopsis Phillips, Fl. Pl. South Africa 12: t. 445. 1932, nec *Stapeliopsis* Pillans, 1928, nec *Stapeliopsis* Choux, 1931. *Stultitia* Phillips, Fl. Pl. South Africa 13: t. 520. 1933. *Orbea* sect. *Stultitia* (Phillips) L. C. Leach, Excelsa, Taxon. Ser. 1: 6. 1978. *Orbea* sect. *Stultitia* subsect. *Confluentilobae* L. C. Leach, Excelsa, Taxon. Ser. 1: 6. 1978.—TYPE: *Stapeliopsis cooperi* (N. E. Brown) Phillips [=*Orbea cooperi* (N. E. Brown) L. C. Leach].

Orbea sect. *Orbea* subsect. *Inspissatae* L. C. Leach, Excelsa, Taxon. Ser. 1: 6. 1978.—TYPE: *Orbea verrucosa* (Masson) L. C. Leach.

Orbea sect. *Stultitia* subsect. *Carentilobae* L. C. Leach, Excelsa, Taxon. Ser. 1: 6. 1978.—TYPE: *Orbea maculata* (N. E. Brown) L. C. Leach.

Orbea sect. *Codonidium* L. C. Leach, Excelsa, Taxon. Ser. 1: 6. 1978.—TYPE: *Orbea paradoxa* (Verdoorn) L. C. Leach.

Orbeanthus L. C. Leach, Excelsa, Taxon. Ser. 1: 71. 1978.—TYPE: *Orbeanthus conjunctus* (A. C. White & B. Sloane) L. C. Leach [=*Orbea conjuncta* (A. C. White & B. Sloane) Bruyns].

Orbeopsis L. C. Leach, Excelsa, Taxon. Ser. 1: 61. 1978.—TYPE: *Orbeopsis lutea* (N. E. Brown) L. C. Leach [=*Orbea lutea* (N. E. Brown) Bruyns].

Pachycymbium L. C. Leach, Excelsa, Taxon. Ser. 1: 69. 1978.—TYPE: *Pachycymbium keithii* (R. A. Dyer) L. C. Leach [=*Orbea carnosa* subsp. *keithii* (R. A. Dyer) Bruyns].

Angolluma Munster, Cact. Succ. J. (Woollahra) 17: 63. 1990.—TYPE: *Angolluma decaisneana* (Lemaire) L. E. Newton (Newton 1993) [=*Orbea decaisneana* (Lemaire) Bruyns].

Spineless, often rhizomatous succulents forming compact to diffuse clumps (occasionally very large, up to 3 m in diameter). Stems decumbent to prostrate, fleshy and firm, glabrous, mottled with purple-brown on green to grey-green (rarely plain brownish); tubercles deltoid to conical, spreading, often laterally flattened and joined into 4 wings along stem (sometimes only loosely arranged into 4 rows along stem), each tipped with a soft acute to acuminate leaf rudiment (rarely hardened at tip) usually subtended by two stipular denticles. Inflorescences glabrous, 1–3 (–5) per stem, arising at any height on stem, each bearing 1–40 flowers developing in gradual to rapid succession (or opening simultaneously) from a short peduncle (rarely up to 15 mm long), with 1–several lanceolate bracts, often with lateral teeth; pedicel mostly spreading (rarely erect). Sepals 5, lanceolate, acuminate. Corolla rotate to campanulate (rarely bicampanulate), often strongly thickened below bases of lobes into a prominent (occasionally broadly funnel-shaped) annulus around mouth of tube, mostly deeply lobed; outside glabrous and smooth, often streaked with purple; inside deeply reticulately rugulose to ± smooth, rarely with obtuse multicellular papillae, often with individual cells projecting as papillae; tube mostly shallowly bowl-shaped to ± absent, occasionally formed entirely by the annulus (with the corolla ± flat); lobes spreading to reflexed, deltate, acute, ± flat above, margins often with vibratile clavate cilia. Corona consisting of two series arising on staminal tube, partly intergrown and not clearly separated from one another, glabrous (rarely papillate-pubescent), usually raised above base of tube on a pentagonal stipe up to 3 mm long; outer lobes often consisting of 5 discrete spreading to erect ± subquadrate lobes beneath the guide-rails (rarely much reduced) to deeply cupular, often spreading around gynostegium behind anthers, often with an erect lobule towards the base enclosing a small nectarial cavity; inner lobes adpressed to backs of anthers, often exceeding them and rising connivent in center, dorsiventrally flattened towards base, becoming terete above, often with a laterally flattened fin-like dorsal appendage. Anthers horizontal on top of style-head, margins often not shrinking back and frequently covering pollinia, rectangular to semicircular; pollinium ± D-shaped, pellucid margin twisting from outer edge onto dorsal surface, caudicle attached with broad cupular pad to base. Follicles erect, terete-fusiform, obclavate, slender, consisting of 2 horns diverging at 30–60°, longitudinally mottled with narrow broken purple stripes, glabrous, smooth.

KEY TO THE SPECIES OF ORBEA

I. Key to the species of *Orbea* from southern Africa (Namibia, Botswana, South Africa, Mozambique, Zimbabwe) and southern tropical Africa (to southern Tanzania).

1. Inflorescence with 4–40 flowers opening ± simultaneously.
   2. Inner corona lobes not much extending beyond anthers and not rising up in center (always dorsiventrally flattened), without any dorsal outgrowths. 31. *O. caudata*.
   2. Inner corona lobes much extending beyond anthers in center and becoming erect and often recurved (if not exceeding the anthers then not dorsiventrally flattened), often with dorsal appendages.

3. Corolla white to cream with maroon to brown spots.
   4. Lower dorsal horn of inner corona lobe considerably longer than half the length of upper horn; pedicel (15–) 30–60 mm long. 33. *O. albocastanea.*
   4. Lower dorsal horn of inner corona lobe less than half the length of upper horn; pedicel 10–15 mm long. 34. *O. knobelii.*
3. Corolla yellow to red or blackish or spotted with yellow on maroon but not white to cream with dark spots.
   5. Inner corona lobes at most equalling anthers, with a terete to strongly laterally flattened recurved horn just behind apex (apex often present only as slight swelling beneath this horn).
      6. Inner corona lobes excavated or furrowed near base with ridges and crests ± in series with outer lobes. 32. *O. melanantha.*
      6. Inner corona lobes neither excavated nor furrowed near base (with two ± erect to recurved dorsal horns somewhat above base). 35. *O. lutea.*
   5. Inner corona lobes much exceeding anthers and dorsiventrally flattened to nearly terete beyond them.
      7. Corolla lobes flat above, inner corona lobes with a stout dorsal horn at middle, corona completely contained within corolla tube. 36. *O. gerstneri.*
      7. Corolla lobes distinctly convex above, inner corona lobes gibbous and/or crested towards base only, tips of lobes often protruding from corolla tube.
         8. Corolla 30–45 mm in diameter. 38. *O. valida.*
         8. Corolla 55–85 mm in diameter. 37. *O. huillensis.*

1. Inflorescence with 1–3 flowers opening in gradual to quick succession.
   9. Stems wholly prostrate, inner corona lobes papillate ("hairy").
      10. Corolla bicampanulate, lobes deltate and acute, smooth inside, inner corona lobes not rising significantly above anthers. 55. *O. conjuncta.*
      10. Corolla rotate to very shallowly bicampanulate, lobes ovate and acuminate, papillate inside, inner corona lobes rising above anthers and diverging towards tips. 56. *O. hardyi.*
   9. Stems ± erect at least in distal half, inner corona lobes smooth.
      11. Inflorescences usually several per stem arranged along sides of stem especially towards apex.
         12. Corolla 6–20 mm in diameter.
            13. Corolla campanulate, outer corona forming an urceolate cup around anthers. 24. *O. carnosa.*
            13. Corolla ± rotate, outer corona not urceolate, lobes spreading ± horizontally.
               14. Outer corona forming continuous flat and spreading pentagonal disc-like structure around gynostegium (often finely toothed along margin) broadest opposite inner lobes; tubercles (3–) 5–25 mm long; stems not at all rhizomatous. 1. *O. schweinfurthii.*
               14. Outer corona consisting of 5 pairs of deeply bifid spreading lobules alternating with inner lobes (not at all disc-like); tubercles 2–4 mm long; stems mostly rhizomatous. 2. *O. ubomboensis.*
         12. Corolla 25–45 mm in diameter.
            15. Corolla lobes with clavate marginal cilia near base, inner corona lobes bifid, the slender terete filiform lobules 7–9 mm long and entangled with similarly filiform dorsal projection above gynostegium. 50. *O. rogersii.*
            15. Corolla lobes without marginal cilia, inner corona lobes 4–5 mm long, not bifid, slender but not filiform, connivent in narrow column above gynostegium. 8. *O. lugardii.*
      11. Inflorescence one per stem near base.
         16. Corolla with ring-like annulus surrounding but not supporting corona.
            17. Inside of corolla smooth, corolla campanulate, 18–32 mm in diameter. 46. *O. paradoxa.*
            17. Inside of corolla rugulose or verrucose, corolla rotate to shallowly bowl-shaped, (30–) 45–110 mm in diameter.
               18. Annulus prominent, forming a tube in center of corolla.
                  19. Corolla with very prominent ± erect-tubular annulus more than twice as tall as gynostegium, margins of corolla lobes with prominent vibratile clavate cilia. 39. *O. ciliata.*
                  19. Corolla with spreading to recurved annulus much shorter than gynostegium, margins of corolla lobes eciliate or with short rigid cilia.

20. Outer corona lobes linear or linear-lanceolate, acute, inner lobes without prominent dorsal horn. 53. *O. namaquensis.*
20. Outer corona lobes linear-oblong with 2–3-toothed apex, inner lobes with prominent dorsal horn. 54. *O. variegata.*

18. Annulus insignificant, forming thickening on side of shallow corolla tube.
21. Inner corona lobes with fairly prominent knob-like dorsal horn. 51. *O. pulchella.*
21. Inner corona lobes without dorsal horn. 52. *O. verrucosa.*

16. Corolla with dome-like or cushion-like annulus supporting and beneath corona.
22. Corolla 10–18 mm in diameter; stems uniformly colored. 30. *O. miscella.*
22. Corolla 22–75 mm in diameter; stems mottled with purple on green.
23. Outer corona continuous and disc-like around gynostegium, forming a horizontal platform below guide-rails and a much swollen ± rectangular ridge rising up to meet inner lobes. 45. *O. maculata.*
23. Outer corona consisting of 5 discrete lobes beneath guide-rails, not spreading and disc-like around gynostegium.
24. Inner corona lobes much exceeding anthers to become erect beyond them, usually terete and ± clavate towards apex.
25. Inside of corolla conspicuously rugulose.
26. Stems with tubercles 4–7 mm long; inner corona lobes <3.5 mm long. 47. *O. cooperi.*
26. Stems with tubercles 10–25 mm long; inner corona lobes 4–5 mm long. 48. *O. tapscottii.*
25. Inside of corolla only faintly rugulose or smooth.
27. Corolla lobes strongly reflexed, margins of lobes with fine rigid cilia; inner corona lobes clearly clavate and tuberculate towards tips. 49. *O. umbracula.*
27. Corolla lobes spreading and corolla ± rotate, margins of lobes with vibratile clavate or spathulate cilia; inner corona lobes at most slightly clavate and tuberculate towards tips (usually neither). 40. *O. halipedicola.*
24. Inner corona lobes dorsiventrally flattened and only slightly exceeding anthers, neither becoming erect nor ± terete and clavate beyond them.
28. Corolla with shallow tube, the corona seated on a small abruptly raised annulus (± 2 times as tall as thick) at base of tube. 44. *O. longidens.*
28. Corolla tube formed entirely by annulus, annulus at most as tall as thick.
29. Corolla inside smooth, annulus widening towards surface of corolla. 43. *O. macloughlinii.*
29. Corolla inside rugulose at least on lobes, annulus at least slightly constricted towards base. 42. *O. woodii.*

II. Key to the species of *Orbea* from Arabia.

1. Corolla tube cupular and at least as tall as broad, entirely containing gynostegium. 19. *O. deflersiana.*
1. Corolla tube much shorter than broad.
2. Corolla divided into lobes nearly to center.
3. Inside of corolla covered with bristles, these becoming slightly clavate and transparent and reaching 2 mm long towards center. 13. *O. chrysostephana.*
3. Inside of corolla covered with minute papillae not more than 1 mm long.
4. Gynostegium noticeably taller than broad (excluding inner corona lobes); corolla lobes very narrowly lanceolate, usually with the margins touching each other behind lobe for whole length. 12. *O. luntii.*
4. Gynostegium mostly as tall as broad (excluding inner lobes) or broader than tall; corolla lobes narrowly lanceolate, usually with the margins touching each other mainly near apex. 11. *O. wissmannii.*
2. Corolla divided into lobes to edge of small flat area around gynostegium in which there is a somewhat ring-like thickening around the mouth of the minute corolla tube.

5. Corona 6–7 mm tall, inner lobes much exceeding anthers and diverging above them. 3. *O. araysiana.*
5. Corona 2.5–3.0 mm tall, inner lobes ± equalling anthers and not rising up in center. 7. *O. sprengeri.*

III. Key to the species of *Orbea* from northeastern, central, and western Africa.

1. Flowers borne in a single inflorescence near base of stem. 41. *O. semota.*
1. Flowers borne in 1–many inflorescences towards apex of stem.
   2. Corolla rotate to shallowly campanulate with corona projecting at least slightly from tube.
      3. Corolla lobes linear to lanceolate (rarely ovate-deltate), mostly with strongly revolute margins, corolla divided nearly to center; inner corona lobes with 1–several dorsal projections.
         4. Inside of corolla covered with fine papillae.
            5. Corolla 8–17 mm in diameter, lobes 3–7 mm long, the margins reflexed.
               6. Outer corona lobes forming a deep pouch nearly as tall as gynostegium, inner lobes rising at most slightly to backs of anthers. 25. *O. subterranea.*
               6. Outer corona lobes forming a shallow pouch much less than half as tall as gynostegium, inner lobes rising steeply to backs of anthers. 26. *O. wilsonii.*
            5. Corolla 23–30 mm in diameter, lobes 10–14 mm long, the margins tightly folded back and touching behind flower. 14. *O. baldratii.*
         4. Inside of corolla smooth (without fine papillae).
            7. Corolla lobes 10–12 mm long, narrowly lanceolate; outer corona lobes forming deep pouch nearly as tall as gynostegium, not deeply notched in middle. 15. *O. laikipiensis.*
            7. Corolla lobes 5–6 mm long; outer corona deeply indented in middle to about half height of gynostegium. 28. *O. taitica.*
      3. Corolla lobes ovate to lanceolate with the margins usually only slightly folded back, corolla with at least a small united and flattish area around corona; inner corona lobes without dorsal projections.
         8. Outer corona forming continuous flat and spreading pentagonal disc-like structure around gynostegium (often finely toothed along margin) and broadest opposite inner lobes. 1. *O. schweinfurthii.*
         8. Outer corona continuous around gynostegium but rounded and not flat and spreading (never toothed around margin) and broadest between inner lobes.
            9. Gynostegium significantly exserted from a minute corolla tube, which surrounds only its base.
               10. Pedicel 8–9 mm long, holding flower facing downwards. 5. *O. abayensis.*
               10. Pedicel 3–6 mm long, holding flower facing upwards. 6. *O. gilbertii.*
            9. Gynostegium just contained within or only slightly exserted from a shallow corolla tube.
               11. Corolla tube with thickened and slightly raised narrow annulus around mouth, inside of corolla finely papillate to rugulose; margin of outer corona swollen, smooth and rounded.
                  12. Gynostegium 7–8 mm in diameter, inner corona lobes overlapping in center. 4. *O. laticorona.*
                  12. Gynostegium 4–6 mm in diameter, inner corona lobes barely exceeding anthers and not overlapping in center. 7. *O. sprengeri.*
               11. Corolla tube without any trace of thickened annulus around mouth, inside of corolla smooth and glabrous; margin of outer corona thin and sometimes irregularly crenulate. 9. *O. gemugofana.*
   2. Corolla shallowly campanulate to tubular with corona contained within tube.
      13. Base of corolla tube flat with gynostegium isolated in center, inside of corolla with prominent stout to cylindrical papillae, each papilla tipped by a transparent bristle.
         14. Outer corona lobes apically deeply bifid, without any teeth behind inner lobes, gynostegium not narrowing below outer corona lobes, apical teeth of inner lobes not rising above anthers. 21. *O. dummeri.*
         14. Outer corona lobes apically entire, with small spreading teeth behind inner lobes, gynostegium narrowing conspicuously below outer corona lobes, apical teeth of inner lobes rising conspicuously above anthers. 20. *O. circes.*

13. Base of corolla tube close to sides of gynostegium and not flat, inside of corolla with small low papillae, sometimes with apical bristles or with (sometimes very fine) bristles only or ± smooth.
    15. Mouth of corolla tube ± at height of anthers.
        16. Outer corona lobes excavated nearly to base of gynostegium between anthers, inner lobes scarcely rising up from level of outer lobes to anthers. 27. *O. semitubiflora.*
        16. Outer corona lobes spreading and ± entire between anthers, inner lobes ascending onto backs of anthers.
            17. Gynostegium with a small but distinct and strongly pentagonal stipe beneath it; corolla 12–15 mm in diameter, with maroon spots on paler background. 26. *O. wilsonii.*
            17. Gynostegium without stipe, walls of corolla tube fused to gynostegium to ± half height of outer lobes; corolla 15–25 mm in diameter, dark purple, sometimes becoming yellow towards base of tube. 16. *O. decaisneana.*
    15. Mouth of corolla tube usually much above height of anthers.
        18. Inner corona lobes with a prominent longitudinal dorsal ridge. 23. *O. distincta.*
        18. Inner corona lobes without a prominent raised dorsal ridge above anthers.
            19. Corolla thickened around mouth of tube, with vibratile cilia along margins of lobes. 29. *O. vibratilis.*
            19. Corolla scarcely or not at all thickened around mouth of tube, without vibratile cilia along margins of lobes.
                20. Outer corona with ascending flap of tissue closing off pouch below guide-rails, inner corona lobes broadly lanceolate and nearly as broad as outer lobes, adpressed to anthers only near base and rising up to meet in center above them. 10. *O. huernioides.*
                20. Pouch below guide-rails formed by outer corona lobes open to base (without ascending flap of tissue), inner corona lobes slender and much narrower than outer, adpressed to anthers for whole length of anthers.
                    21. Corolla yellow to greenish, gynostegium equal in height to breadth (rarely slightly broader). 22. *O. denboefii.*
                    21. Corolla brown to dark purple-brown, gynostegium considerably broader than tall.
                        22. Corolla inside with fine white bristles up to 3 mm long, corolla tube usually widening slightly towards mouth. 18. *O. tubiformis.*
                        22. Corolla inside with fine bristles up to 0.5 mm long, corolla tube usually somewhat constricted towards mouth. 17. *O. sacculata.*

1. Orbea schweinfurthii (A. Berger) Bruyns, Aloe 37: 76. 2001. *Caralluma schweinfurthii* A. Berger, Stapel. u. Klein. 103. 1910. *Pachycymbium schweinfurthii* (A. Berger) M. G. Gilbert, Bradleya 8: 23.1990. *Angolluma schweinfurthii* (A. Berger) Plowes, Excelsa 16: 118. 1994.—TYPE: ZAIRE. Rutihuru plains SW of Lake Edward, *Stuhlmann 2208* (holotype: B, destroyed).—LECTOTYPE, here designated: Fig. 22, no. 5, p. 104, in A. Berger, Stapelieen und Kleinien, 1910.

Caralluma piaranthoides Obermeyer, Fl. Pl. South Africa 15: t. 599. 1935.—TYPE: ZIMBABWE. Wankie distr., *Levy 8444* (holotype: PRE!).

Small succulent forming diffuse mats up to 1 m or more in diameter, not rhizomatous. Stems 3–15 cm long, 0.4–1.2 cm in diameter (excluding teeth, sometimes more slender towards base), slender, decumbent (usually prostrate in proximal half, then ascending towards apex, rarely erect), branching from base to near apex, green to red mottled with purple-brown; tubercles 3–25 mm long, arranged very loosely into 4 obtuse rows along stem (stem ± cylindrical in cross-section when turgid) with a slight groove between rows, tapering to a prominent slender conical (sometimes laterally flattened) spreading tooth, tooth sometimes with two small denticles near apex, slightly flattened above towards apex. Inflorescences 1–4 per stem around apex and close to axils of neighboring tubercles,

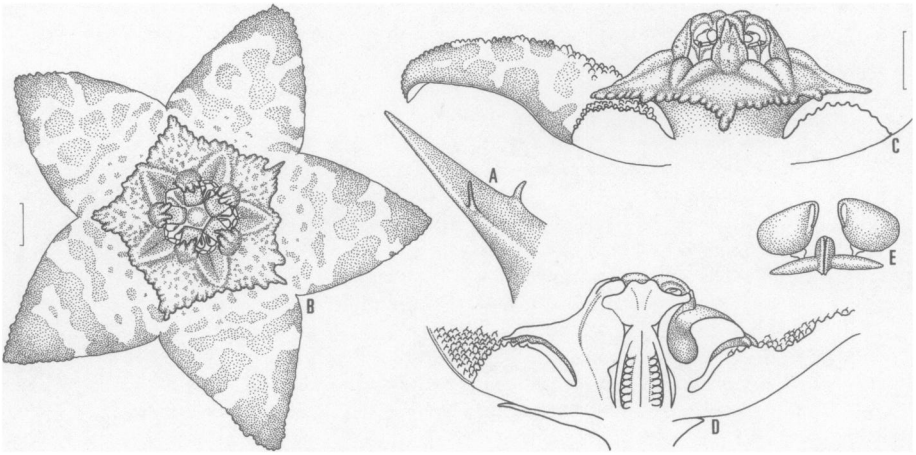

FIG. 9. *Orbea schweinfurthii.* A. Leaf rudiment with stipular denticles. B. Face view of flower. C. Side view of center of a dissected flower. D. Flower in vertical section. E. Pollinarium. Scale bars: A, C, D, 1 mm (at C); B, 1 mm; E, 0.25 mm (at C). [Based on *Bruyns 2289.*]

each of 1–3 (–8) flowers developing in gradual succession from a short (<1 mm long) peduncle; pedicels 2–4 mm long, 1 mm in diameter, erect, with small often toothed ± rectangular bracts <1 mm long at and near base. Sepals 2–3 mm long, 1 mm wide at base, ovate-lanceolate, acuminate. Corolla 1.0–1.5 cm in diameter, rotate; outside pale grey-green with maroon spots towards base; inside deep yellow with dark maroon spots, becoming solid towards tips of lobes, densely papillate but not rugulose; tube <0.5 mm long, formed by thickening of corolla below sinuses of lobes into a slight pentagonal cushion-like annulus beneath outer corona lobes; lobes ± 3.0–3.5 mm long, 3.0 mm wide at base, spreading, ovate-deltate, acute, with reflexed tips, lightly convex above, the margins slightly reflexed. Corona ± 2 mm tall, 7 mm in diameter, raised to level of mouth of tube on cylindrical stipe ± 0.5 mm long, pale yellow to cream speckled with purple; outer lobes horizontally spreading and fused laterally to form a continuous flat pentagonal disc-like structure (with corners opposite anthers, 1.5 mm wide from bases of inner lobes) around gynostegium with many-toothed to entire margin, with broad groove beneath each guide-rail; inner lobes ± 0.5 mm long, adpressed to backs of anthers and about half as long, ± deltate, usually with 1–4 short obtuse apical teeth, dorsiventrally flattened. Figs. 1B, 9.

Distribution (Fig. 10). Botswana, Malawi, Namibia, Rwanda, Tanzania, Uganda, Zaire, Zambia, Zimbabwe; 450–1300 m.

This extremely widely distributed species is found over a broad area mainly in central Africa (Leach & Plowes 1966). More recent explorations have detected it in Malawi around Lake Malawi (Hargreaves 1997), in Botswana in the Okavango Delta, in the Caprivi strip of Namibia, and also revealed it to be fairly widespread in central Tanzania. Collections of *O. schweinfurthii* are very scattered, but it seems to be particularly common in eastern Zaire and southwestern Uganda around Lake Edward.

In southern Africa *O. schweinfurthii* usually grows in low-lying, flat areas that, during the rainy season, become extremely wet, often with scattered pools of standing water. It is usually found in *Colophospermum mopane* (J. Kirk ex Bentham) J. Kirk ex Léonard

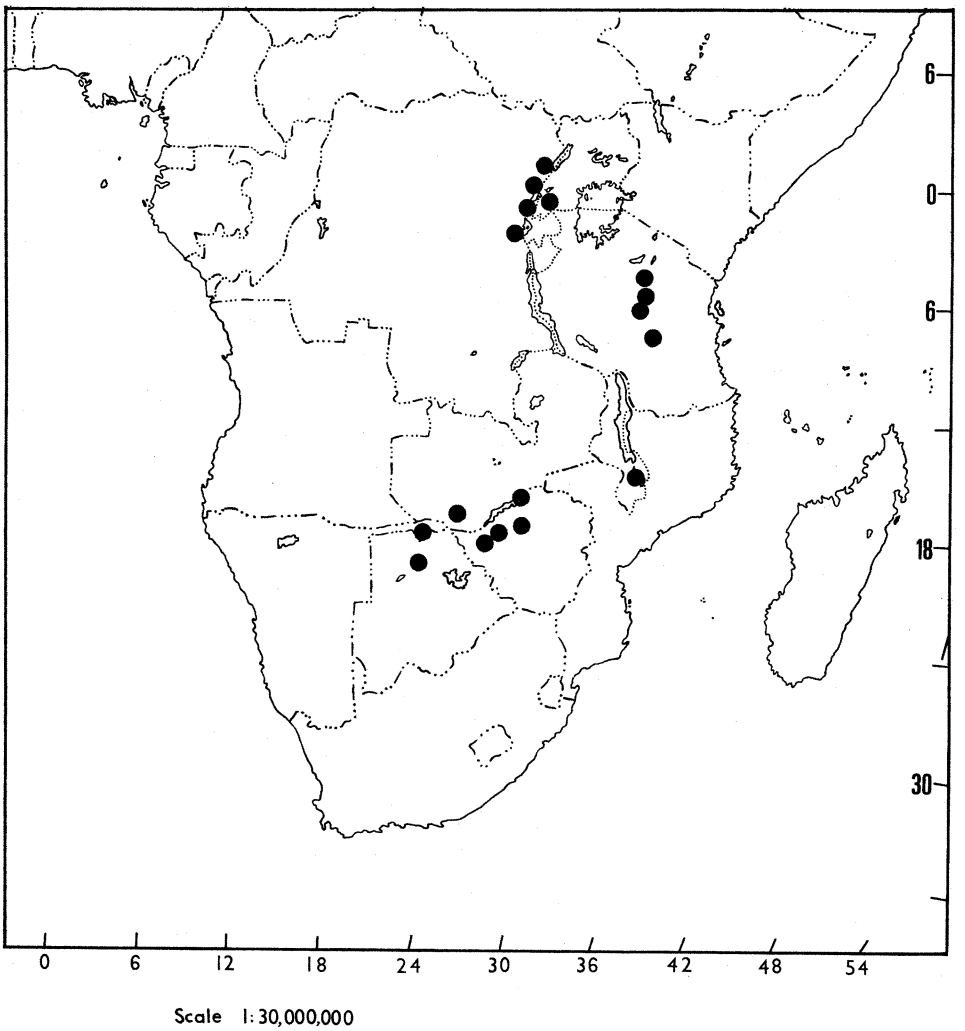

FIG. 10. Distribution of *Orbea schweinfurthii*.

woodland under small bushes or in the open alongside trees, sometimes in sandy soils but sometimes in quite muddy or loamy areas. In Tanzania it grows on stony slopes as well as in flat areas. Here it is sometimes associated with dense *Acacia-Euphorbia-Monadenium* scrub (as in the gorge of the Great Ruaha River), sometimes with *Acacia-Commiphora-Balanites* scrub, and was also found in dry *Brachystegia* woodland.

ADDITIONAL SPECIMENS EXAMINED. **Botswana.** [1923] 26 km W of Kwai [-BA], *Bruyns 6510* (BOL). **Malawi.** [1535] Liwonde Nat. Park [-AA], 20 Mar 1977, *Brummitt et al. 14873* (ZOM); Liwonde [-AA], *Bruyns 7750* (BOL); 5 km W of North Shire [-AC], *Bruyns 7753* (BOL). **Namibia.** [1724] Muyako [-CD], *Bruyns 2293* (WIND, NBG); Bukalo [-DA], *Bruyns 2289* (BOL). **Rwanda.** Bugesera, Kibugabuga, *Liben 639* (SRGH). **Tanzania.** [0535] 86 km S of Kondoa [-DB], *Bruyns 8724* (K). [0635] 18 km S of Dodoma [-BC], *Bruyns 8727* (MO); 61 km S of Dodoma [-DB], *Bruyns 8732* (E). [0735] 184 km S of Dodoma [-BC], *Bruyns 8735* (MO). [0736] 48 km W of Mikumi [-AD], *Leach & Brunton 10139* (PRE). **Uganda.** [0030] Ankole,

Ruizi R. [-C], *Jarrett 441* (PROB, fide Leach & Plowes 1966). **Zaire.** [0029] Kangatsi [-BA] N of Lake Edward, 18 Mar 1953, *de Witte 8587* (BR); Vitshumbi [-CB], *de Witte 1023* (BR); 10 km W of Ishasha [-DA], 11 Feb 1972, *Bamps 3137* (BR). [0228] Katanda [-BB], *Lebrun 7669* (BR); Kabare [-BD], *Bequaert 5381* (BR). **Zambia.** [1625] Machili, 10 Feb 1961, *Fanshawe 6234* (BR). **Zimbabwe.** [1628] Chirundu, Kariba distr. [-BB], *Drummond et al. 6919* (SRGH). [1729] 130 km SW of Chinhoyi [-CA], *Bruyns 7448* (BOL). [1826] ± 9 miles from Wankie, Lukosi R. [-BC], Feb/Mar 1965, *Leach 12123* (BR, K, PRE). [1827] Lusulu, Binga distr. [-BB], *Bingham 1413* (SRGH).

Orbea schweinfurthii is easily distinguished from all other species of *Orbea* by the very small flowers with their pentagonal, disc-like outer corona usually with a pectinate margin.

Plants of *O. schweinfurthii* may form diffuse clumps as large as 1 m in diameter. They have a very loosely spreading, pronouncedly decumbent or "semi-trailing" habit; in many stems the proximal half is prostrate (and sometimes becomes slightly subterranean, though it is never rhizomatous) and only towards the apex does the stem begin to ascend. Many of the stems have only a few pairs of tubercles, so that in a stem 6 cm long there are often only 4–6 pairs of tubercles, and these are especially widely spaced towards the base.

The tiny, more or less flat flowers are produced in several small inflorescences near the tips of the stems. Usually the corolla is mottled inside with maroon on a deep yellow background, with the maroon coalescing towards the tips of the lobes, and it is covered quite densely with multicellular papillae. The flowers emit a fruity, sweetish odor.

The corona in *O. schweinfurthii* is unique and most distinctive. It consists of a pentagonal disc spreading just above the surface of the flower and five small inner lobes pressed to the backs of the anthers. The disc-like part is broadest opposite the anthers and has five grooves beneath the guide-rails leading, in fact, to a fairly deep nectarial cavity beneath the rails (Fig. 9D). The corona begins its development (Fig. 11) with the appearance of the outer corona as five small ridges below the guide-rails; somewhat later the inner lobes begin to appear. The continuous coronal disc around the gynostegium is formed gradually by lateral spreading of adjacent outer lobes, initially producing a slight bulge between the outer lobes and continuing to grow until the part between adjacent outer lobes is considerably longer than the lobes themselves. It seems reasonable, therefore, to refer to this structure as a disc-like outer corona, as it does not appear that any parts of the inner lobes contribute to it.

Orbea schweinfurthii is one of the two most basal species in the genus. Although the stems and inflorescences are typical of *Orbea*, especially of many of the "northern" species, the flowers are particularly small. The very small pollinia are unusually broad and superficially resemble those of *Caralluma adscendens*, but the wings on the corpuscle are differently shaped and the respective insertion crests are differently oriented than are those in *Caralluma*.

Orbea schweinfurthii was named by Alwyn Berger for the German scientist and explorer Georg August Schweinfurth, in whose herbarium Stuhlmann's specimen was preserved. The holotype was subsequently lost during the bombing of Berlin during World War II. Leach and Plowes (1966) selected a neotype for *O. schweinfurthii*, but this designation is here set aside and Berger's illustration (1910, fig. 22, no. 5) is chosen as lectotype. Although this illustration depicts only the corona, it is unmistakable and was based on Stuhlmann's collection.

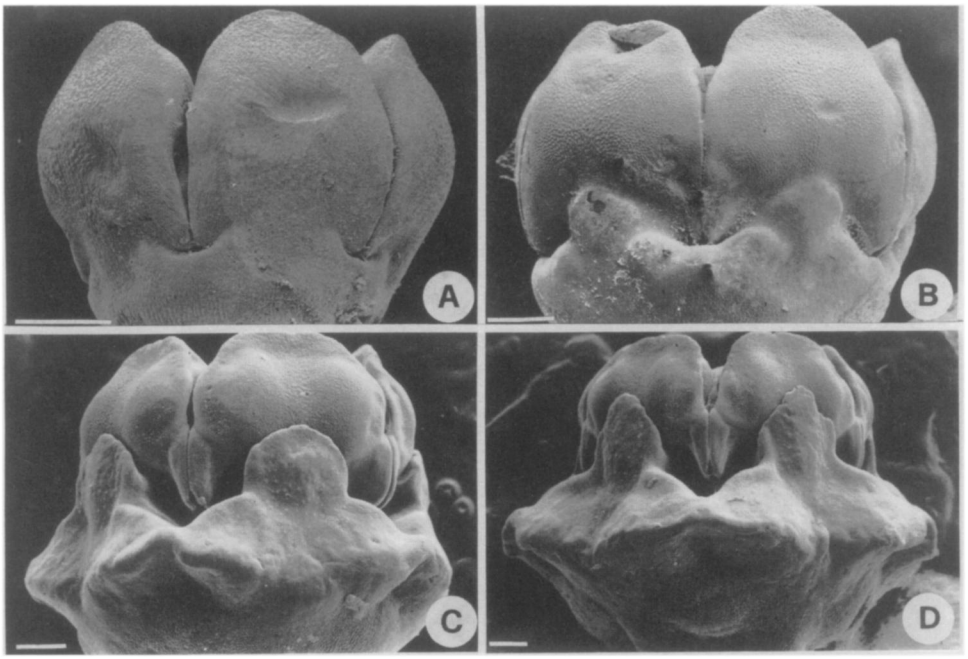

FIG. 11. Ontogeny of the corona of *Orbea schweinfurthii*. A. Outer corona only just visible as a ridge below guide-rails, inner corona not present yet. B. Both series now visible, the outer slightly lower than the inner. C. Outer corona beginning to spread behind inner lobes, with the least developed spot ± behind middle of inner lobe. D. Further development of corona: the distinct gap between adjacent outer lobes below the middle of the inner lobes later disappears completely and the outer coronal disc becomes broadest there (see Fig. 9B). Scale bars: 200 μm. [Based on: Tanzania, W of Mikumi, *Newton s.n.*, no voucher.]

2. Orbea ubomboensis (Verdoorn) Bruyns, Aloe 37: 76. 2001. *Caralluma ubomboensis* Verdoorn, Fl. Pl. South Africa 12: t. 443. 1932. *Pachycymbium ubomboense* (Verdoorn) M. G. Gilbert, Bradleya 8: 25. 1990. *Angolluma ubomboensis* (Verdoorn) Plowes, Excelsa 16: 119. 1994.—TYPE: SOUTH AFRICA. Natal: Lebombo Mtns, *Pole Evans sub PRE 8764* (holotype: PRE!).

Dwarf succulent usually consisting of several very small clumps of stems 3–10 cm in diameter connected by ± horizontal underground rhizomes. Stems 1.5–8 cm long, 0.4–1 cm in diameter, slender, erect from underground rhizomes (up to 15 cm long) to nearly prostrate and without any underground rhizomes, uniformly dark green to dark grey or dark brown, occasionally mottled with darker brown; tubercles 2–4 mm long, few, very obscure and joined into 4 obtuse angles along stem with slight groove between angles, each tubercle with a short spreading deltoid tooth (<1 mm long) near distal end, flattened above and occasionally with 2 small stipular denticles on either side near base. Inflorescences 1–3 per stem near apex, each of 1–3 flowers developing in gradual to rapid succession from a short peduncle (<5 mm long); pedicels 2–7 mm long, 1 mm in diameter, erect. Sepals 1.5–2.0 mm long, 1 mm wide at base, ovate-lanceolate, acuminate. Corolla 0.7–1.7 cm in diameter, rotate, deeply lobed; outside smooth, pale cream-green to purple-brown and 2–3-veined down each lobe; inside red or maroon to dark purple-brown, deeply to finely transversely rugulose and papillate over entire surface; tube ± 0.5 mm long,

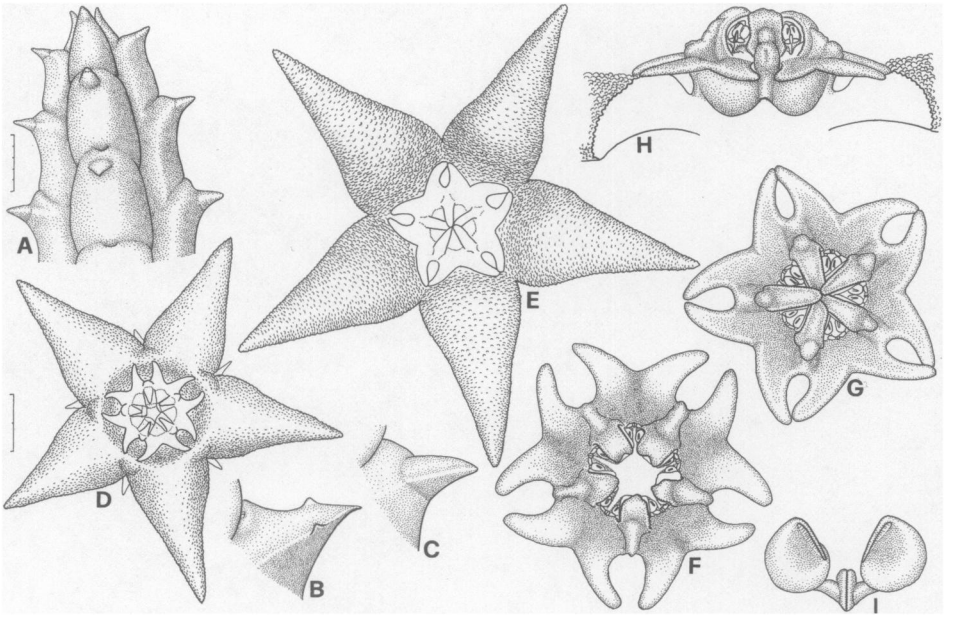

FIG. 12. *Orbea ubomboensis.* A. Portion of stem. B, C. Leaf rudiments. D, E. Face views of flower. F, G. Face views of gynostegium. H. Side view of center of dissected flower. I. Pollinarium. Scale bars: A, 5 mm; B, C, F–H, 1 mm (at D); D, E, 2 mm; I, 0.25 mm (at D). [Based on: A, C, *Bruyns 7471*; B, E, G, I, *Bruyns 4455*; D, *Hardy 5409*; F, H, ex hort. F. Noltee.]

containing lower half of gynostegium, with corolla somewhat thickened around mouth; lobes 3–7 mm long, 2–4 mm wide at base, spreading to recurved, deltate to ovate, acute, convex above, the margins reflexed, eciliate. Corona 1.5 mm tall, 2.5–5.0 mm in diameter, raised above base of tube on short pentagonal stipe (<0.5 mm long); outer lobes 1.0–1.5 mm long, spreading to touch surface of corolla at mouth of tube, bifid nearly to base into dorsiventrally flattened linear diverging obtuse lobules, with low flattened ridge joining adjacent lobes behind anthers, dark purple-brown becoming red towards base or wholly maroon; inner lobes 0.5–1.0 mm long, adpressed to backs of anthers and sometimes exceeding them to meet in center, dorsiventrally flattened, linear, obtuse to truncate-emarginate, white with reddish margins to wholly maroon. Figs. 1D, 3C, D, 12.

Distribution (Fig. 13). Mozambique, South Africa, Swaziland, Zimbabwe; 70–1400 m.

Orbea ubomboensis has been gathered most often in that part of the Ubombo Mountains that lies alongside the border of Swaziland, roughly between the town of Ubombo in Natal and Goba in Mozambique. It is also known in the extreme northeastern corner of the Transvaal between Wyllies Poort and Pafuri, and it occurs northward from this area into eastern Zimbabwe at least as far north as Gutu. It was recently also collected north of the Save River in Mozambique.

Orbea ubomboensis occurs in a wide variety of habitats, usually on rock outcrops on hills or mountains. It may grow in seasonally quite wet areas as, for example, around Lebombo (Ubombo), where plants grow in shallow pockets of soil in crevices on rock outcrops with *Xerophyta* and *Aloe vanbalenii* Pillans. In the area north of the Soutpansberg it is found in dry and fairly open "forests" of *Androstachys johnstonii* Prain (the Lebombo ironwood) among rocks on the slopes of hills, while it occurs in crevices on granite domes

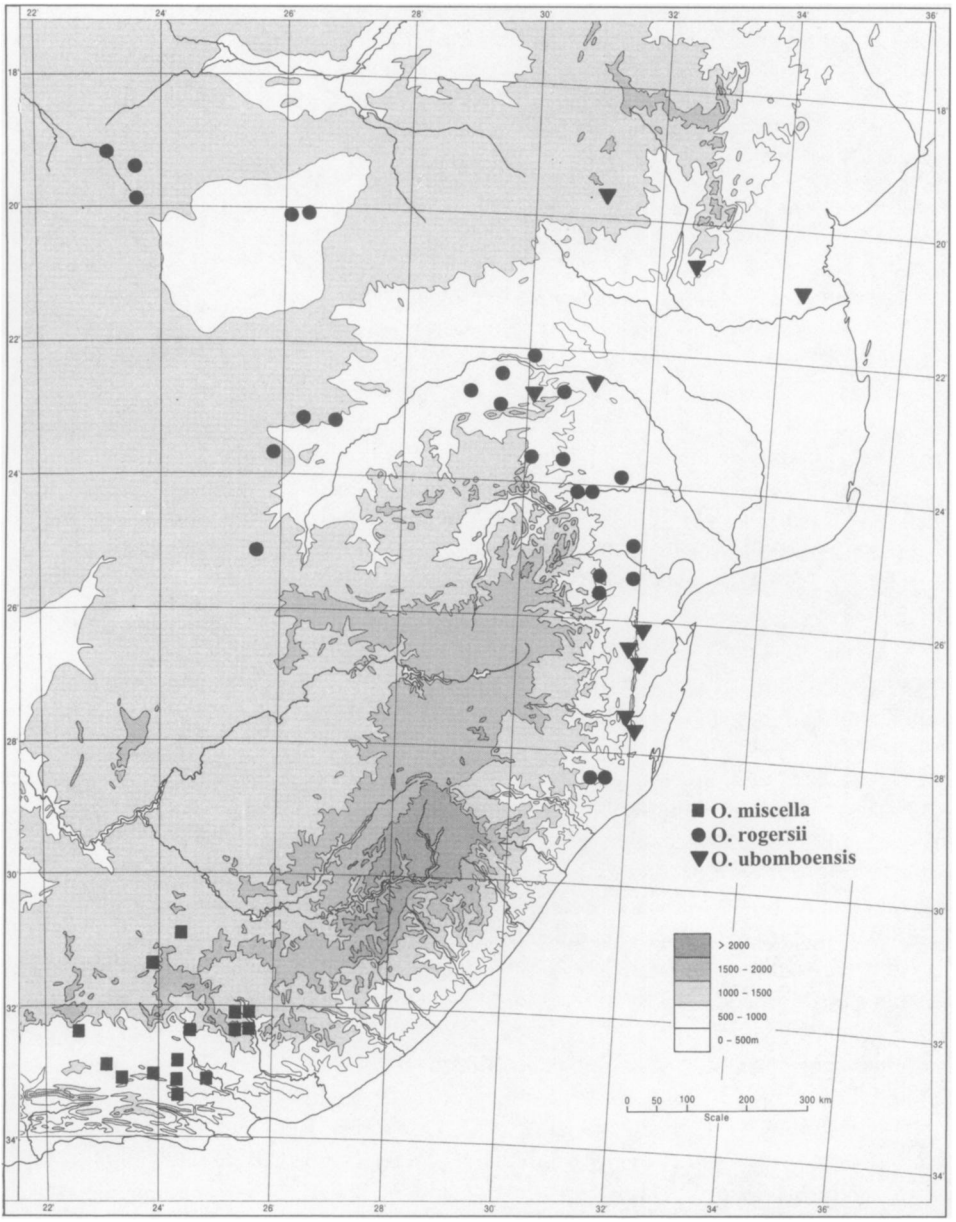

FIG. 13. Distribution of *Orbea miscella*, *O. rogersii*, and *O. ubomboensis*.

near Gutu in Zimbabwe. In Mozambique north of the Save River (at an altitude of about 70 m) it was found to be locally very common in dry *Brachystegia* woodland on pale sands.

ADDITIONAL SPECIMENS EXAMINED. **Mozambique.** [2034] N of Save River [-CD], *Bruyns 8750* (K, MO). [2632] Goba [-AA], 26 Sep 1955, *Lemos 113* (LMA), *Hall* (NBG). **South Africa.** NATAL: [2731] Jozini Dam [-BD], *P.C.V. du Toit* (PRE). [2732] Ubombo [-CA], *Bruyns 4455* (BOL).—TRANSVAAL: [2230] Nzhelele Dam [-CA], *Bruyns 7471* (K). [2231] Mutale Gorge, Pafuri [-AC], *Hardy 5409* (PRE); Pafuri [-AC], *Mockford s.n.* (PRE). **Swaziland.** [2631] Stegi [-BD], 1936, *Hurling & Neil s.n.* (BOL). [2632] Palata [-CA], 11 Jan 1962, *Dhlamini s.n.* (NBG, PRE). **Zimbabwe.** [1931] ± 4 miles S of Gutu [-CA], 13 Jan 1964, *Leach 12062* (SRGH).

Orbea ubomboensis is distinguished from all other species of *Orbea* in southern Africa by the small, uniformly colored, dark flowers borne near the apex of the stem. Although the flowers superficially resemble some of those in species from the northern part of the range of the genus, the corona is different and the stems are unlike any seen further north, with particularly small tubercles and an unusual dark color; those from the north are usually brightly mottled on a pale background.

Although the stems may reach 8 cm long in cultivation, in the field they are small, often only 2 cm tall and 5 mm in diameter. They form small clumps, which may be connected beneath the surface by slender, white runners up to 1.5 cm long. Plants observed in *Brachystegia* woodland in Mozambique showed no evidence of subterranean growth at all; the small stems spread nearly horizontally on the surface of the soil, as is usually seen in *O. schweinfurthii*, but this is the only locality where such a habit has been seen or recorded. The aboveground portions are usually uniformly dark green or dark grey to brown and only very occasionally have any of the usual darker mottling against a paler background.

The flowers of *O. ubomboensis* are small and uniformly colored. Their inner surface is velvety in appearance; under the microscope this can be seen to be a dense covering of irregularly transverse ridges that are themselves covered with small, multicellular papillae. In this species the flowers emit quite a strong, slightly fruity, fetid smell. In cultivation numbers of tiny flies (3–4 mm long) have been seen swarming over the flower shortly after it has opened and have been observed to remove pollinia.

Leach (1978) and Gilbert (1990) suggested that this species is allied to *O. miscella*, but this study found it to be most closely related to *O. schweinfurthii* (Fig. 6).

3. Orbea araysiana (Lavranos & Bilaidi) Bruyns, Aloe 37: 73. 2001. *Stultitia araysiana* Lavranos & Bilaidi, J. Cact. Succ. Soc. Amer. 43: 207. 1971. *Pachycymbium araysianum* (Lavranos & Bilaidi) M. G. Gilbert, Bradleya 8: 23. 1990. *Angolluma araysiana* (Lavranos & Bilaidi) Plowes, Excelsa 16: 115. 1993.—TYPE: YEMEN. Jebel al Arays [N 1345 BD], 850 m, 24 Dec 1970, *Lavranos, Bavazzano & Bilaidi 8602* (holotype: FT).

Small succulent forming dense clumps up to 30 cm in diameter, not rhizomatous. Stems 2–8 cm long, 1–1.2 cm in diameter (excluding teeth), decumbent, grey-green flecked with purple-brown; tubercles 5–12 mm long, arranged roughly into 4 obtuse rows along stem with a very slight groove between them, spreading to ascending, conical, tapering to a slender tip, without stipular denticles. Inflorescences 1–3 per stem near apex, each of 1–2 flowers developing in gradual succession, peduncle absent, with a few lanceolate bracts to 1 mm long; pedicel 3–7 mm long, 2 mm in diameter, ascending to spreading, holding flower facing upwards or outwards. Sepals 3–4 mm long, 1.5 mm wide at

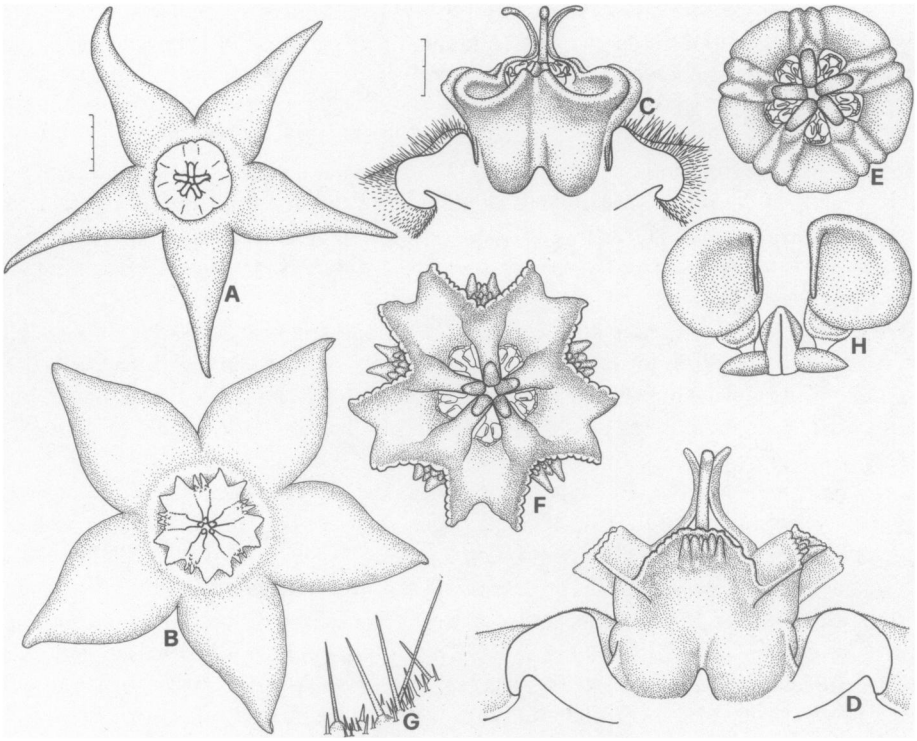

FIG. 14. *Orbea araysiana.* A, B. Face views of flower. C, D. Side views of center of dissected flower. E, F. Face view of gynostegium. G. Papillae on inside of corolla at base of lobes. H. Pollinarium. Scale bars: A, B, 5 mm (at A); C–F, 2 mm (at C); G, 0.5 mm (at C); H, 0.25 mm (at C). [Based on: A, C, E, G, H, *Lavranos sub K 52447*; B, D, F, *Řičánek & Hanáček 284*.]

base, ovate-lanceolate, acute. Corolla 3.4–3.7 cm in diameter, rotate; outside grey-green flecked with purple-brown; inside pale to dark red-brown, sometimes slightly shiny, covered densely with fine bristles up to 1.5 mm long, each arising from a small papilla, to finely papillate; tube ± 1.5 mm long, 6–8 mm in diameter, formed by thickened ridge on corolla around base of gynostegium, closely containing base of gynostegium; lobes 12–15 mm long, 7–10 mm wide at base, spreading, ovate to ovate-lanceolate, convex above, the margins reflexed (sometimes touching behind lobe), eciliate. Corona 6–7 mm tall, 7–8 mm in diameter, without basal stipe, purple-black to red (pale red towards base), shiny; outer lobes forming deep pouches about 3 mm tall between anthers (with spreading margins), with a thickened raised canaliculate boss behind inner lobes; inner lobes 3–4 mm long, adpressed to backs of anthers, connivent in center and then diverging above, slender, linear, dorsiventrally flattened, obtuse. Fig. 14.

Distribution (Fig. 16). Yemen; 600–900 m.

Orbea araysiana is only known from the Jebel al Arays in the former South Yemen, somewhat to the east of Aden. Plants grow in crevices in lava outcrops on steep slopes facing the sea.

ADDITIONAL SPECIMENS EXAMINED. **Yemen.** [N 1345] Jebel al Arays [-BD], 30 km E of Shuqra, *Lavranos s.n.* (K), *Řičánek & Hanáček 284* (K).

Among all the "northern" species of *Orbea* with relatively flat flowers and more or less ovate corolla lobes *O. araysiana* is unique in its particularly long and slender inner corona lobes, which rise up in the center of the flower in a column well above the level of the anthers.

It was originally thought (Lavranos & Bilaidi 1971) that the small annulus was taxonomically significant, and this feature and the long inner corona lobes caused the species to be placed in *Stultitia*. Similar small annuli are present in all the species of *Orbea* with apical inflorescences, flattish flowers, and more or less ovate corolla lobes. These include *O. abayensis*, *O. gilbertii*, *O. laticorona*, and *O. sprengeri*; *O. araysiana* is allied with them (see Fig. 6).

In the original material the outer corona lobes had relatively rounded margins, but in recently collected plants these margins are noticeably more dissected. In addition, in new collections the corolla lobes are broader and the inner surface is not covered with such obvious bristles. In these cases the flower is similar to that of *O. abayensis*.

4. Orbea laticorona (M. G. Gilbert) Bruyns, Aloe 37: 75. 2001. *Caralluma sprengeri* subsp. *laticorona* M. G. Gilbert, Cact. Succ. J. Gr. Brit. 40: 41. 1978. *Pachycymbium laticoronum* (M. G. Gilbert) M. G. Gilbert, Bradleya 8: 23. 1990. *Angolluma laticorona* (M. G. Gilbert) Plowes, Excelsa 16: 115. 1994.—TYPE: ETHIOPIA. Shoa region, ± 5 km S of Debre Zeit, Green Lake, [N 0838 DB] 08°43′N, 38°59′E, 2000 m, *Gilbert & Gilbert 1383* (holotype: K!; isotype: ETH).

Angolluma nubica Plowes, Excelsa 16: 112. 1994.—TYPE: SUDAN. 5 km SW of Erkowit at base of Jebel Auliyayi [N 1837 DC)], 1000–1200 m, *Plowes 7550* (holotype: K!; isotype: SRGH).

Small succulent forming diffuse mats, not rhizomatous. Stems 5–15 cm long, 0.8–1 cm in diameter (excluding teeth), decumbent, grey-green mottled with purple-brown; tubercles 5–13 mm long, arranged into 4 rows along stem, ascending, conical, attenuated into very fine tips, without stipular denticles. Inflorescences 1–4 per stem near apex, each with 1–3 flowers opening in gradual succession ± without a peduncle, with a few bracts to 1 mm long; pedicel 6–10 mm long, 1.5–2.0 mm in diameter, ascending and spreading to hold flower facing ± horizontally to slightly upwards. Sepals 3–5 mm long, 1.0–1.5 mm wide at base, lanceolate, acute. Corolla 2.0–4.4 cm in diameter, rotate to slightly reflexed; outside pale green flecked with purple; inside red-brown to light brown, faintly to markedly rugulose and covered with fine papillae; tube 1–2 mm long, ± 5 mm in diameter, usually with the corolla distinctly thickened around mouth into a slightly raised annulus, steep-sided to bowl-shaped; lobes 10–16 mm long, 8–9.5 mm wide at base, spreading to slightly reflexed, ovate-deltate to ovate-lanceolate, convex above, the margins reflexed, eciliate. Corona 2.5–3.0 mm tall, 7–8 mm in diameter, dark brown to red-brown, with a short basal stipe <1 mm long; outer lobes forming a continuous, conspicuously thickened, smooth and rounded ring around anthers, sometimes slightly higher behind anthers, somewhat pouch-like beneath each guide-rail above deep enclosed nectarial cavity; inner lobes 1.0–1.3 mm long, adpressed to backs of anthers, often meeting in center and covering entire style-head. Figs. 4F, 15.

Distribution (Fig. 16). Ethiopia, Sudan; 1400–2000 m.

Orbea laticorona is known in central Ethiopia and in the northeastern corner of Sudan. In Ethiopia *O. laticorona* grows in black soils on calcareous patches of volcanic origin, in flat areas, and on slopes. Plants are often seen in overgrazed patches inhabited

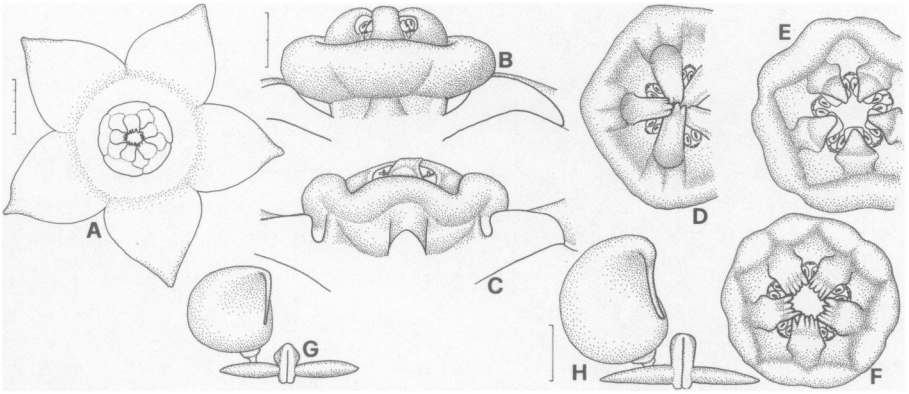

FIG. 15. *Orbea laticorona.* A. Face view of flower. B, C. Side views of center of dissected flower. D–F. Face views of gynostegium. G, H. Part of pollinarium. Scale bars: A, 5 mm; B–F, 2 mm (at B); G, H, 0.25 mm (at H). [Based on: A, F, *Darvall 4*; B, D, G, *Gilbert & Gilbert 1383*; E, *Plowes 7550*; C, H, *J. Robbie sub Bally S107.*]

by stunted *Acacia* and *Balanites* shrubs. Such spots may harbor a profusion of succulents, and this species has been seen growing with *Echidnopsis montana* (R. A. Dyer & E. A. Bruce) P. R. O. Bally, *Caralluma speciosa* (N. E. Br.) N. E. Br., and *Sarcostemma viminale* (L.) R. Br., as well as other succulents belonging to the genera *Cissus*, *Kalanchoe*, and *Senecio*.

ADDITIONAL SPECIMENS EXAMINED. **Ethiopia.** [N 0839] Mojjo [-CA], *Bruyns 8435* (E). [N 0738] N of Shashamene [-DA], *Bruyns 8497* (MO). **Sudan.** [N 1837] Erkowit, [-DC] 18°49′N, 37°01′E, *Darvall 4* (K), *Robbie sub Bally S107* (K). [N 1836] Gebeit, [-DD] 18°58′N, 36°48′E, *Darvall 5* (K).

Orbea laticorona differs from *O. sprengeri* in its broader outer corona and longer inner corona lobes. The two species are undoubtedly closely related, and Gilbert (1978) originally treated *O. laticorona* as a subspecies of *O. sprengeri*. In the breadth of the outer corona, *O. laticorona* is suggestive of *O. abayensis* and *O. gilbertii*, but in both of these the whole gynostegium is exserted from the corolla tube further than is ever the case in *O. laticorona*.

Plowes's *Angolluma nubica* was said to differ from "*A. laticorona*" by the more lanceolate corolla lobes, the procumbent-ascending (usually shortly rhizomatous) stems, and the connivent tips of the inner corona lobes. The collections of R. Darvall from the Red Sea Hills, in 1937 and 1939, prove that the inner corona is extremely variable, with deltate to truncate lobes, even on a single flower. The different shape of the corolla lobes is caused by the margins' folding back more strongly in "*A. laticorona*." Gilbert gave the stems of "*A. laticorona*" as "procumbent," but in fact the photograph (Gilbert 1978: 40) shows an erect stem; it is more likely that the stems are decumbent, i.e., with horizontal base and the rest erect. There is no difference between this habit and the attitude of the stems in the photo in Plowes (1994: 122).

The main difference between the two appears to be that the ring formed by the outer corona is uniformly high in "*A. laticorona*," but in *A. nubica* it has a wavy outline, highest opposite the anthers and lowest opposite the guide-rails. There is much variation in the shape of the corona lobes in *O. sprengeri*, and there seems to be no point in recognizing *A. nubica* as a distinct species. It is here included in *O. laticorona*, as also by Gilbert (1978, as *Caralluma sprengeri* subsp. *laticorona*).

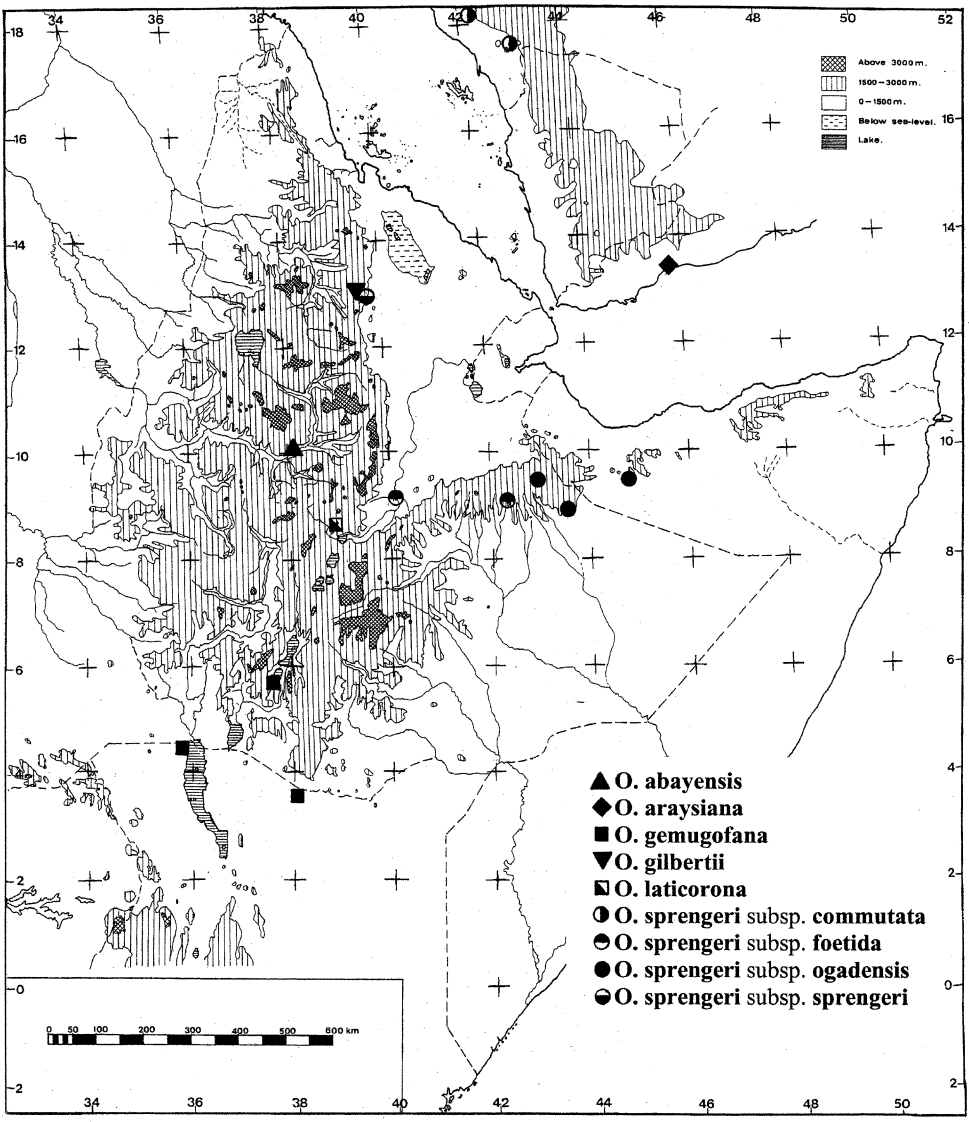

FIG. 16. Distribution of *Orbea abayensis, O. araysiana*, *O. gemugofana*, *O. gilbertii, O. laticorona* (in Ethiopia), and *O. sprengeri*.

5. Orbea abayensis (M. G. Gilbert) Bruyns, Aloe 37: 73. 2001. *Caralluma abayensis* M. G. Gilbert, Cact. Succ. J. Gr. Brit. 40: 46. 1978. *Pachycymbium abayense* (M. G. Gilbert) M. G. Gilbert, Bradleya 8: 23. 1990. *Angolluma abayensis* (M. G. Gilbert) Plowes, Excelsa 16: 117. 1994.—TYPE: ETHIOPIA. Shewa region, Abbai (Abay or Blue Nile) Gorge, near 205 Km marker between Addis Abeba and Debre Marcos, [N 1038 AA] 10°03′N, 38°13′E, 1250–1600 m, *Gilbert 3891* (holotype: K!; isotype: ETH).

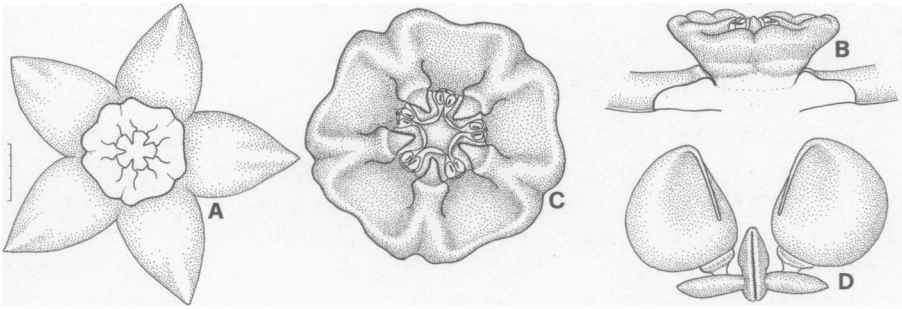

FIG. 17. *Orbea abayensis.* A. Face view of flower. B. Side view of center of flower with two corolla lobes removed. C. Face view of gynostegium. D. Pollinarium. Scale bars: A, 5 mm; B, 3 mm; C, 2 mm (at B); D, 0.25 mm (at B). [Based on *Gilbert s.n.*, Abbai Gorge, Ethiopia.]

Small succulent forming relatively dense clumps to 30 cm in diameter, not rhizomatous. Stems 5–14 cm long, 0.8–1 cm in diameter (excluding teeth), erect, grey-green flecked with purple-brown; tubercles 10–20 mm long, arranged into 4 obtuse rows along stem with a very slight groove between them, spreading, conical, tapering to slender tip, without stipular denticles. Inflorescences 1–8 per stem near apex, each with flowers developing in gradual succession, peduncle absent, with lanceolate bracts up to 1 mm long; pedicel 8–9 mm long, 2.0–2.5 mm in diameter, spreading to slightly descending, holding flower facing slightly downwards. Sepals 4.5–5.0 mm long, 2.5–3.0 mm wide at base, ovate-lanceolate, acute. Corolla 2.5–4.0 cm in diameter, rotate; outside grey-green flecked with purple-brown; inside pale brown, dull and very finely papillate; tube ± 1 mm long, 4–5 mm in diameter, partly formed by the thickened ridge on corolla around base of gynostegium, closely containing base of gynostegium; lobes 10–16 mm long, 8.0–9.5 mm wide at base, spreading, ovate-deltate, acute, convex above, the margins slightly reflexed, eciliate. Corona (2.5–) 3.5–4.0 mm tall, 8–9 mm in diameter, reddish brown and shiny, without basal stipe; outer lobes forming ± a continuous ring 1.5–2.0 mm wide around anthers, usually highest and somewhat radially grooved behind anthers, somewhat incised opposite guide-rails, broadly pouch-like beneath each guide-rail above deep enclosed nectarial cavity; inner lobes 0.7–1.0 mm long, adpressed to backs of anthers and ± equalling them, deltate to ovate-lanceolate, dorsiventrally flattened, ± acute. Fig. 17.

Orbea abayensis is known only from the type collected in the Shoa Province of Ethiopia in the gorge of the Abbai River, previously known as the Abay or Blue Nile (Fig. 16). Plants grow in calcareous patches on gypsum among a scanty cover of *Acacia*, *Dichrostachys*, and other low trees, often with other succulents, such as various species of *Aloe*, *Eulophia petersii* (Rchb. f.) Rchb. f., *Sanseviera*, and *Sarcostemma viminale*.

The manner in which the gynostegium is significantly exserted from the minute corolla tube distinguishes *O. abayensis* and *O. gilbertii* from all forms of *O. sprengeri* and *O. gemugofana*. The differences between *O. abayensis* and *O. gilbertii* are discussed under the latter species (no. 6).

6. Orbea gilbertii (Plowes) Bruyns, comb. nov. *Angolluma gilbertii* Plowes, Excelsa 16: 116. 1994.—TYPE: ETHIOPIA. Tigre region, between Mekele and Kwiha [N 1339 BA], 1800–1900 m, *Gilbert s.n.* (holotype: K!).

Small succulent forming loose clumps to 30 cm in diameter, occasionally shortly rhizomatous. Stems 5–14 cm long, 0.8–1 cm in diameter (excluding teeth), decumbent, grey-green flecked with purple-brown; tubercles 5–7 mm long, arranged into 4 obtuse rows along stem with a very slight groove between them, spreading, conical, tapering to a slender tip, without stipular denticles. Inflorescences 1–8 per stem near apex, each with 1–3 flowers developing in gradual succession, peduncle absent, with lanceolate bracts up to 1 mm long; pedicel 3–6 mm long, 2.0–2.5 mm in diameter, spreading and ascending, holding flower facing upwards. Sepals 3–6 mm long, 1.5–2.5 mm wide at base, ovate-lanceolate, acute. Corolla 2.5–4.0 cm in diameter, rotate; outside grey-green flecked with purple-brown; inside pale brown, dull and very finely papillate; tube ± 1 mm long, 4–5 mm in diameter, partly formed by a thickened ridge on corolla around base of gynostegium, closely containing base of gynostegium; lobes 10–18 mm long, 8.0–9.5 mm wide at base, spreading, ovate-deltate, acute, convex above, the margins slightly reflexed, eciliate. Corona 3.5–4.0 mm tall, 8–9 mm in diameter, reddish brown and shiny, without basal stipe; outer lobes forming a ± continuous ring 1.5–2.0 mm wide around anthers, usually highest and somewhat radially grooved behind anthers, somewhat incised opposite guide-rails, broadly pouch-like beneath each guide-rail above deep enclosed nectarial cavity; inner lobes 0.7–1.0 mm long, adpressed to backs of anthers and ± equalling them, deltate to ovate-lanceolate, dorsiventrally flattened, ± acute.

Orbea gilbertii is known only from the type found in the Tigre region of Ethiopia (Fig. 16). Specimens grow in shallow soils on limestone with a scanty cover of *Aloe*, *Euclea*, and other small trees (Gilbert 1978). Gilbert (1978) found that flowers of this species emitted a strong fetid odor, and that they were visited by flesh-flies of the genus *Sarcophaga*.

Gilbert (1978) considered plants from the Tigre region with a strongly exserted corona, as in *O. abayensis*, to represent *Caralluma commutata* A. Berger; however, now that material from Arabia has become available, this is unlikely to be correct. Plowes (1994) recognized these collections as representing a new species, *Angolluma gilbertii*. He claimed that this species differed from *O. abayensis* by the less flattened corona, said to be twice as tall as that of *O. abayensis*. The measurements that he gave of "2.5–4 mm high at the margin" are at least as tall as those for *O. abayensis* and, in the specimen of the latter illustrated here (Fig. 17), the corona is just under 4 mm tall. As pointed out by Gilbert (1978), these two taxa differ by the much longer pedicels of *O. abayensis*, which hold the flower facing downwards, whereas the shorter pedicels of *O. gilbertii* hold the flower facing upwards. *Orbea gilbertii* also has more loosely clustering stems with occasional rhizomes and considerably shorter tubercles.

7. Orbea sprengeri (Schweinfurth) Bruyns, Aloe 37: 76. 2001. *Huernia sprengeri* Schweinfurth, Cat. Dammann & Co. 1893: 46. 1893. *Caralluma sprengeri* (Schweinfurth) N. E. Brown, Bull. Misc. Inform. 1895: 263. 1895. *Pachycymbium sprengeri* (Schweinfurth) M. G. Gilbert, Bradleya 8: 22. 1990. *Angolluma sprengeri* (Schweinfurth) Plowes, Excelsa 16: 110. 1994.—TYPE: ETHIOPIA. Mitsiwa (Massowa), *Schweinfurth s.n.* (holotype: not located).—NEOTYPE, here

designated: Fig. 22, nos. 1–4, p. 104, in A. Berger, Stapelieen und Kleinien, 1910. [see note below]

Small succulent forming diffuse mats, sometimes rhizomatous. Stems 5–15 cm long, 0.8–1 cm in diameter (excluding teeth), decumbent, grey-green mottled with purple-brown; tubercles 5–13 mm long, arranged into 4 rows along stem, ascending, conical, attenuated to a very fine tip, without stipular denticles. Inflorescences 1–4 per stem near apex, each with 1–3 flowers opening in gradual succession ± without a peduncle, with a few bracts to 1 mm long; pedicel 6–10 mm long, 1.5–2.0 mm in diameter, ascending and spreading to hold flower facing ± horizontally to slightly upwards. Sepals 3–5 mm long, 1.0–1.5 mm wide at base, lanceolate, acute. Corolla 2.0–4.4 cm in diameter, rotate to slightly reflexed; outside pale green flecked with purple; inside light brown to dark red- or purple-brown, sometimes paler in narrow ring around corona, faintly to markedly rugulose and covered with fine papillae; tube 1.5–2.0 mm long, ± 5 mm in diameter, corolla distinctly thickened around mouth into slightly raised annulus, the tube thus steep-sided; lobes 9–20 mm long, 5–8 mm wide at base, spreading to slightly reflexed, ovate-lanceolate, convex above, the margins reflexed, eciliate. Corona 2.5–3.0 mm tall, 4–6 mm in diameter, dark brown to yellow or reddish, with short basal stipe <1 mm long; outer lobes forming a continuous (but not extremely swollen) ring of ± uniform height around anthers 1–2 mm wide, somewhat pouch-like beneath each guide-rail above deep enclosed nectarial cavity; inner lobes 1.0–1.5 mm long, adpressed to backs of anthers and ± equalling them but not meeting in or rising up in center, linear to narrowly ovate-deltate, dorsiventrally flattened, obtuse to emarginate. Figs. 18, 19.

Distribution (Fig. 16). Eritrea, Ethiopia, Kenya, Saudi Arabia, Somalia, Sudan; in arid areas with scattered trees, growing on lava, granite, or limestone substrates; 400–2000 m.

Orbea sprengeri and *O. laticorona* are very closely allied. *Orbea laticorona* differs in its somewhat broader outer corona and the longer inner corona lobes.

Gilbert (1990) listed "*Huernia sprengeri* Schweinf." as a nomen nudum; yet, there seem to be no grounds for this, especially since *Echidnopsis dammanniana* Sprenger and *Huernia macrocarpa* Sprenger were both described in the same manner in the Dammann Company Catalogue, and both are considered to have been validly published (see Bruyns, 1988, for *E. dammanniana* and Leach, 1988, for *H. macrocarpa*). The illustration that accompanied the "description" in the Dammann Company Catalogue is very poor and merely identifies *O. sprengeri* as having more or less rotate flowers. Another and much better figure by Schweinfurth was published by Berger (1910) and is here selected as the neotype.

Gilbert (1978) recognized four subspecies in *Caralluma sprengeri*, of which one ("subsp. *laticorona*") was later raised to specific level. Here his later treatment (Gilbert 1990) is followed, except that *C. commutata* is reduced to an additional subspecies.

Key to the Subspecies of Orbea sprengeri

1. Corona equalling corolla tube or slightly included within it. 7d. *O. sprengeri* subsp. *commutata*.
1. Corona slightly exserted from mouth of corolla tube.
   2. Corolla lobes (13–) 16–20 mm long; inner surface of corolla with small papillae, each tipped with a white bristle. 7a. *O. sprengeri* subsp. *sprengeri*.
   2. Corolla lobes 9–12 (–13) mm long; inner surface of corolla with or without papillae, bristles absent.

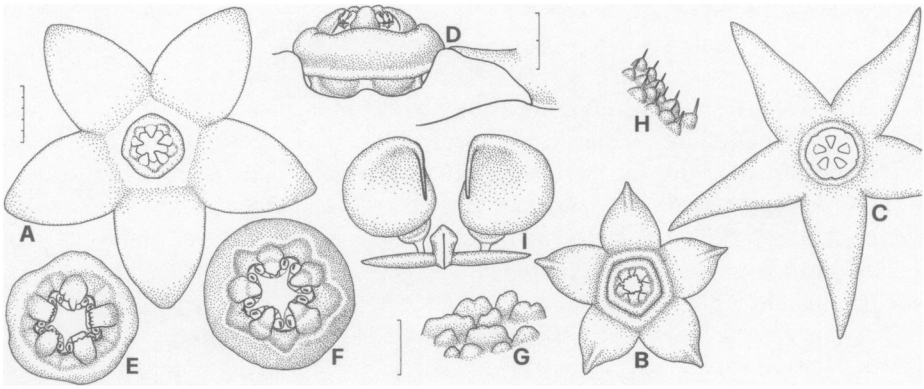

FIG. 18. *Orbea sprengeri* subsp. *sprengeri* (C, H), subsp. *foetida* (A, D, E, F, I), and subsp. *ogadensis* (B, G). A–C. Face views of flower. D. Side view of gynostegium. E, F. Face views of gynostegium. G. Rugose surface on inside of corolla at base of lobes. H. Papillae on inside of corolla at base of lobes. I. Pollinarium. Scale bars: A–C, 5 mm (at A); D–F, 2 mm (at D); G, H, 0.5 mm (at G); I, 0.25 mm (at G). [Based on: A, D, F, I, *Gilbert sub K 53698*; B, G, *Bally 11698*; C, H, *Gilbert sub K 13207*; E, *Gilbert 2298*.]

3. Inside of corolla covered with fine but distinct papillae. 7b. *O. sprengeri* subsp. *foetida*.
3. Inside of corolla rugulose, distinct papillae not apparent. 7c. *O. sprengeri* subsp. *ogadensis*.

7a. Orbea sprengeri subsp. **sprengeri.**

Stems sometimes shortly rhizomatous. Corolla light brown and not noticeably paler around corona, covered with minute papillae, each with short white apical bristle; lobes (13–) 16–20 mm long, 5.5–7.0 mm wide at base, not reflexed, lanceolate, acute. Corona slightly exserted from mouth of corolla-tube, yellow. Fig. 18C, H.

Distribution (Fig. 16). Eritrea, Ethiopia, Kenya (1 record), Sudan (?); 1600–2000 m.

Subspecies *sprengeri* is found in the northern part of Ethiopia and in the adjoining part of Eritrea (Gilbert 1978). Schweinfurth also recorded it from near Erkowit in Sudan (Berger 1910), but no specimens have been seen. There is also a record from the Kedong Valley in Kenya.

ADDITIONAL SPECIMENS EXAMINED. **Ethiopia.** [N 1339] between Mekele and Kwiha [-BA], *Gilbert sub K 13207* (K). **Kenya.** Kedong Valley, *Perkins s.n.* (K).

In *O. sprengeri* subsp. *sprengeri* the corolla lobes are comparatively long and they narrow uniformly from the base to the tip. The inside of the corolla is covered with discrete, rounded papillae, each of which has a fine, apical bristle.

7b. Orbea sprengeri subsp. **foetida** (M. G. Gilbert) Bruyns, Aloe 37: 76. 2001. *Caralluma sprengeri* subsp. *foetida* M. G. Gilbert, Cact. Succ. J. Gr. Brit. 40: 42. 1978. *Pachycymbium sprengeri* subsp. *foetidum* (M. G. Gilbert) M. G. Gilbert, Bradleya 8: 23. 1990. *Angolluma foetida* (M. G. Gilbert) Plowes, Excelsa 16: 115. 1994.—TYPE: ETHIOPIA. Harerghie region, 8 km from Babile towards Fiche, [N 0942 AB] 09°10′N, 42°20′E, 1650 m, *Gilbert 2297* (holotype: K!; isotype: ETH).

Stems sometimes shortly rhizomatous. Corolla light to dark brown, sometimes with narrow pale ring around corona, covered with minute papillae, these mostly without a short apical bristle (apical bristle often present in tube); lobes 9–13.5 mm long, 6–8 mm wide at base, mostly somewhat reflexed, ovate, acuminate to acute. Corona slightly exserted from mouth of corolla-tube, dark brown. Fig. 18A, D, E, F, I.

Distribution (Fig. 16). Ethiopia; 1300–1700 m.

Subspecies *foetida* has been collected a few times in the Harerghie region of eastern Ethiopia, where it occurs from around Metahara eastwards to Awash, and is also known from near Babile, east of Harar.

ADDITIONAL SPECIMENS EXAMINED. **Ethiopia.** [N 0839] ± 5 km E of Metahara [-DD], *Bruyns 8454* (BOL). [N 0940] Awash Station [-AA], *Gilbert sub K 53698* [K]; Awash River Gorge [-AA], *Horwood s.n.* (ZSS). [N 0942] near Babile, 8 km towards Fiche [-AB], 09°10′N, 42°20′E, *Gilbert 2298* (K).

In *O. sprengeri* subsp. *foetida* the corolla lobes are fairly broad and the papillae on the inside of the corolla lack an apical bristle. Gilbert (1978) also recorded that flowers of this subspecies emit a stronger and more unpleasant odor than those of the others, and that they are pollinated by blowflies of the genus *Lucilia*.

During anthesis the ringlike outer corona becomes covered with nectar. This forms a ringlike pool that spreads onto the surface of the corolla around the gynostegium and makes the gynostegium appear rather larger than it is.

7c. Orbea sprengeri subsp. **ogadensis** (M. G. Gilbert) Bruyns, Aloe 37: 76. 2001. *Caralluma sprengeri* subsp. *ogadensis* M. G. Gilbert, Cact. Succ. J. Gr. Brit. 40: 43. 1978. *Pachycymbium sprengeri* subsp. *ogadensis* (M. G. Gilbert) M. G. Gilbert, Bradleya 8: 23. 1990. *Angolluma ogadensis* (M. G. Gilbert) Plowes, Excelsa 16: 115. 1994.—TYPE: ETHIOPIA. Harerghie region, 6 km SE of Jijiga towards Degehabur, 1800 m, *de Wilde & Gilbert 6481* (holotype: WAG; isotype: ETH).

Stems with rhizomes up to 20 cm long. Corolla dark grey-brown to red-brown with a narrow pale ring around corona, deeply rugulose or covered with obtuse papillae, these without apical bristles; lobes 5.5–11.0 mm long, 4.5–5.5 mm wide at base, not reflexed, ovate to ovate-lanceolate, acuminate. Corona slightly exserted from mouth of corolla-tube, yellow to pink-brown, inner lobes yellowish with pinkish apex. Fig. 18B, G.

Distribution (Fig. 16). Ethiopia, Somalia. 1400–1800 m.

Subspecies *ogadensis* is recorded from the eastern part of Ethiopia, mainly in the Ogaden region, and adjacent Somalia.

ADDITIONAL SPECIMENS EXAMINED. **Ethiopia.** [N 0942] 7 km SE of Jijiga on road to Ogaden [-BD], 09°20′N, 42°50′E, *de Wilde sub Gilbert 1852* (K). [N 0843] 124 km SSE of Jijiga towards Degehabur [-DC], 08°45′N, 43°30′E, *Gilbert s.n.* (K). **Somalia.** [N 0944] Gaan Libah [-DB], 09°35′N, 44°48′E, *Bally 11698* (K).

Orbea sprengeri subsp. *ogadensis* shares relatively small flowers with subsp. *foetida*, but in subsp. *ogadensis* the papillae on the inside of the corolla are always fused into irregular ridges, and the distinct papillae are not apparent. As in subsp. *foetida*, there are no apical bristles on the papillae.

The flowers are sometimes much smaller than the dimensions given by Gilbert (1978). In Bally's collection from Somalia the lobes are only just over 5 mm long, and the whole flower measures only 16 mm across.

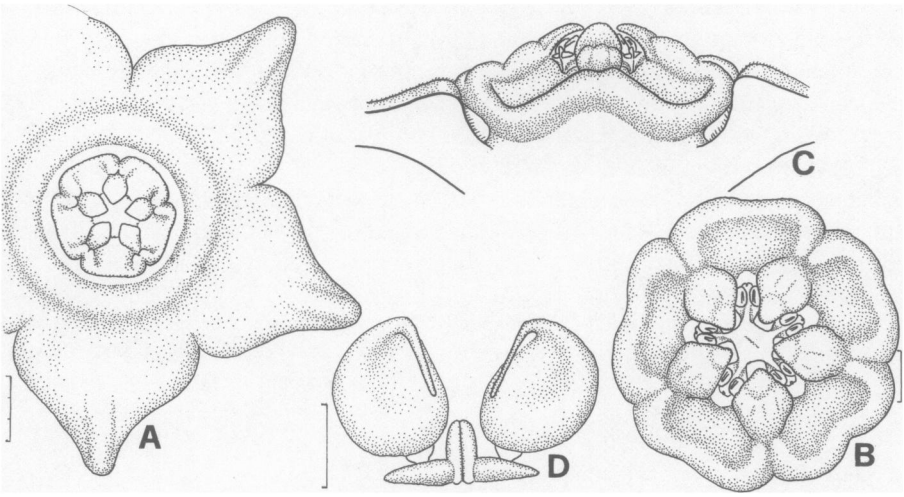

FIG. 19. *Orbea sprengeri* subsp. *commutata.* A. Face view of flower. B. Face view of gynostegium. C. Side view of center of dissected flower. D. Pollinarium. Scale bars: A, 3 mm; B, C, 1 mm (at B); D, 0.25 mm. [Based on: A, B, *Collenette 2818*; C, D, *Collenette 6764*.]

7d. Orbea sprengeri subsp. **commutata** (A. Berger) Bruyns, comb. nov. *Orbea commutata* (A. Berger) Bruyns, Aloe 37: 74. 2001. *Caralluma commutata* A. Berger, Stapel. u. Klein.: 105. 1910. *Pachycymbium commutatum* (A. Berger) M. G. Gilbert, Bradleya 8: 23. 1990. *Angolluma commutata* (A. Berger) Plowes, Excelsa 16: 115. 1994.—TYPE: YEMEN. Menakha, *Schweinfurth s.n.* (holotype: B, destroyed).—LECTOTYPE, designated by Gilbert, 1990: Fig. 23 in A. Berger, Stapelieen und Kleinien, 1910.

Angolluma commutata subsp. *sheilae* Plowes, Excelsa 16: 116. 1994.—TYPE: SAUDI ARABIA. Wadi Hali near Abha, *Lavranos & Collenette sub Plowes 7495* (holotype: K!; isotype: SRGH).

Stems not rhizomatous. Corolla brown to red-brown, finely papillate; lobes 7–10 mm long, 6–8 mm wide at base, convex above and the margins recurved, ovate-deltate, acute. Corona equalling corolla tube or slightly included within it, dark red-brown. Fig. 19.

Distribution (Fig. 16). Saudi Arabia; 400–700 m.

Subspecies *commutata* is only known in Saudi Arabia from the southwestern region near Abha, where it occurs on gentle, rocky slopes among scattered *Acacia* trees and other shrubs.

ADDITIONAL SPECIMENS EXAMINED. **Saudi Arabia.** [N 1743] Jebel Fayfa [-AA], *Collenette 3292* (ZSS). [N 1842] 14 km N of Muhayl [-CA], 18°37′N, 42°03′E, *Collenette 2618* (E), 28 Jul 1991, *Collenette 7870* (K); 12 km N of Muhayl [-CA], *Collenette 2222* (ZSS); Wadi al Us [-A], *Collenette 3739* (E), *4472* (E); 30 km SE of Muhayl [-A], *Collenette 2976* (ZSS). Grandi Lavori road, *Collenette 2818* (E, K). [N 1941] Jebel Shada [CB], 19°42′N, 41°22′E, 10 Oct 1988, N of Mikhua, *Collenette 6764* (K).

Orbea sprengeri subsp. *commutata* differs from the other subspecies of *O. sprengeri* in the manner in which the corona is included in the tube or, at most, is flush with the

surface of the corolla (and only rarely slightly exserted). In the other three subspecies the corona is always somewhat exserted from the tube.

Schweinfurth's illustration of *Caralluma commutata*, which was reproduced in Berger (1910: t. 23), shows quite deep pouches formed by the outer corona lobes and unusually long caudicles attaching the pollinia to the corpuscle. Nevertheless, the resemblance of these flowers to ones illustrated in Collenette (1985: 54) suggests that they belong to the same taxon. Some variation in the depth of the corolla tube can be found. Sometimes the corona is flush with the surface of the rest of the flower, while at other times it may even be slightly exserted. Specimens have been examined also where it is sunken below the mouth of the tube and well separated, too, from the sides of the tube. The corolla tube may also be circular to distinctly pentagonal in outline. Most flowers have a somewhat thickened annulus around the corona, and this is sometimes slightly paler than the rest of the corolla.

The outer corona is also variable. Adjacent lobes may be indented behind the anthers so that altogether they form a distinctly pentagonal structure, as in Schweinfurth's illustration. Many other specimens have been seen where they are fused into a complete ring around the gynostegium with no trace of this indentation, or they may even be longer behind the anthers than between them. The margin of the outer corona may be broad and rounded or thinner and finely notched. In the latter case it is very similar to that shown in the illustration that Berger published for *Caralluma sprengeri* (Berger 1910: t. 22).

All these various forms seem to grow together in Saudi Arabia and appear to represent a single taxon. The presence of only a single (fairly minor) feature separating *Orbea commutata* from *O. sprengeri* suggests that separation at specific level is not justified. Gilbert (1990) was the first to suggest that it is possible that only one species is involved. This study has confirmed his view, and consequently "*O. commutata*" is relegated to subspecific rank.

8. Orbea lugardii (N. E. Brown) Bruyns, Aloe 37: 75. 2001. *Caralluma lugardii* N. E. Brown, Fl. Trop. Afr. 4(1): 487. 1903. *Pachycymbium lugardii* (N. E. Brown) M. G. Gilbert, Bradleya 8: 28. 1990. *Angolluma lugardii* (N. E. Brown) Plowes, Excelsa 16: 120. 1994.—TYPE: BOTSWANA. Totin (Toteng), near Lake Ngami, *Lugard 74* (holotype: K!).

Caralluma longicuspis N. E. Brown, Fl. cap. 4(1): 884. 1909.—TYPE: NAMIBIA. *sub Pillans 14* (holotype: BOL!).

Small succulent usually consisting of several clumps 6–50 cm in diameter connected by ± horizontal rhizomes. Stems 4–15 cm long, 0.6–1.2 cm in diameter (excluding teeth), erect often with subterranean base (to 10 cm long or more and 0.4–0.8 cm in diameter), pale green to silvery grey flecked with purple-brown mainly down grooves between angles; tubercles 3–5 mm long, arranged and partly joined into 4 obtuse angles along stem with a groove between angles, tapering to a conical spreading acuminate tooth, somewhat flattened above and slightly laterally expanded at the base, without denticles. Inflorescences 2–6 per stem, usually in distal half or near apex, each of 1–3 (–7) extremely smelly flowers developing in gradual succession (sometimes all opening simultaneously) from a short peduncular swelling; pedicel 3–6 mm long, 1.0–1.5 mm in diameter, ascending and usually holding flower facing upwards, with a few broadly ovate acute bracts 1–2 mm long at base. Sepals 3–5 mm long, 1.0–1.5 mm wide at base, lanceolate, acuminate. Corolla 3–4.5 cm in diameter, campanulate to rotate, very deeply

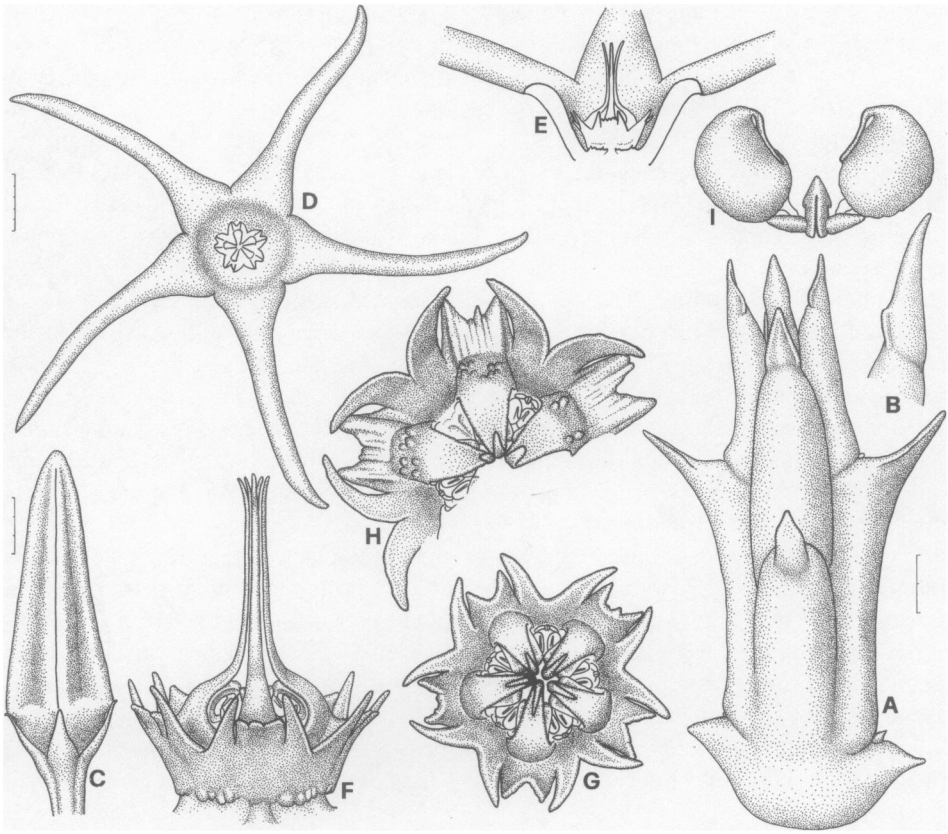

FIG. 20. *Orbea lugardii.* A. Portion of stem. B. Leaf rudiment with stipular ridge. C. Bud. D. Face view of flower. E. Side view of center of dissected flower. F. Side view of gynostegium. G, H. Face views of gynostegium, drawn to the same scale. I. Pollinarium. Scale bars: A, 2 mm; B, F, G, H, 1 mm (at A); C, E, 3 mm (at C); D, 5 mm; I, 0.25 mm (at A). [Based on: A, C–G, I, *Bruyns 2328*, Tsumeb, Namibia; B, H, *Bruyns 3282*.]

and narrowly lobed; outside smooth and pale green; inside not rugulose but finely papillate all over and very variably colored, usually with the lobes paler than the center (yellow-green, yellow, red, brown with red or brown center); tube 3–6 mm long, 5–8 mm in diameter, bowl-shaped, corolla only very slightly thickened towards mouth, containing gynostegium except for tips of inner corona lobes; lobes 18–25 mm long, 3–4 mm wide at base, shortly deltate towards base then slenderly attenuate, acuminate, spreading, with minute rigid cilia along recurved margins. Corona ± 6 mm tall, 4.5–6.0 mm in diameter, raised above base of tube on short stout pentagonal stipe (<0.5 mm long), glabrous; outer lobes 1.0–2.0 mm long, ascending, deeply bifid into narrow elongate-deltate acute diverging lobules, red to purple-brown; inner lobes 4–5 mm long, adpressed to backs of anthers then connivent-erect and sometimes diverging at apices, dorsiventrally flattened, linear from the narrowly ovate base, reddish around base to yellow distally, with a few small ridges on rear above a longer square emarginate spreading gibbosity, laterally fused with and in series with outer lobes. Figs. 1C, 20.

Distribution (Fig. 21). Botswana, Namibia, South Africa; 600–1750 m.

Orbea lugardii is of almost universal occurrence in Namibia, except in the winter-

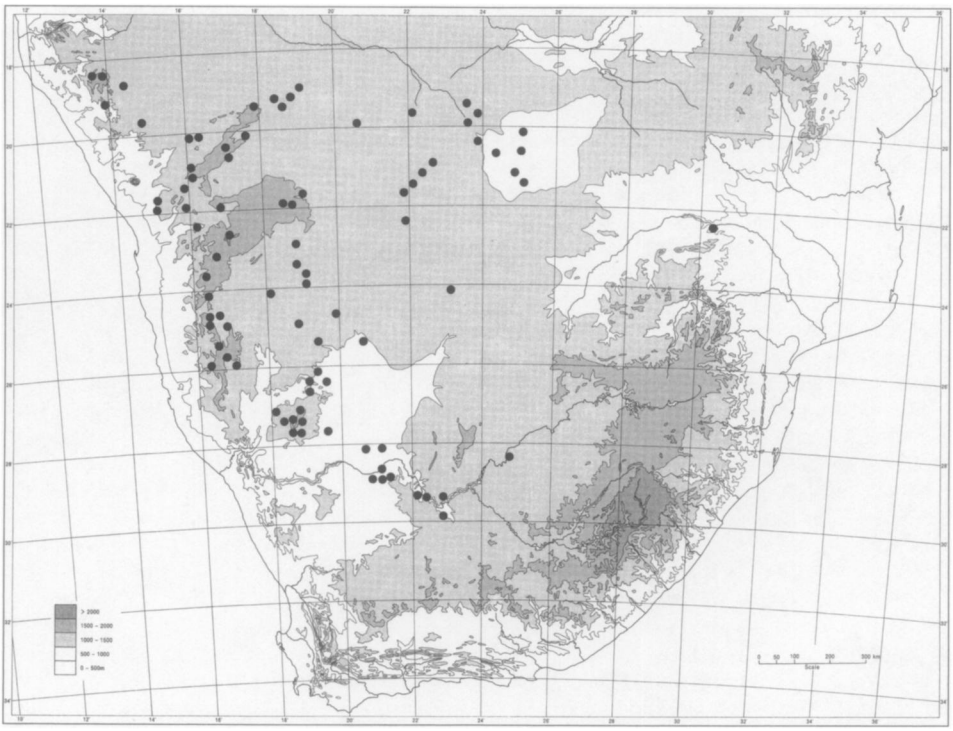

FIG. 21. Distribution of *Orbea lugardii*.

rainfall area south of Helmeringhausen, the arid Namib Desert along the coast, in the sands of the relatively moist Ovamboland, and in the Caprivi. In Botswana it is mainly found in the west (probably more widely towards the south than the existing records show) and in the central parts of the Okavango Delta. In South Africa it is found in two areas: in the northern Cape from Upington and Kimberley northwards into the Kalahari and in the extreme northern Transvaal north of the Soutpansberg (from where there is only a single record, and it may be more widespread in this area). White and Sloane (1937: 387) also mention its probable occurrence in Zimbabwe, but this has not been confirmed by any records. It remains a possibility that it might occur in southern Angola.

In general, *O. lugardii* is a species of dry, but not desertic, areas and grows under small bushes, such as *Rhigozum trichotomum* Burch., *Monechma cleomoides* (S. Moore) C. B. Clarke, or *Blepharis*, or among scattered trees, which are often species of *Acacia* or *Colophospermum mopane*. Specimens are usually scattered and often not easy to see, but, in overgrazed conditions, they can become large (up to 50 cm in diameter) and may be very common indeed. *Orbea lugardii* has a particular predilection for calcrete and often grows where this substrate is covered with a thin layer of sand.

ADDITIONAL SPECIMENS EXAMINED. **Botswana.** [1922] 17 km W of Nokaneng [-CA], *Bruyns 6474* (BOL). [1923] 20 km N of Makwee [-BC], *Bruyns 6506* (BOL); 19 km N of Shorobe [-DB], *Bruyns 6513* (BOL);

33 km N of Maun [-DC], *Bruyns 6505* (BOL). [2022] 39 km N of Kuke [-DC], *Bruyns 6473* (BOL). [2023] Boseja distr., Maun [-AB], *Smith 1858* (SRGH); 8 km E of Makalamabedi [-BD], *Bruyns 6516* (BOL). [2024] 20 km N of Seokwane [-CB], *Bruyns 6518* (BOL). [2025] 3 km S of Gweta [-AA], *Bruyns 6984* (BOL); 39 km S of Gweta [-CA], *Bruyns 6985* (BOL). [2121] 19 km NE of Ghanzi [-DB], *Bruyns 6456* (BOL). [2122] Kuke [-AB], *Bruyns 6469* (BOL); 31 km NE of D'Kar [-AC], *Bruyns 6464* (BOL). [2124] Mopipi [-BB], *Bruyns 6522* (BOL). [2125] 24 km NW of Orapa [-AC], *Bruyns 6523* (BOL). [2221] 81 km SE of Ghanzi [-BD], *Bruyns 6454* (BOL). [2423] 53 km E of Kang [-AA], *Bruyns 6447* (BOL). **Namibia.** [1813] Kaoko Otavi [-BC], *Bruyns 5571* (WIND); 51 km N of Otjomatemba [-BD], *Bruyns 5560* (WIND); near Kaoko Otavi [-BD], *Bruyns 5567* (WIND). [1814] 8 km towards Opuwa [-CB], *Bruyns 5613* (PRE). [1819] Saamtrek [-CC], *Bruyns 5523* (WIND). [1913] N of Anebib [-BB], *Bruyns 5545* (WIND). [1914] Beulah [-DB], *Bruyns 4058* (BOL). [1917] Nosib [-BD], *Bruyns 2328* (NBG). [1918] Veldduin [-AB], *Bruyns 5513* (K); Moedhou [-BB], *Bruyns 5514* (BOL); Osmoor [-BC], *Bruyns 4139a* (BOL). [1920] Gautscha Pan [-DC], *Bruyns 4129* (BOL). [2016] Outjo Townlands [-AA], *Bruyns 2354* (BOL); Arubes-Ost [-AB], *Giess 8630* (WIND). [2017] base of Omuverume Plateau [-AC], *Rutherford 197* (WIND); Waterberg [-BA], *Bruyns 5530* (WIND); Okosongomingo [-CA], *Bruyns 5537* (WIND). [2115] Kakombo [-BD], *Hardy 6310* (PRE); Omaruru [-BD], *STE 7025* (BOL); 33 km Usakos to Uis [-CA], *Bruyns 3593* (WIND); Black Range [-CC], *Ward 10903* (WIND); Karibib [-DD], *Dinter 6783* (BOL). [2116] Otjua [-AA], *Bruyns 2350* (BOL); Okahandja [-DD], *Bradfield 306 A* (PRE). [2118] Sturmveld [-DB], *Toelken s.n.* (NBG); Waldhoeh [-DB], *Bruyns 5482* (WIND); Wilhelmsruhe [-DC], *Bruyns 1950* (WIND). [2216] Nomatsaus [-AC], *Bruyns 3634* (BOL). [2217] Goreangab Dam, Windhoek [-CA], *Giess 9051* (WIND). [2218] Kirschberg [-DD], *Bruyns 5468* (WIND). [2316] Naos turnoff [-BA], *Bruyns 5627* (PRE); Nauchas [-CB], *Bruyns 5636* (WIND). [2318] Eersbegin [-BD], *Bruyns 5464* (WIND). [2319] Hoogwater [-CA], *Bruyns 5467* (WIND); Bwana [-CD], *Bruyns 5461* (BOL). [2416] Buellsport [-AB], *Bruyns 5654* (PRE); Hoheacht [-CB], *Bruyns 4158* (PRE); Swartmodder [-CD], *Bruyns 4166* (BOL); 6 km W of Maltahoehe [-DD], *Bruyns 4163* (BOL); Burgsdorf [-DD], *Bruyns 5664* (WIND); Maltahoehe [-DD], *Bruyns 5661* (WIND). [2418] 42 km N of Stampriet [-AA], *Bruyns 3582* (WIND); Gochas [-DD], *Bruyns 3578* (BOL). [2419] Meerpoort [-DB], *Bruyns 5457* (WIND). [2516] Rooiberg Suid [-BC], *Bruyns 5676* (WIND); Congella [-DB], *Bruyns 4950* (PRE). [2517] Alsuma [-CC], *Bruyns 4182* (BOL). [2519] Tweeriviere [-AD], *Bruyns 5452* (WIND). [2619] 22 miles E of Koes [-AB], *Leistner 1796* (KMG, PRE); Springboktrek Suid [-AC], *Bruyns 3572* (WIND); Gaibis [-BC], *Bruyns 5447* (WIND); Aroab road [-CA], *Bruyns 3568* (BOL). [2718] Rooiwal [-AD], *Bruyns 5749* (WIND); Pietierskloof [-BB], *Bruyns 3545* (WIND); Witmond [-BC], *Bruyns 5764* (WIND); Narudas Nord [-BD], *Bruyns 3524* (BOL); S of Noachebeb [-DA], *Bruyns 5778* (WIND); Groenrivier [-DB], *Hall sub NBG 476/55* (NBG); Vredenhof [-DB], *Bruyns 3504* (WIND). [2719] Nimmerust [-DA], *Bruyns 5439* (WIND); Retreat [-DA], *Bruyns 5431* (WIND). **South Africa.** CAPE PROVINCE: [2520] near Kwang Pan [-BC], *Leistner 1837* (KMG, PRE). [2820] Koegoekoep [-BA], *Bruyns 3483* (BOL); 7.5 miles S of Neilersdrift [-DD], *Acocks 18828* (PRE). [2821] Ghams [-AA], *Bruyns 3477* (BOL); Louisvale [-CA], *Mennell s.n.* (BOL); 20 km S of Keimoes [-CC], *Bruyns 3466* (BOL); Rateldraai [-CD], *Mennell s.n.* (BOL). [2824] Riverton [-BD], comm. *Tapscott s.n.* (BOL). [2922] Marydale [-AC], *Hall sub NBG 253/53* (NBG); Koegasbrug [-AD], *Hall s.n.* (NBG); Kloof [-BD], *Bruyns 3282* (BOL); Groot Rondekop [-DD], *Bruyns 3649* (BOL).—TRANSVAAL: [2230] 8 miles SE of Messina [-AC], *Mes s.n.* (PRE).

Orbea lugardii, *O. rogersii*, *O. schweinfurthii*, and *O. ubomboensis* are the only species in southern Africa in which the flowers are borne near the apex of the stem. The flowers of *O. lugardii* are much larger than those of either *O. schweinfurthii* or *O. ubomboensis*, and these species can never be confused with it. *Orbea lugardii* lacks the characteristic hairs inside the corolla found in *O. rogersii*. Also, the outer and inner corona lobes of *O. lugardii* are much more fused and much shorter (and considerably differently shaped). Moreover, the leaf-rudiments and tubercles in *O. lugardii* are shorter than those of *O. rogersii*, which is not at all rhizomatous. Most plants of *O. lugardii* are small and extremely rhizomatous, and they may consist of several clumps of stems (sometimes only single stems) connected under the surface by slender runners.

In *O. lugardii* the deeply bifid outer corona lobes are pressed laterally against the sides of the broad dorsal appendages of the inner lobes, so that altogether there is an almost continuous, cupular structure containing the center of the gynostegium. The inner lobes are adpressed to the anthers and then rise up in a long, slender column in the center.

9. Orbea gemugofana (M. G. Gilbert) Bruyns, Aloe 37: 74. 2001. *Caralluma gemugofana* M. G. Gilbert, Cact. Succ. J. Gr. Brit. 40: 43. 1978. *Pachycymbium gemugofanum* (M. G. Gilbert) M. G. Gilbert, Bradleya 8: 23. 1990. *Angolluma gemugofana* (M. G. Gilbert) Plowes, Excelsa 16: 118. 1994.—TYPE: ETHIOPIA. Gemu Gofa region, east of Arba Minch [N 0537 DC], 05°59′N, 37°39′E, *Gilbert & Gilbert 1731* (holotype: K!; isotypes: EA, ETH).

Small succulent forming diffuse mats, not rhizomatous. Stems 4–10 cm long, 0.5–0.8 cm in diameter (excluding teeth), decumbent, grey-green flecked with purple-brown; tubercles 8–15 (–22) mm long, arranged into 4 rows along stem (joined near bases), ascending, conical, attenuated to a very fine tip, mostly without stipular denticles. Inflorescences 1–8 per stem near apex, each with 1–3 flowers opening in gradual succession ± without a peduncle, with a few bracts <1 mm long; pedicel 2–5 mm long, 1.5 mm in diameter, ascending and holding flower facing partly upwards. Sepals 3–5 mm long, 1.0–1.5 mm wide at base, lanceolate, acute. Corolla 2–3.5 cm in diameter, nearly rotate to shallowly campanulate; outside pale green; inside yellow, olive-green to brown, smooth and quite devoid of bristles or fine papillae; tube 1.0–3.5 mm long, 7–8 mm wide, shallowly bowl-shaped, not thickened around mouth; lobes 6–10 mm long, 3.5–5.0 mm wide at base, spreading to reflexed, ovate-deltate, convex above, the margins slightly reflexed, eciliate. Corona 3 mm tall, 4–6 mm in diameter, dull pink to glistening dark red or brown, without basal stipe; outer lobes forming a continuous ring around gynostegium about 1 mm wide, with highest ridge behind anthers and lowest spots opposite guide-rails, somewhat pouch-like beneath guide-rails with ± enclosed nectarial cavity; inner lobes 1.0–1.5 mm long, adpressed to backs of anthers, narrowly deltate, dorsiventrally flattened, obtuse, rarely exceeding anthers to meet in center. Fig. 22.

Distribution (Fig. 16). Ethiopia, Kenya, Uganda; 900–1400 m.

Orbea gemugofana is found quite widely in the Gemo Gofa region and the western part of the Sidamo region of southern Ethiopia (Gilbert 1978). In Kenya a few collections have been made in the northern part of the territory, mainly to the west of Lake Turkana, whereas in Uganda the species remains known only from the collection of Eggeling.

Plants of *O. gemugofana* are often associated with *Acacia*-scrub in flat to gently sloping, loamy to stony areas. Gilbert (1978) observed it in several places with *Huernia recondita* M. G. Gilbert. My own observations found it often in barren, overgrazed spots associated with many other stapeliads, such as *Caralluma arachnoidea* (P. R. O. Bally) M. G. Gilbert, *C. priogonium* K. Schum., *C. speciosa* (N. E. Br.) N. E. Br., *C. turneri* E. A. Bruce, *Echidnopsis sharpei* A. C. White & B. Sloane, *Edithcolea grandis* N. E. Br., and *H. recondita*.

ADDITIONAL SPECIMENS EXAMINED. **Ethiopia.** [0536] N of Hammer Koke [-BC], *Bruyns 8509* (BOL). [N 0637] Arba Minch [-BA], *Bruyns 8500* (E). **Kenya.** [N 0338] Mt Furole [-CA], 03°42′N, 38°03′E, *Hartmann & Newton 21398* (K). [N 0435] Labur [-BD], *Lavranos* (ZSS). 5 miles from Moniget, *Ritchie sub Bally S 39* (K). **Uganda.** Bukomero, *Eggeling 940 sub Bally* S 21 (K).

Orbea gemugofana is similar to *O. sprengeri* in that it also has nearly flat flowers; however, in contrast to *O. abayensis*, *O. laticorona*, and *O. sprengeri*, the corolla is not entirely flat, and there is a shallowly bowl-shaped tube from which the tips of the corona lobes usually project. The corolla is not thickened at all around the mouth of the tubelet (as is always the case in *O. abayensis*, *O. laticorona*, and *O. sprengeri*), but a slight

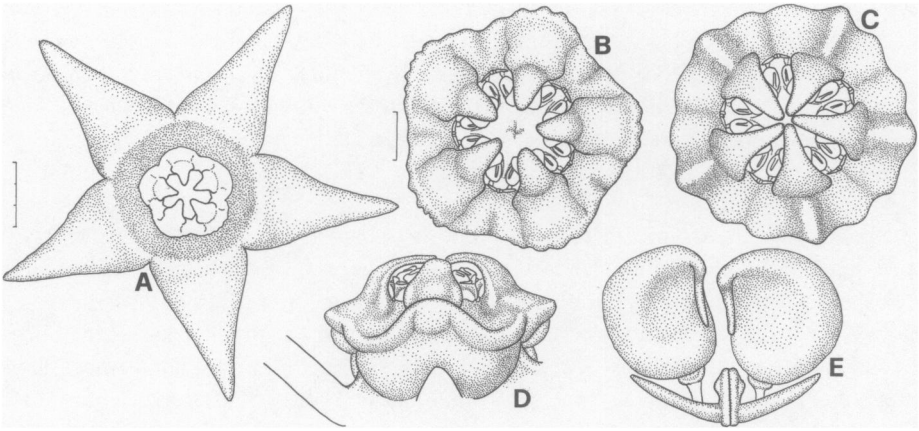

FIG. 22. *Orbea gemugofana.* A. Face view of flower. B, C. Face views of gynostegium. D. Side view of gynostegium. E. Pollinarium. Scale bars: A, 3 mm; B–D, 1 mm (at B); E, 0.25 mm (at A). [Based on: A, B, Labur, Kenya, *Lavranos*; C, Ethiopia, *Gilbert* (K); D, E, *Hartmann & Newton 21398.*]

thickening has been noticed in several specimens towards the base of the tube close to the gynostegium. The surface of the corolla is entirely without the fine papillae found in *O. abayensis*, *O. laticorona*, and *O. sprengeri*.

Among the species of *Orbea* occurring in Ethiopia, *O. gemugofana* can often be distinguished immediately by the pale flowers. They are apparently odorless but are pollinated by a "bluebottle" fly belonging to the genus *Calliphora* (Gilbert 1978).

In *O. gemugofana* the outer corona appears to form a platform below the guide-rails. Dissection of this structure reveals that this platform is created by a flap rising up almost to touch the base of the rails and that hidden behind it is a considerable cavity. This is similar (despite the otherwise notably different coronas) to the arrangement in *O. huernioides*, but the cavity is more hidden than in what appear to be similar species, such as *O. abayensis*, *O. laticorona*, and *O. sprengeri*, though these are not closely allied to *O. gemugofana*.

This species was known as early as 1940 from Kenya; these collections had been tentatively assigned to *Caralluma commutata* by P. R. O. Bally before Gilbert (1978) recognized them as representing a distinct species.

10. Orbea huernioides (P. R. O. Bally) Bruyns, Aloe 37: 74. 2001. *Caralluma huernioides* P. R. O. Bally, Candollea 20: 15. 1965. *Pachycymbium huernioides* (P. R. O. Bally) M. G. Gilbert, Bradleya 8: 22. 1990. *Angolluma huernioides* (P. R. O. Bally) Plowes, Excelsa 16: 106. 1994.—TYPE: SOMALIA. Southern foothills of Al Madu Range [N 1048 DC], 10°45′N, 48°44′E, N of Domo, 17 Oct 1956, *Bally 11166* (holotype: G!; isotypes: K! ZSS!).

Small succulent forming clumps to 30 cm in diameter, not rhizomatous. Stems 6–12 cm long, 1–1.5 cm in diameter (excluding teeth), decumbent, grey-green flecked with maroon; tubercles 5–10 mm long, arranged very roughly into 4 obtuse rows along stem with a slight groove between them, spreading to ascending, conical, acuminate (to a very fine point), without stipular denticles. Inflorescences 1–4 per stem mainly towards apex, each of 1–7 flowers developing in gradual succession ± without a peduncle, with a few

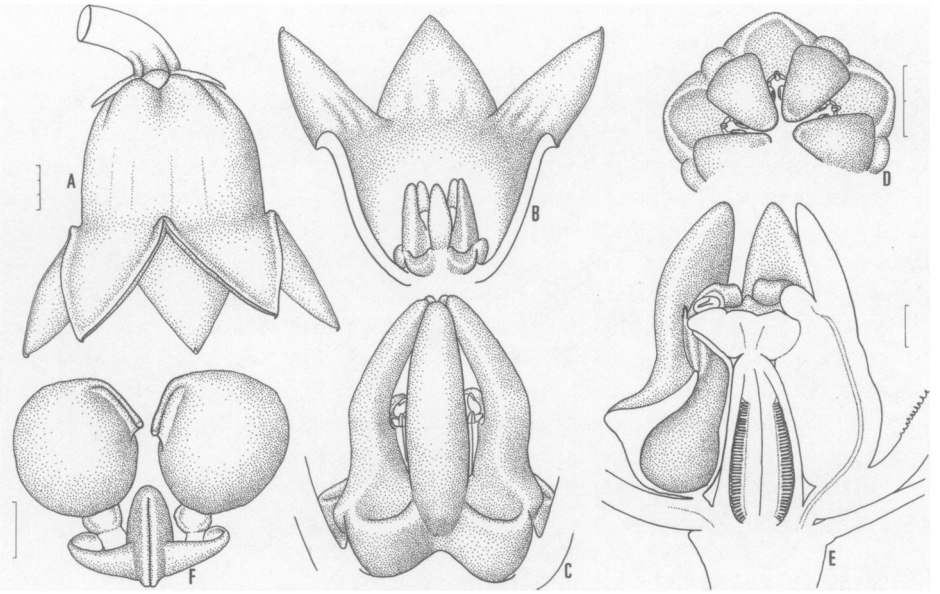

FIG. 23. *Orbea huernioides.* A. Flower in natural attitude. B. Dissected flower. C. Side view of gynostegium. D. Face view of gynostegium. E. Flower in vertical section. F. Pollinarium. Scale bars: A, B, 3 mm (at A); C, D, 2 mm (at D); E, 1 mm; F, 0.25 mm. [Based on: *Lavranos s.n.*, Galgalo, Somalia.]

subulate bracts 1.5–2.5 mm long; pedicel 15–18 mm long, 2.5 mm in diameter, spreading then descending, holding flower facing downwards, pale green sometimes with longitudinal maroon stripes. Sepals 3–5 mm long, 1.5 mm wide at base, ovate-lanceolate, acuminate. Corolla 1.8–2.2 cm long, 2.2–2.5 cm wide, campanulate; outside pale green with few darker longitudinal flecks; inside yellow to pale red, with many reddish brown papillae up to 0.5 mm long; tube 10–12 mm long, 12 mm in diameter, cupular; lobes 7–9 mm long, 7–8 mm wide at base, spreading, ovate-deltate, convex above, the margins reflexed, ciliate. Corona 5.5–8.0 mm tall, 7 mm in diameter, without basal stipe; outer lobes ± 2 mm long, somewhat pouch-like between anthers, dark purple-red, with a flap of tissue rising towards base of guide-rail and closing off nectarial cavity ± completely; inner lobes 3–4 mm long, 1.3–2.0 mm wide, ascending from anthers (not adpressed to their backs) and usually connivent in center, dorsiventrally flattened, broadly lanceolate, obtuse, pale pinkish. Fig. 23.

Distribution (Fig. 36). Somalia; 1200–1500 m.

Orbea huernioides is known only from the foothills of the Al Mado Range of northern Somalia, where it grows on eroded, rocky slopes with only a scanty cover of bushes.

ADDITIONAL SPECIMEN EXAMINED. **Somalia.** [N 1049] Ridge above Galgalo [-CC], *Lavranos & Bavazzano 8524* (E).

Orbea huernioides was so named because of the resemblance of the nodding habit and shape of the flowers to those of *Huernia keniensis* R. E. Fries. Bally (1965) thought

it related to *Caralluma sacculata* and *C. tubiformis*, but a closer examination shows that this may not necessarily be correct.

The nodding habit of the flowers is unusual, since in all the other tubular-flowered species (except sometimes in *O. denboefii*) the flowers are held erect. The coronal structure is also peculiar. The outer corona appears to consist of pouches between the anthers; however, although it has a slight lip (which gives this pouch-like impression), the area inside this apparent pouch is filled in entirely by a flap of tissue that rises towards the guide-rail. This flap encloses a considerable cavity. Such cavities with a flap of tissue closing them, partially or completely, are typical of the flat-flowered species, like *O. sprengeri* and *O. gemugofana*. This structure is otherwise not found in the deeply tubular-flowered species, where there is generally no flap at all, and the pouch-like outer corona lobes are open to their bases. The inner corona lobes are also unusual in that they ascend away from the anthers and are notably broader than in most species.

In *O. huernioides* the pollinia are unusual in being almost spherical. The guide-rails are comparatively long and bend slightly in towards the axis of the flower towards their bases. In the other tubular-flowered species the guide-rails are exceptionally short with a widely flared mouth.

11. Orbea wissmannii (O. Schwartz) Bruyns, Aloe 37: 76. 2001. *Caralluma wissmannii* O. Schwartz, Mitt. Inst. Allg. Bot. Hamburg 10: 195. 1939. *Pachycymbium wissmannii* (O. Schwartz) G. Gilbert, Bradleya 8: 24. 1990. *Angolluma wissmannii* (O. Schwartz) Plowes, Excelsa 16: 118. 1994.—TYPE: YEMEN. Pass between Jebel Shibam and Jebel Dhulwa, 2400–2800 m, 27 Jul 1931, *Wissmann 1207* (holotype: HAM!).

Small succulent forming diffuse mats, sometimes rhizomatous. Stems 5–8 cm long, 0.8–1.2 cm in diameter (excluding teeth), decumbent, grey-green flecked with dark green to purple-brown; tubercles 4–6 mm long, arranged into 4 rows along stem (joined towards bases), conical and somewhat laterally flattened, acuminate, very rarely with small stipular denticles. Inflorescences 1–5 per stem near apex, each of 1–5 flowers developing in gradual succession on a peduncle at most 5 mm long, with several fine acuminate bracts up to 1.5 mm long; pedicel 5–10 mm long, 1.5–2.0 mm in diameter, ascending to erect. Sepals 3–4 mm long, 1 mm wide at base, lanceolate, acute. Corolla (1.2–) 2.5–4 cm in diameter, rotate, lobed nearly to center; outside pale green mottled with purple-brown; inside yellow to suffused with pale red becoming paler towards apex of lobes, densely covered with fine papillae (up to 1 mm long); tube absent; lobes 9–20 mm long, 2–4 mm wide at base, spreading when fully open (often ascending), narrowly lanceolate, strongly convex, the eciliate margins usually recurved and touching each other mainly near apex, acuminate. Corona 1.5–4.0 mm tall, 2–4 mm in diameter, without basal stipe, bright yellow or sometimes red on outside; outer lobes forming pouch 1.5–2.0 mm deep beneath guide-rail with a very small opening beneath rail, apex of lobes truncate to obtuse and spreading above pouch, giving rise to a truncate to emarginate spreading spur up to 0.5 mm long below inner lobes; inner lobes 1–2 mm long, adpressed to backs of anthers, rarely exceeding them to meet in center, dorsiventrally flattened, rectangular to narrowly deltate, acute to truncate and emarginate. Figs. 24, 25, 27.

Distribution (Fig. 26). Oman, Saudi Arabia, Yemen; 1000–3000 m.

Orbea wissmannii is quite remarkably variable; no two flowers have identical coronas, and an almost bewildering range of structures is evident. The collections of

A. Butler and F. Noltee, which are illustrated here, particularly serve to demonstrate this variability.

D. V. Field, in identifying specimens for Collenette (1985), brought the name *Caralluma wissmannii* back into use for this species, which he recognized as separate from *C. eremastrum*. In fact, the type specimens for these names are poor, and it would be difficult to separate the two taxa on the basis of these specimens alone were it not for the fact that Schwartz mentioned that in *C. eremastrum* the corolla lobes are flat and not rolled back along their whole length. Apart from the manner in which the margins of the corolla lobes are not folded back tightly but only slightly, another difference is found in the outer corona lobes, which lack the flap projecting towards the guide-rail and closing off the nectarial cavity. There is usually also an abrupt change in color on the corolla lobes, with the lower part brownish and the upper greenish yellow. More recently collected material from Yemen has shown that plants cannot with certainty be assigned to either "*C. wissmannii*" or "*C. eremastrum*." Consequently the latter is recognized here merely as a variety of *Orbea wissmannii*.

KEY TO THE VARIETIES OF ORBEA WISSMANNII

1. Corolla lobes <10 mm long, gynostegium <2 mm tall. 11b. *O. wissmannii* var. *parviloba*.
1. Corolla lobes >12 mm long, gynostegium >3 mm tall.
   2. Margins of corolla lobes strongly recurved to touch each other behind lobe. 11a. *O. wissmannii* var. *wissmannii*.
   2. Margins of corolla lobes only slightly folded back and the lobes lightly convex adaxially. 11c. *O. wissmannii* var. *eremastrum*.

11a. Orbea wissmannii var. **wissmannii.**

Caralluma meintjesiana Lavranos, J. S. African Bot. 28: 209. 1962. *Pachycymbium meintjesianum* (Lavranos) M. G. Gilbert, Bradleya 8: 24. 1990.—TYPE: YEMEN. Audhali Plateau, near Mukeiras [N 1345 DC], *Meintjes sub Lavranos 1657* (holotype: K!).

Corolla lobes 15–20 mm long, 2–4 mm wide at base, erect to widely spreading, linear, the margins strongly recurved and touching each other behind lobe, usually yellow and suffused with red in proximal half. Corona 3–4 mm tall, 3–4 mm in diameter, bright yellow; outer lobes forming a pouch, usually with lobe spreading somewhat at mouth, pouch closed by a flap below guide-rails. Fig. 24.

Distribution (Fig. 26). Saudi Arabia, Yemen; 1500–3000 m.

ADDITIONAL SPECIMENS EXAMINED. **Saudi Arabia.** [N 1842] 12 km northwest of Abha [-AD], *Collenette 5441* (E). [N 1942] Tanumah [-AA], *Collenette 3628* (ZSS). [N 2041] Al Bahah [-AB], *Collenette s.n.* (ZSS). **Yemen.** [N 1344] 30 km from Ta'izz towards Rahidah [-AC], *Butler s.n.* (K); Jiblah [-CC], 13°55′N, 44°09′E, 10 Apr 1981, *Miller & Long 3526* (E). [N 1543] Menakha [-BA], *Noltee 485* (K); Kawkaban [-BD], *M.-Hohenstein & Deil 516* (E); E of Kuhlan towards Amran [-D], *Miller & Long 3217* (E); Kuhlan [-DA], *Miller & Long 3227* (E); Hajjah [-DA], *Noltee 397A* (K). Without locality, *Wood 2587* (K).

Lavranos placed his *Caralluma meintjesiana* with *C. chrysostephana*, *C. eremastrum*, and *C. luntii*, but later (Lavranos 1964) included it in "*C. baldratii*" on the advice of P. R. O. Bally and W. Rauh, but without comment. The position with respect to *O. baldratii* remains unclear. I have not seen material of *O. baldratii* from either Eritrea or Sudan, but the plant from this area depicted in Plowes (1994) suggests that Bally and Rauh are

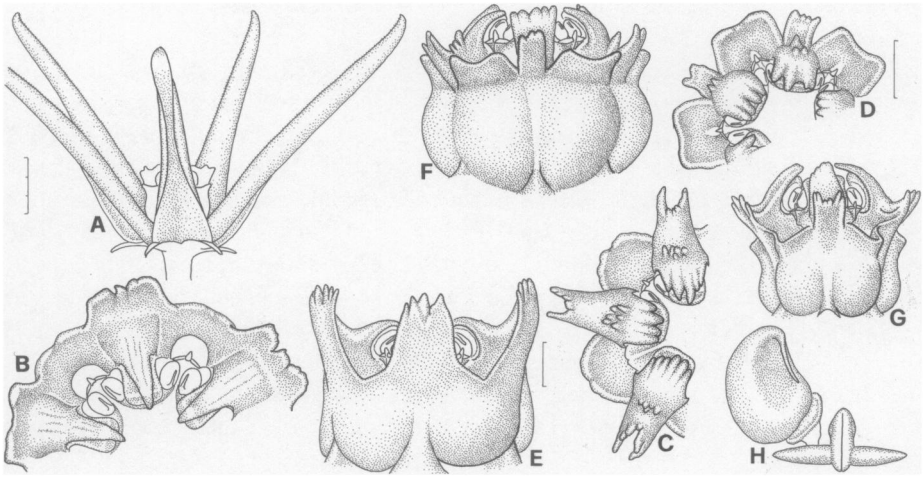

FIG. 24. *Orbea wissmannii* var. *wissmannii.* A. Side view of flower. B–D. Face views of about half of gynostegium. E–G. Side views of gynostegium. H. Part of pollinarium. Scale bars: A, 3 mm; B–D, F, 1 mm (at D); E, G, 1 mm (at E); H, 0.25 mm (at D). [Based on: A, *Noltee 394,* Haddah, Yemen (no voucher); B, E, H, *Butler s.n.*, Wadi Dhar, Yemen (no voucher); C, *Noltee 397A*; D, F, *Miller & Long 3526*; G, *Butler s.n.*, 30 km from Ta'izz towards Rahidah, Yemen.]

perhaps correct that *O. wissmannii* var. *wissmannii* may be merely a variant of *O. baldratii*. The position is left unresolved until material from Africa can be examined.

Orbea wissmannii var. *wissmannii* is found in the highlands of Saudi Arabia and Yemen, usually among rocks on relatively bare mountain slopes.

11b. Orbea wissmannii var. **parviloba** Bruyns, Aloe 37: 76. 2001.—TYPE: YEMEN. Jebel Raymah [N 1443 DB], 14°37′N, 43°45′E, 21 Mar 1984, *Miller & King 5336* (holotype: E!).

Corolla pale greenish yellow; lobes 9–10 mm long, ± 1.5 mm wide at base, linear, the margins strongly recurved and touching each other behind lobe, usually yellow and suffused with red in proximal half. Corona 1.5–2.0 mm tall, 2.5 mm in diameter, bright yellow; outer lobes forming a pouch, usually with lobe spreading somewhat at mouth, pouch closed by a flap below guide-rails. Fig. 25.

Distribution (Fig. 26). Oman, Yemen; 100–2000 m.

ADDITIONAL SPECIMENS EXAMINED. **Yemen.** Without locality, *Wood 1913* (K). **Oman.** [N 1754] Dhofar, Wadi Hinna [-BA], 17°02′N, 54°35′E, 15 Apr 1986, *McLeish 666* (E).

Orbea wissmannii var. *parviloba* differs from var. *wissmannii* only in its much smaller corolla, corona, and pollinaria. The shape of the corolla lobes, which generally seem to remain erect to slightly spreading, and the structure of the corona are like that of var. *wissmannii*; the gynostegium exhibits variation in its profile similar to that seen in var. *wissmannii*.

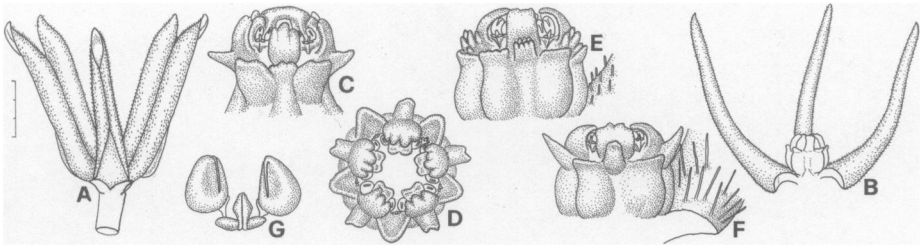

FIG. 25. *Orbea wissmannii* var. *parviloba.* A. Side view of flower. B. Side view of flower with two corolla-lobes removed. C, E, F. Side views of gynostegium. D. Face view of gynostegium. G. Pollinarium. Scale bars: A, B, 3 mm (at A); C–F, 1 mm (at A); G, 0.25 mm (at A). [Based on: A, C, G, *Wood 1913*; B, E, *McLeish 666*; D, F, *Miller & King 5336.*]

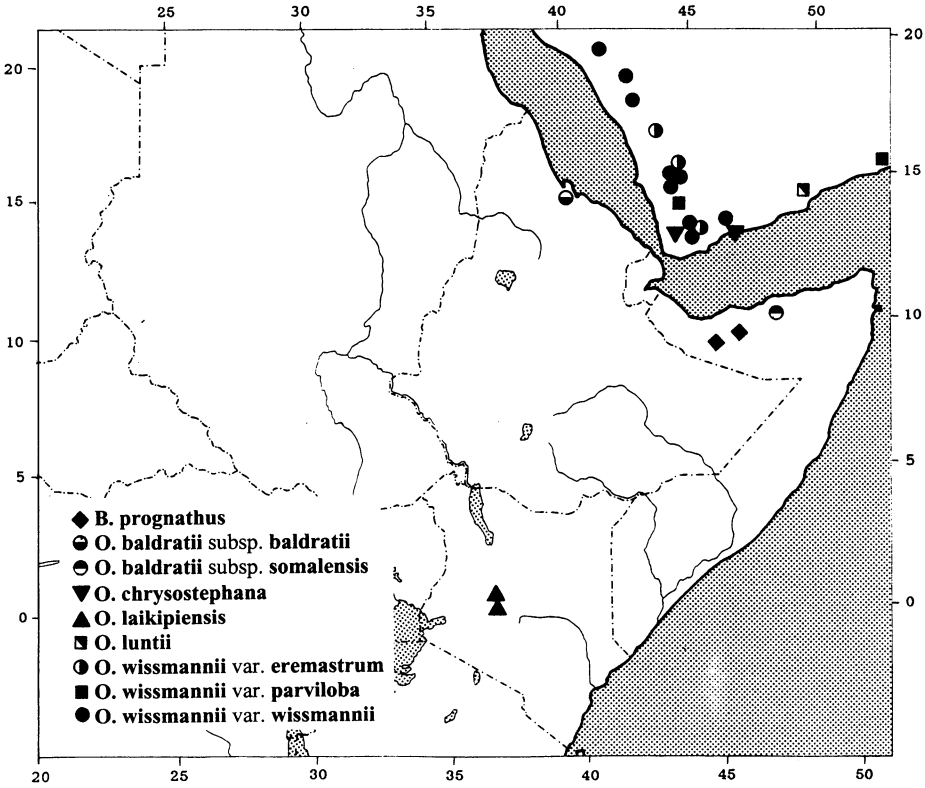

FIG. 26. Distribution of *Ballyanthus prognathus*, *O. baldratii*, *O. chrysostephana*, *O. laikipiensis*, *O. luntii*, and *O. wissmannii*.

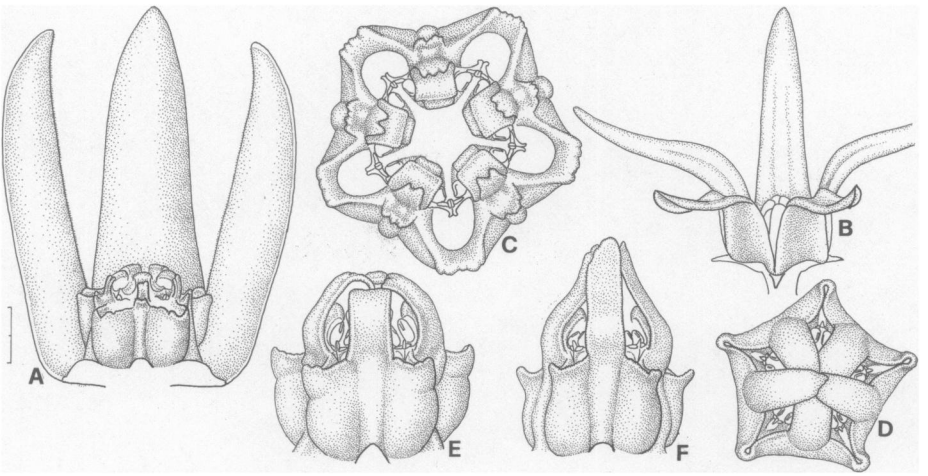

FIG. 27. *Orbea wissmannii* var. *eremastrum.* A. Side view of flower with two corolla lobes removed. B. Side view of flower. C, D. Face views of gynostegium. E, F. Side views of gynostegium. Scale bars: A, B, 2 mm (at A); C–F, 1 mm (at A). [Based on: A, C, cultivated material of unknown origin; B, D, E, *Noltee 104*, halfway between Sumarah Pass and Ibb, Yemen (no voucher); F, *Noltee 116*.]

11c. Orbea wissmannii var. **eremastrum** (O. Schwartz) Bruyns, Aloe 37: 76. 2001. *Caralluma eremastrum* O. Schwartz, Mitt. Inst. Allg. Bot. Hamburg 10: 194. 1939. *Pachycymbium eremastrum* (O. Schwartz) M. G. Gilbert, Bradleya 8: 24. 1990. *Angolluma eremastrum* (O. Schwartz) Plowes, Excelsa 16: 118. 1994.—TYPE: YEMEN. Hajjah, *Rathjens 103* (holotype: HAM!).

Corolla lobes 12–15 mm long, ± 3–4 mm wide at base, mostly erect, linear, the margins only slightly recurved and thus the lobes lightly convex adaxially, usually brown to flesh-colored at least in proximal half, greenish yellow towards tips, broadly acute. Corona 3–4 mm tall, 3–4 mm in diameter, bright yellow; outer lobes forming pouch, usually without lobe spreading at mouth, pouch open widely below guide-rails. Fig. 27.

Distribution (Fig. 26). Saudi Arabia, Yemen; 1000–1600 m.

ADDITIONAL SPECIMENS EXAMINED. **Saudi Arabia.** [N 1743] Jebel Fayfa [-AA], *Collenette 3518* (ZSS). **Yemen.** [N 1344] foot of Sumarah Pass, above Dalil [-C], *Lavranos & Newton 13140* (E). Near Al Makhadir, half-way between Sumarah Pass & Ibb, *Noltee 116* (K).

In *O. wissmannii* var. *eremastrum* the corolla lobes are somewhat broader than in var. *wissmannii*, and the margins are not so far recurved that they touch behind the lobes. The lobes are also usually rather smoother than in var. *wissmannii*. Also, the pouch formed by the inner corona lobe is often not closed off by an extra flap of tissue (Fig. 24B, C, D shows how variable this is in var. *wissmannii*), though the mouth of the pouch may be so constricted that this is not visible (as in Fig. 27D).

Orbea wissmannii var. *eremastrum* is found on steep slopes among short bushes.

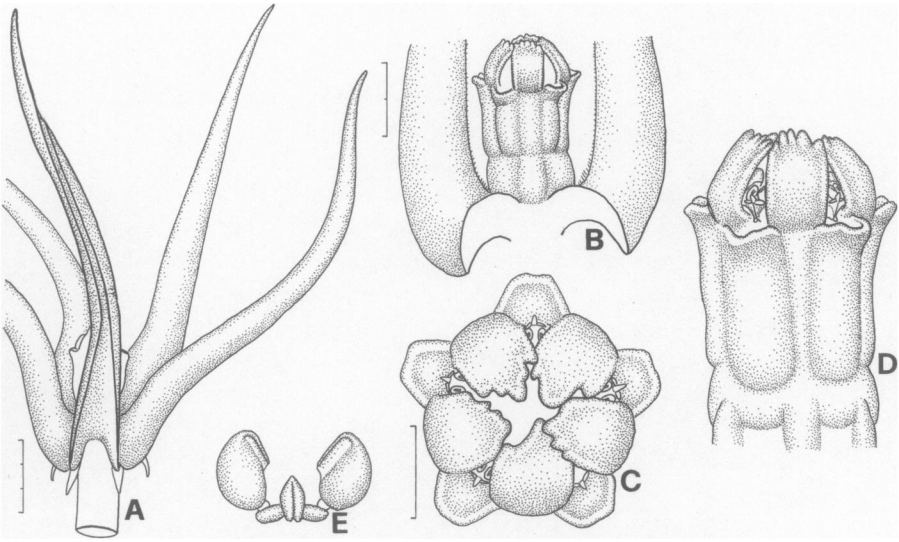

FIG. 28. *Orbea luntii.* A. Side view of flower. B. Side view of center of dissected flower. C. Face view of gynostegium. D. Side view of gynostegium. E. Pollinarium. Scale bars: A, 3 mm; B, 2 mm; C, 1 mm; D, 1 mm (at B); E, 0.25 mm (at B). [Based on *Lavranos 1933.*]

12. Orbea luntii (N. E. Brown) Bruyns, Aloe 37: 75. 2001. *Caralluma luntii* N. E. Brown, Bull. Misc. Inform. 1894: 335. 1894. *Pachycymbium luntii* (N. E. Brown) M. G. Gilbert, Bradleya 8: 24. 1990. *Angolluma luntii* (N. E. Brown) Plowes, Excelsa 16: 118. 1994.—TYPE: YEMEN. South Yemen, Hadramawt, hills near Dobaibah, 4000 ft, Feb 1894, *Lunt 209* (holotype: K!).

Small succulent forming diffuse clumps to 15 cm in diameter, not rhizomatous. Stems 5–15 cm long, 0.6–1.2 cm in diameter (excluding teeth), decumbent, grey-green flecked with dark green to purple-brown; tubercles 4–10 mm long, spreading, arranged into 4 rows along stem and only joined towards the base, conical, acuminate, without stipular denticles. Inflorescences 1–5 per stem near apex, each of 1–5 flowers developing in gradual succession on a peduncle at most 5 mm long, with several fine acuminate bracts up to 1.5 mm long; pedicel 8–20 mm long, 1.0–1.5 mm in diameter, ascending to erect. Sepals 2.0–4.0 mm long, 0.5–1.0 mm wide at base, lanceolate, acute. Corolla 12–18 mm long, ± 15–20 mm wide, lobed nearly to center; outside pale green becoming darker towards apex of lobes; inside cream changing abruptly to red or purple in upper half of lobes and along margins, densely covered with fine papillae not more than 0.5 mm long; tube absent; lobes 12–18 mm long, 1.0–2.0 mm wide at base, ascending to connivent (apparently never spreading fully), very narrowly lanceolate, strongly convex above, the eciliate margins usually recurved and touching each other, acuminate. Corona ± 4.0–4.5 mm tall, 3 mm in diameter, without basal stipe, yellow to red or purple; outer lobes forming a narrow pouch ± 2 mm deep beneath guide-rail and ± completely closed beneath rail, apex of lobes truncate and spreading slightly above pouch, without a spur behind inner lobes; inner lobes ± 1.5 mm long, adpressed to backs of anthers and just exceeding them to meet in center, dorsiventrally flattened, rectangular, emarginate. Fig. 28.

Distribution (Fig. 26). Yemen; 1200–2000 m.

Orbea luntii is known only from the mountainous region known as the Hadramawt to the northeast of Aden in the former South Yemen.

ADDITIONAL SPECIMEN EXAMINED. **Yemen.** [N 1448] Mawla Matr [-DC], Hadramawt, *Lavranos 1933* (K).

The distinctive features of this species are the extremely narrow corolla lobes, which always remain ascending, and the relatively tall, almost cylindrical gynostegium, which is noticeably taller than broad and may be an unusual, dark red color. The abrupt change in color on the corolla lobes is not known in *O. wissmannii*. Plants with similarly tall gynostegia but without the extremely narrow corolla lobes have been gathered much further to the north in Yemen (compare Fig. 27F); it seems possible that *O. luntii* and *O. wissmannii* are forms of a single species, of which *O. luntii* is merely a more extreme variant.

13. Orbea chrysostephana (Deflers) Bruyns, Aloe 37: 74. 2001. *Stapelia chrysostephana* Deflers, Bull. Soc. Bot. France 43: 117. 1896. *Caralluma chrysostephana* (Deflers) A. Berger, Stapel. u. Klein. 115. 1910. *Pachycymbium chrysostephanum* (Deflers) M. G. Gilbert, Bradleya 8: 24. 1990. *Angolluma chrysostephana* (Deflers) Plowes, Excelsa 16: 118. 1994.—TYPE: YEMEN. Steep southern slopes of Jebel al Arays [N 1345 BD], 500–600 m, Apr 1893, *Deflers 1071* (holotype: P).

Small mat-forming succulent, not rhizomatous. Stems 6–10 cm long, ± 1 cm in diameter (excluding teeth), decumbent, grey-green flecked with dark green to purple; tubercles 8–10 mm long, arranged into 4 obtuse rows along stem with a slight groove between them, ascending to spreading, conical, tapering to a slender tip, without stipular denticles. Inflorescences 1–4 per stem near apex, each of 1–3 flowers developing in gradual succession, peduncle absent, with a few lanceolate bracts up to 2 mm long; pedicel 15–20 mm long, 1.5 mm in diameter, ascending to erect, holding flower facing upwards. Sepals 2–3 mm long, 1.5 mm wide at base, lanceolate, acute. Corolla 2–3 cm in diameter, rotate to campanulate, lobed nearly to center; outside grey-green finely streaked with red; inside purple-brown covered with fine acute bristles, each arising from a small papilla in distal half, in proximal half these interspersed with slightly clavate transparent white bristles up to 2 mm long; tube 1.5–2.5 mm deep; lobes 12–15 mm long, 5–7 mm wide at base, ascending to spreading, ovate-lanceolate, narrow and convex, the eciliate margins reflexed (touching behind lobes). Corona 5–6 mm tall, 6–7 mm in diameter, without basal stipe; outer lobes forming deep pouches 3–4 mm tall between anthers with the margins rounded and slightly spreading, golden-yellow; inner lobes 1–2 mm long, adpressed to backs of anthers for short distance then erect and sometimes recurved, linear, dorsiventrally flattened, obtuse to emarginate, red dorsally towards base, yellow above. Fig. 29.

Distribution (Fig. 26). Yemen; 300–600 m.

Orbea chrysostephana was originally collected in the Jebel al Arays east of Aden in the former South Yemen, but plants with similar flowers have also been collected in the former North Yemen. Plants are found on rocky, arid slopes at much lower altitudes than *O. wissmannii*. Deflers collected the type in the Jebel al Arays from where *Stultitia araysiana* was also described; the two seem to grow fairly close together (Lavranos & Bilaidi 1971).

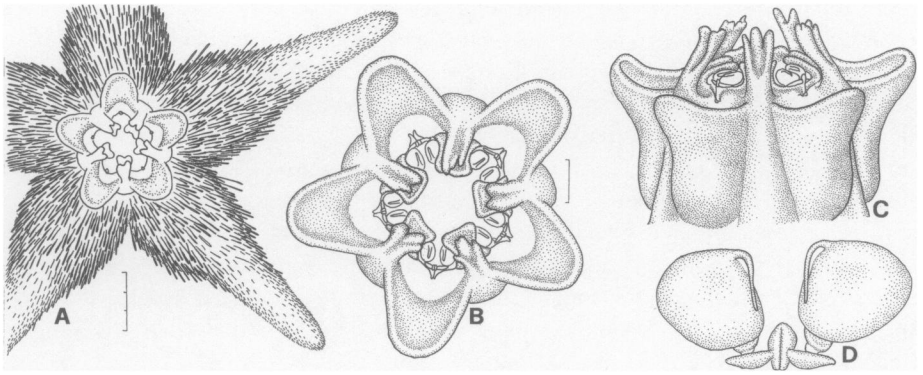

FIG. 29. *Orbea chrysostephana.* A. Face view of flower. B. Face view of gynostegium. C. Side view of gynostegium. D. Pollinarium. Scale bars: A, 3 mm; B, C, 1 mm (at B); D, 0.25 mm (at A). [Based on *Miller & Long 3487*.]

ADDITIONAL SPECIMEN EXAMINED. **Yemen.** [N 1343] Jebel Ras [-DC], 15 km NE of Hays, *Miller & Long 3487* (E).

The flower of *C. chrysostephana* is similar to that of *C. wissmannii* in that it is deeply lobed and the lobes are narrow at anthesis; however, they are considerably broader and more ovate towards the base than in *O. wissmannii*. The coronas are also similar, with the outer lobes forming tall, deep pouches beneath the guide-rails, which, as Deflers (1896) clearly showed, are partially closed beneath the guide-rails by an inward-projecting flap of tissue. The inside of the corolla is covered towards the center with bristles longer than are known in *C. wissmannii*. It is possible that this is a case of variation similar to that known in the complex including *O. tubiformis* and *O. sacculata*.

14. Orbea baldratii (A. C. White & B. Sloane) Bruyns, Aloe 37: 73. 2001. *Caralluma baldratii* A. C. White & B. Sloane, Stapelieae, ed. 2, 1: 268. 1937. *Pachycymbium baldratii* (A. C. White & B. Sloane) M. G. Gilbert, Bradleya 8: 24. 1990. *Angolluma baldratii* (A. C. White & B. Sloane) Plowes, Excelsa 16: 119. 1994.—TYPE: ERITREA. Near Asmara, Adi K'eyah (Addi Che), *Baldrati sub White & Sloane 208* (holotype: not located).—LECTOTYPE, designated by Gilbert, 1990: Figs. 200 and 201 in White and Sloane, Stapelieae, ed. 2, 1937.

Small succulent forming clusters of stems connected by underground rhizomes. Stems 2–10 cm long, 0.5–1.5 cm in diameter (excluding teeth), decumbent to erect above ground, pale green with purple-brown mottling; tubercles 5–17 mm long, arranged into 4 obtuse rows along stems, spreading, narrowly deltoid, slender and attenuating to a fine tip, without stipular denticles. Inflorescences 1–8 per stem mostly in distal half, each with 1–3 flowers opening in gradual succession, peduncle absent, with a few bracts <1 mm long; pedicel 1–2 mm long, 1 mm in diameter, ascending to spreading, holding flower facing horizontally to slightly downwards. Sepals 2–5 mm long, 1.0–1.5 mm wide at base, ovate-lanceolate, acuminate. Corolla 2.3–3 cm in diameter, rotate, lobed nearly to center; outside pale green suffused with brown; inside pale to dark red-brown to yellow suffused with red-brown, upper half of lobes often darker than rest, densely covered with fine

papillae (up to 1 mm long); tube ± 1 mm long, 3–4 mm wide, very shallowly bowl-shaped to ± absent; lobes 10–14 mm long, 2–4 mm wide at base, ascending or spreading to slightly reflexed, narrowly lanceolate, strongly convex above, the eciliate margins usually recurved and touching each other behind lobe, acuminate. Corona 3–4 mm tall, 3.5–4.5 mm wide, without basal stipe, dark purple-black to reddish becoming paler towards base; outer lobes forming a pouch 1.5–2.0 mm deep beneath guide-rail with a very small opening beneath rail; apex of lobes truncate to obtuse and spreading above pouch, giving rise to a truncate to emarginate spreading spur up to 0.5 mm long below inner lobes; inner lobes 1–2 mm long, adpressed to backs of anthers, rarely exceeding them to meet in center, dorsiventrally flattened, rectangular, truncate to variably toothed or emarginate, sometimes with few spreading dorsal teeth. Fig. 30.

Distribution (Fig. 26). Eritrea, Somalia, Sudan; 900–2000 m.

Gilbert (1978) discussed *O. baldratii* (as "*Caralluma baldratii*") in some detail. He found that material from around the type locality south of Asmara was very markedly rhizomatous, and that the inner corona lobes had small dorsal projections above the dorsal "horn" and generally had a coronal structure matching that of *Caralluma subterranea*. Since forms with smaller flowers were found in southern Ethiopia and these more closely resembled plants from Kenya, which were known as *Caralluma subterranea*, he subsumed *C. subterranea* under *C. baldratii* (Gilbert 1978). In a later account (Gilbert 1990), he placed these taxa in *Pachycymbium* and reduced "*C. subterranea*" to a subspecies of "*P. baldratii*"; in support he stated that the differences are "quantitative only" and are "combined with an apparent discontinuity in distribution." Plowes (1994) suggested that the material from around Asmara was different from that in the south of Ethiopia, and that specimens from the south belonged to "*C. subterranea*," as it is found in Kenya and Tanzania, rather than to "*C. baldratii*." A comparison of the photograph of *O. baldratii* in Plowes (1994) with that of southern Ethiopian material in Gilbert (1990) bears this out. Plowes's photograph also suggests that *O. baldratii* may belong to the same species as the material from Arabia, which here is assigned to *O. wissmannii*. This needs to be investigated further. For the present, *O. baldratii*, *O. subterranea*, and *O. wissmannii* are maintained as separate species, although it is possible that *O. baldratii* and *O. wissmannii* may prove to be conspecific, despite their relative positions on the cladogram (Fig. 6). The last two differ in that that the corona lobes are yellow in *O. wissmannii* and the stems hardly rhizomatous at all, whereas in *O. baldratii* the corona lobes are dark purple to red and the stems strongly rhizomatous.

The illustrations in White and Sloane (1937, Figs. 200, 201), now constituting the lectotype of *O. baldratii*, seem to have caused considerable confusion. Bally and Rauh believed that material from Arabia belonged to *O. baldratii* and, as a consequence, persuaded Lavranos that his *Caralluma meintjesiana*, which an "excess of enthusiasm" had caused him to describe as a new species (Lavranos 1964), was a synonym of *C. baldratii*. Lavranos's name is here placed in the synonymy of *O. wissmannii* var. *wissmannii* (no. 11a). Bruce and Bally (1947) believed material from Kenya to belong to *O. baldratii* as well, whereas this is now recognized to represent a distinct species, *O. laikipiensis* (no. 15).

Key to the Subspecies of Orbea baldratii

Corolla inside somewhat spotted around gynostegium, lobes with the margins slightly spreading towards base, inner corona lobes usually apically toothed. 14a. *O. baldratii* subsp. *baldratii*.

Corolla inside without spots around gynostegium, lobes tightly folded back right to base, inner corona lobes entire to finely emarginate. 14b. *O. baldratii* subsp. *somalensis*.

14a. Orbea baldratii subsp. **baldratii.**

Corolla inside red-brown on distal half of lobes, becoming brownish to cream with small red spots in lower half and around gynostegium; lobes spreading to slightly reflexed, margins slightly spreading towards base of lobe. Outer lobes of corona blackish purple to red, the part between anthers slightly shorter than the part behind anthers; inner lobes red, apically usually toothed, sometimes with spreading dorsal teeth.

Distribution (Fig. 26). Eritrea, Sudan; 900–2000 m.

Very little is known of the range of subsp. *baldratii*, except for its occurrence around Asmara in Eritrea and near Erkowit in the adjacent part of Sudan (Plowes 1994).

The flowers in *O. baldratii* subsp. *baldratii* usually seem to be reddish with a paler center and a reddish corona. There are generally various small dorsal teeth on the rear of the inner corona lobes, which are themselves toothed towards their apices.

14b. Orbea baldratii subsp. **somalensis** Bruyns, Aloe 37: 73. 2001.—TYPE: SOMALIA. Al Mado, near Erigavo [N 1047 CB], Jan 1973, *Lavranos sub Bally 16017* (holotype: ZSS, alcohol collection 11-407!).

Corolla inside dark red-brown, becoming paler towards center; lobes ascending, tightly folded back right to base. Outer lobes of corona yellow between anthers and much shorter than the purple-black part behind anthers; inner lobes purple-black, almost square, truncate and finely emarginate, without dorsal processes. Fig. 30.

Distribution (Fig. 26). Somalia; ± 1700 m.

The type collection is from a flat area to the south of the higher parts of the Al Mado, with soils derived from gypsum.

ADDITIONAL SPECIMEN EXAMINED. **Somalia.** Without locality, *Lavranos s.n.* (ZSS).

In *O. baldratii* subsp. *somalensis* the corolla lobes usually remain in an ascending position, pointing in the same direction as the flower, and they are tightly folded back along

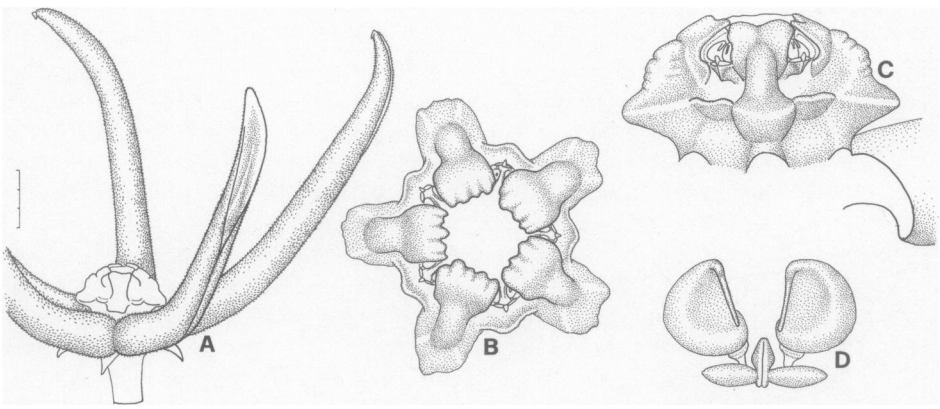

FIG. 30. *Orbea baldratii* subsp. *somalensis.* A. Side view of flower. B. Face view of gynostegium. C. Side view of gynostegium. D. Pollinarium. Scale bars: A, 3 mm; B, C, 1 mm (at A); D, 0.25 mm (at A). [Based on: *Lavranos s.n.*, Somalia.]

their whole length right to the base. Here the outer corona lobes have a much smaller portion between the anthers than behind them, and the little lobe between the anthers is usually yellow. The inner corona lobes are without any dorsal projections and are more or less square in outline. In the few cultivated specimens seen the tubercles on the stems were much shorter than those in subsp. *baldratii*, but the plants had the rhizomatous habit typical of subsp. *baldratii*.

15. Orbea laikipiensis (M. G. Gilbert) Bruyns, Aloe 37: 75. 2001. *Pachycymbium laikipiense* M. G. Gilbert, Bradleya 8: 24. 1990. *Angolluma laikipiensis* (M. G. Gilbert) Plowes, Excelsa 16: 119. 1994.—TYPE: KENYA. Kerio Valley, *Bally 12376* (holotype: K!).

Small succulent forming clumps, rhizomatous. Stems 5–8 cm long, 0.8–1.2 cm in diameter (excluding teeth), decumbent, grey-green flecked with dark green to purple-brown; tubercles 4–6 mm long, arranged into 4 rows along stem (joined towards base), conical and somewhat laterally flattened, acuminate, rarely with small stipular denticles. Inflorescences 1–5 per stem near apex, each of 1–5 flowers developing in gradual succession on a peduncle at most 5 mm long, with several fine acuminate bracts up to 1.5 mm long; pedicel 3–5 mm long, 1.5–2.0 mm in diameter, ascending to erect. Sepals 3–4 mm long, 1 mm wide at base, lanceolate, acute. Corolla 1.8–2.5 cm in diameter, rotate, lobed nearly to center; outside pale green mottled with purple-brown; inside smooth, brownish red to yellow or cream, usually yellowish towards center; tube absent; lobes 10–12 mm long, 2.5–3.5 mm wide at base, spreading when fully open (often ascending), narrowly lanceolate, strongly convex above, the eciliate margins recurved and touching each other behind lobe, acuminate. Corona ± 3 mm tall, 4.0–4.5 mm in diameter, without basal stipe, bright yellow; outer lobes forming pouch 1.5–2.0 mm deep beneath guide-rail with a very small opening beneath rail, apex of lobes truncate to obtuse and spreading above pouch (but not spreading on outside towards base), notched in middle to entire, giving rise to a single deltate to obscurely toothed dorsal ridge behind each inner lobe; inner lobes adpressed to backs of anthers and sometimes exceeding them, deltate, acute to truncate or emarginate. Fig. 31.

Distribution (Fig. 26). Kenya; 600–1900 m.

Orbea laikipiensis is found on the Laikipia Plateau to the north of Rumuruti and in some of the valleys spreading northwards from this area towards Lake Turkana. Plants grow in volcanic soils among tufts of grass and scattered *Acacia* trees.

ADDITIONAL SPECIMENS EXAMINED. **Kenya.** [N 0036] Kifuku Ranch [-BA], Rumuruti, *Dodds s.n.* (BOL); 20 km S of Sukuta Marmar [-DA], *Gilbert et al. 5430* (EA); Sukuta Naibor, 12 km S of Sukuta Marmor, *Carter 85/2028* (K).

Bruce and Bally (1947) illustrated material from the area around Lake Baringo in Kenya under the name *Caralluma baldratii*, and it was only much later that material from this area was described by Gilbert (1990) as *Pachycymbium laikipiense*. According to Gilbert (1990), the "nearest relative [is] *P. meintjesianum*," here included in *O. wissmannii*. Gilbert considered "*P. meintjesianum*" to differ in the very shallowly concave, spreading outer corona lobes, the longer pedicels, the much duller colored corolla, and the inner corona lobes much shorter than the anthers. Yet, the pedicel in Kenyan material can be up to 5 mm long, which falls into the range known in *O. wissmannii*, and the inner corona

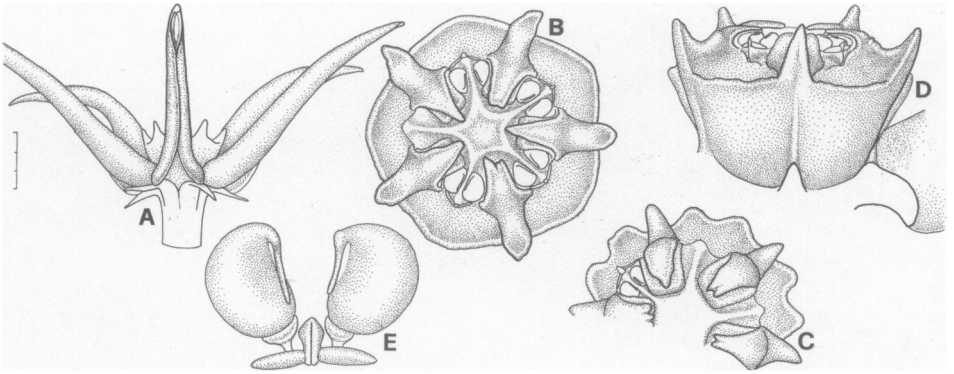

FIG. 31. *Orbea laikipiensis.* A. Side view of flower. B, C. Face views of gynostegium (partially in C). D. Side view of gynostegium. E. Pollinarium. Scale bars: A, 3 mm; B–D, 1 mm (at A); E, 0.25 mm (at A). [Based on: A, B, D, *Dodds s.n.*, Rumuruti, Kenya; C, *Powys s.n.*, Pinguone, Rumuruti, Kenya.]

lobes often exceed the anthers in *O. wissmannii*. Similarly, the outer lobes in *O. laikipiensis* can even be apically bifid, which again simply emphasizes the variability of these structures and their unreliability for providing taxonomic distinctions.

In general, the whole gynostegium in *O. laikipiensis* seems to be far more uniformly cupular around the outside and does not have the spreading pouches around the base opposite the guide-rails that one finds in *O. wissmannii*. A useful distinction lies also in the smooth inside of the corolla in *O. laikipiensis*, which in *O. baldratii* and *O. wissmannii* is always finely papillate.

The corolla in *O. laikipiensis* is variable in color; it is usually brownish red becoming yellow towards the center but it may also be cream.

16. Orbea decaisneana (Lemaire) Bruyns, Aloe 37: 74. 2001. *Boucerosia decaisneana* Lemaire, Herb. gén. amat. 4: t. 21. 1844. *Caralluma decaisneana* (Lemaire) N. E. Brown, Gard. Chron. 12: 369. 1892. *Stapelia decaisneana* (Lemaire) Chevalier, Rev. Int. Bot. Appl. Agric. Trop. [1934]: 262. 1934. *Pachycymbium decaisneanum* (Lemaire) M. G. Gilbert, Bradleya 8: 22. 1990. *Angolluma decaisneana* (Lemaire) L. E. Newton, J. Cact. Succ. Soc. Amer. 65: 198. 1994.—TYPE: SENEGAL. *Perrottet s.n.* (holotype: not located).—LECTOTYPE, designated by Gilbert, 1990: Lemaire's t. 21 in the protologue.

Caralluma hesperidum Maire, Bull. Soc. Hist. Nat. Afrique Nord 13: 17. 1922. *Caralluma commutata* subsp. *hesperidum* (Maire) Maire in Jahandiez & Maire, Cat. pl. Maroc 3: 582. 1934. *Angolluma hesperidum* (Maire) Plowes, Excelsa 16: 107. 1994.—TYPE: MOROCCO. S of Mogador, Jebel Amsitten, *Maire s.n.* (holotype: MPU?).

Caralluma venenosa Maire, Bull. Soc. Hist. Nat. Afrique Nord 22: 305. 1931. *Angolluma venenosa* (Maire) Plowes, Excelsa 16: 108. 1994.—SYNTYPES: ALGERIA. Hoggar Mtns, Mt Ater, Oued Haman, *Maire 805, 807, 808* (MPU?).

Angolluma sudanensis Plowes, Excelsa 16: 109. 1994.—TYPE: SUDAN. Darfur, 15 km N of Nyala, 700 m, May 1987, *Plowes 7496* (holotype: K!; isotype: SRGH).

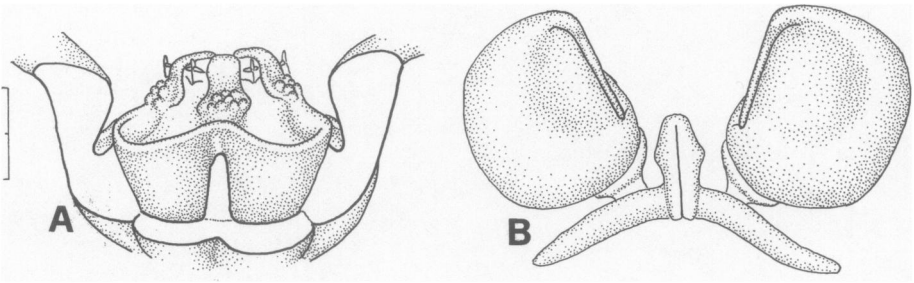

FIG. 32. *Orbea decaisneana* A. Side view of center of dissected flower. B. Pollinarium. Scale bars: A, 2 mm; B, 0.25 mm (at A). [Based on: *Plowes 7496*.]

Small succulent forming diffuse mats to 50 cm in diameter, sometimes rhizomatous. Stems 1–4 cm long, 1.2–1.5 cm in diameter (excluding teeth), decumbent, grey-green flecked with brown to purple; tubercles 10–15 mm long, arranged into 4 obtuse rows along stem with a slight groove between them, spreading to ascending, conical, tapering to a very slender tip, without stipular denticles. Inflorescences 1–3 per stem near apex, each of 1–5 (–10) flowers developing in gradual succession, ± without a peduncle, with small lanceolate bracts to 1 mm long; pedicel 1–5 mm long, 1.5–2.0 (–3) mm in diameter, spreading and sometimes descending. Sepals 3–5 mm long, 1.5 mm wide at base, lanceolate, acute. Corolla 0.8–1.5 cm long, 1.5–2.5 cm in diameter, campanulate; outside cream flecked with brown; inside dark purple sometimes becoming yellow towards base of tube, covered with small papillae, each tipped with a fine whitish bristle; tube 4–6 mm long, 6–8 mm in diameter, cupular, pentagonal, corolla somewhat thickened around mouth; lobes 7–12 mm long, 5.5–7.0 mm wide at base, ascending then spreading, ovate-lanceolate, slightly convex above, the margins reflexed, eciliate. Corona ± 4 mm tall, 5.0–5.5 mm in diameter, purple, without basal stipe; outer lobes ± 2 mm long, pouch-like with rim of pouch entire and lower in center than at sides where rising to join bases of inner lobes; inner lobes ± 1 mm long, adpressed to backs of anthers, rising and then horizontal towards center where sometimes touching at tips, rectangular, dorsiventrally flattened, somewhat rugulose dorsally near base, obtuse to acute. Fig. 32.

Distribution (Fig. 33). Algeria, Burkina, Mali, Morocco, Senegal, Sudan; 5–2000 m.

This species is poorly recorded but appears to occur around the periphery of the Sahara, especially in West Africa, and on various high mountains within the desert itself. Plants have been recorded from dry grasslands near the coast in Senegal and among stones on slopes on granite in the Hoggar Mountains in Algeria. They are also found on limestone outcrops along the Moroccan coast, sometimes in association with the small palm *Chamaerops humilis* L. and the succulent shrub *Euphorbia beaumeriana* Cosson & Hook. f. (Rauh 1972).

ADDITIONAL SPECIMENS EXAMINED. **Burkina.** 12°26′N, 01°25′W, 2 km from Gampela towards Ougadougou, *Lejoly 230/83* (BR). **Mali.** 13°55′N, 04°31′W, Djenne, *Chevalier 1145* (P). **Morocco.** 30°30′N, 09°40′W, Agedir (Beni Uriaguel), *Font Quer 354* (Z, G). **Senegal.** 14°53′N, 17°09′W, Kayar, *J. & A. Raynal 6438* (P). 16°01′N, 16°30′W, St Louis, *Chevalier 3489* (P). 15°50′N, 16°29′W, Gandiol, *Trochain 4540* (P). Lac Resba, *Trochain 5144*, *3260* (P). **Sudan.** [N 1322] 50 km SE of Geneina [-BB], *Plowes 7479* (K).

Orbea decaisneana shares with several other species of *Orbea* in the northern hemisphere (*O. gemugofana*, *O. semitubiflora*, *O. taitica, O. vibratilis*, *O. wilsonii*) the shallow but significant corolla tube. From *O. vibratilis* it is separated by the different habit of the

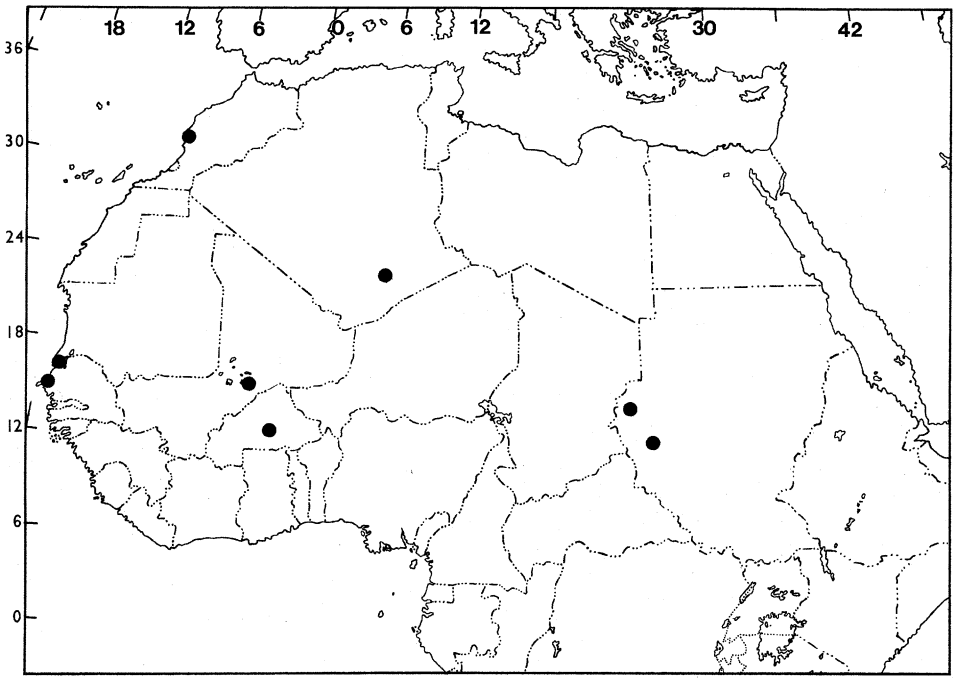

FIG. 33. Distribution of *Orbea decaisneana*.

stems, the lack of marginal cilia on the corolla lobes, and the distinctly different coronal structure; from *O. gemugofana* it is separated by the manner in which the corolla tube is well separated from the gynostegium and by the lack of any enclosed lower part of the outer corona in *O. decaisneana*. It shares with *O. semitubiflora* and *O. taitica* the lack of any basal stipe to the gynostegium and the manner in which the corolla is fused into the gynostegium quite high up between the outer corona lobes. The two species differ mainly in the manner in which the outer corona lobes are deeply cleft: towards their middle in *O. semitubiflora* and *O. taitica,* and with a more or less level rim in *O. decaisneana*. Also, the inner lobes rise up considerably towards the center in *O. decaisneana* but scarcely at all in *O. semitubiflora* and *O. taitica*.

White and Sloane (1937) gave the margins of the corolla as beset with "elongated clavate hairs" in their summary and translation of Maire's original description of "*Caralluma venenosa*"; however, Maire actually stated there that the corolla lobes are free of cilia along the margins.

Although Field (1976) and Gilbert (1978) rejected Bullock's (1963) broad concept of *Caralluma decaisneana* and recommended the resurrection of *C. commutata* and *C. sprengeri*, neither of them saw any reason to resurrect *C. hesperidum* and *C. venenosa*. Plowes (1994) recognized these taxa as species of *Angolluma*, but noted only some ecological differences, and shorter and thicker stems; however, since stem dimensions are, in all probability, linked to the different ecological circumstances under which these variations are expressed, their taxonomic significance is doubtful.

Field (1976) examined some specimens from Sudan and concluded that they belonged to *Caralluma decaisneana.* Plowes (1994) considered that this material ought to

be segregated as a distinct species, *Angolluma sudanensis.* The results of the present investigation agree with Field's conclusions, and these Sudanese collections are here included in *Orbea decaisneana.*

17. Orbea sacculata (N. E. Brown) Bruyns, Aloe 37: 76. 2001. *Caralluma sacculata* N. E. Brown, Bull. Misc. Inform. 1909: 328. 1909. *Pachycymbium sacculatum* (N. E. Brown) M. G. Gilbert, Bradleya 8: 21. 1990. *Angolluma sacculata* (N. E. Brown) Plowes, Excelsa 16: 105. 1994.—TYPE: ETHIOPIA. Shewa region, Mt Fantale, *Drake-Brockman 129* (holotype: K!).

Caralluma kochii Lavranos, J. Cact. Succ. Soc. Amer. 43: 61. 1971. *Pachycymbium kochii* (Lavranos) M. G. Gilbert, Bradleya 8: 21. 1990. *Angolluma kochii* (Lavranos) Plowes, Excelsa 16: 106. 1994.—TYPE: SOMALIA. Eastern end of Al Madu, above Galgalo, *Lavranos 7308* (holotype: FT).

Small succulent forming diffuse clumps, often extensively rhizomatous. Stems 5–8 cm long, 0.8–1.5 cm in diameter (excluding teeth), decumbent, grey-green flecked with darker green to purple-brown; tubercles 6–12 mm long, arranged very roughly into 4 obtuse rows along stem ± without grooves between them, spreading to ascending, conical, tapering into slender tip, without stipular denticles. Inflorescences 1–2 per stem near apex, each with 1–2 flowers opening in gradual succession, peduncle absent, with a few bracts <1 mm long; pedicel 6–8 mm long, 2 mm in diameter, erect, holding flower facing upwards. Sepals 3.5–6 mm long, 1.5 mm wide at base, lanceolate, acuminate. Corolla 2–3 cm in diameter, tubular-campanulate; outside cream often longitudinally flecked with purple-brown; inside dark purple-brown sometimes becoming speckled with purple-brown on pale yellow towards base of tube, ± glabrous to covered with fine bristles up to 0.5 mm long; tube 5–10 mm long, 6–8 mm wide, deeply cupular and somewhat pentagonal towards mouth, usually narrowing towards mouth; lobes 5–11 mm long, 3–5 mm wide at base, ascending to spreading, ovate-deltate to ovate-lanceolate, mostly narrower and convex above, the margins reflexed, eciliate. Corona 3–4 mm tall, 6–7 mm in diameter, without basal stipe, purple-black; outer lobes 2–3 mm long, deeply pouch-like with rim of pouch erect and emarginate to bifid with small deltate erect teeth; inner lobes 1–2 mm long, adpressed to backs of anthers and often ascending beyond them, linear and narrowing towards apex, dorsiventrally flattened, obtuse to acute. Figs. 34, 35.

Distribution (Fig. 36). Djibouti, Ethiopia, Somalia; 900–1200 m.

Orbea sacculata is of restricted occurrence in Ethiopia from near Metahara around the base of Mt Fantale eastwards towards Dire Dawa. In Somalia it has only been recorded from the Al Mado. Plants in Ethiopia occur in shallow soils of volcanic origin in or near clumps of grass or amongst stones, sometimes with other stapeliads, such as *Caralluma dicapuae* (Chiov.) Chiov. and *C. socotrana* (Balf. f.) N. E. Br. In Somalia *O. sacculata* grows among small bushes on limestone with several other succulents.

ADDITIONAL SPECIMENS EXAMINED. **Djibouti.** Without locality, *Lavranos s.n.* (K). **Ethiopia.** [N 0941] near Urso, 40 km W of Dire Dawa towards Erer Gota [-CB], *Gilbert & de Wilde 2287* (K). [N 0839] Garibaldi Caldera [-DC], 08°50′N, 39°42′E, *Gilbert & Volleson s.n.* (K); Awash Nat. Park, *Gilbert 1648* (K). **Somalia.** [N 1049] Al Mado [-CC], above Galgalo, *Lavranos s.n.* (K).

Gilbert (1978: 50) suggested that "*Caralluma sacculata*" and "*C. tubiformis*" may be the same species, but the taxa are here maintained. *Orbea tubiformis* differs from

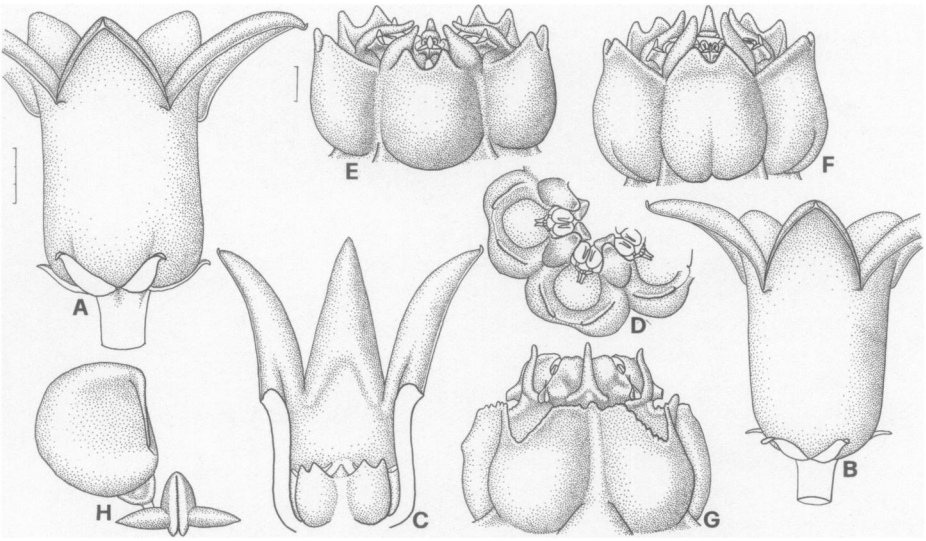

FIG. 34. *Orbea sacculata.* A, B. Side views of flower. C. Side view of dissected flower. D. Face view of part of gynostegium. E–G. Side views of gynostegium. H. Part of pollinarium. Scale bars: A–C, 3 mm (at A); D–G, 1 mm (at E); H, 0.25 mm (at A). [Based on: A, C, E, *Gilbert 1648*; B, *Gilbert & Vollesen s.n.*; D, F, H, *Gilbert & de Wilde 2287*; G, Djibouti, *Lavranos s.n.*]

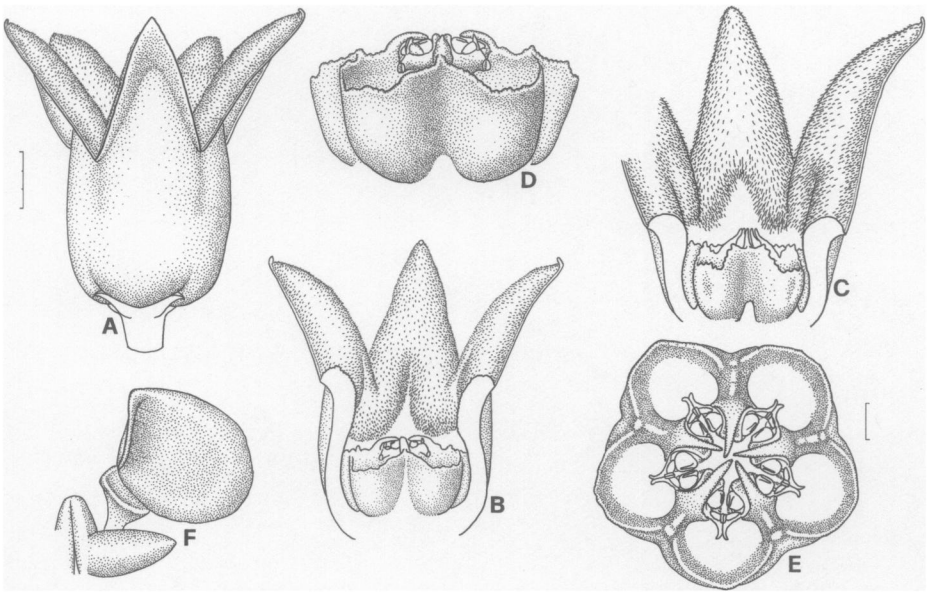

FIG. 35. *Orbea sacculata.* A. Side view of flower. B, C. Side views of dissected flower. D. Side view of gynostegium. E. Face view of gynostegium. F. Part of pollinarium. Scale bars: A–C, 3 mm (at A); D, E, 1 mm (at E); F, 0.25 mm (at A). [Based on: A, B, D, E, *Lavranos s.n.*, Galgalo, Somalia, ex hort. de Boer; C, F, *Lavranos 9000*.]

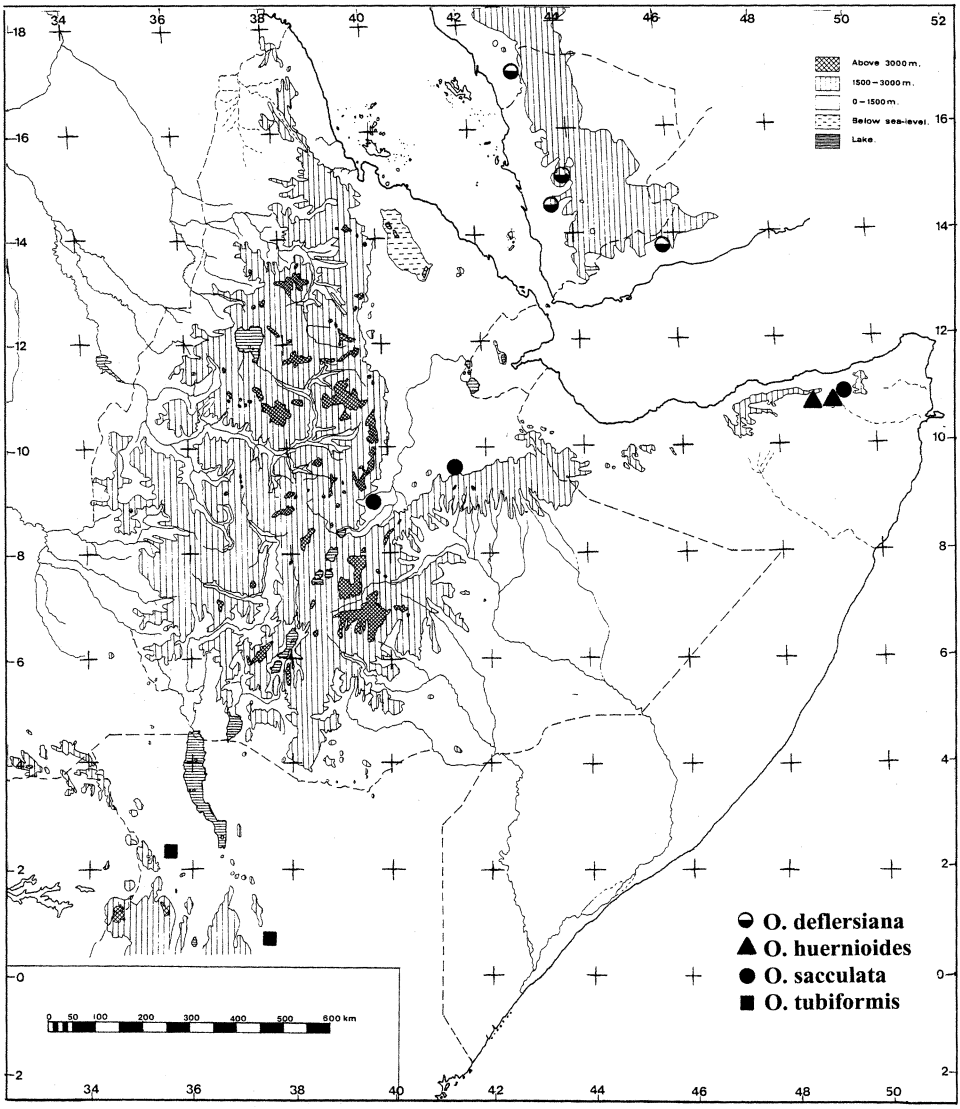

FIG. 36. Distribution of *Orbea deflersiana*, *O. huernioides*, *O. sacculata*, and *O. tubiformis*.

O. sacculata in having a broader corolla tube, which becomes slightly broader towards the mouth, lower and more rounded outer corona lobes, and much longer bristles on the inside of the corolla (the longest ones 3 mm long in *O. tubiformis* and only 0.5 mm long in *O. sacculata*).

Comparison of *O. sacculata* and *Caralluma kochii* proved them to be conspecific. Lavranos (1971) compared *Caralluma kochii* with "*C. tubiformis*" and stated that his new species differs in that the flower is not at all setate inside; apparently he was not aware of the similarity to "*C. sacculata*." Plowes (1980) also compared *C. kochii* only to "*C. tubiformis*," and concluded that *C. kochii* differed in having the "corolla lobes longer than the tube" and that the "outer corona lobes are not as pouch-like." In fact, in Ethiopia, flowers

of *O. sacculata* are variable in the length of the corolla tube, even amongst the material collected by Gilbert, and the lobes can be both longer than or shorter than the tube. The tube can be particularly short in *C. kochii* but also can equal the lobes, and two taxa cannot be recognized on that basis.

In Ethiopian material, flowers of *O. sacculata* are quite variable in the length of the papillae inside the corolla. While some are almost glabrous, others are covered with minute, white bristles (*Gilbert & de Wilde 2287*), so that the slightly longer bristles in specimens named "*C. kochii*" (up to 0.5 mm long) are merely a further extension of this character. In material from Djibouti, the bristles are also up to 0.5 mm long. Differences in length of these bristles do not separate *O. sacculata* from "*C. kochii*," but do enable one to separate *O. sacculata* from *O. tubiformis*.

The coronas of *O. sacculata* and "*C. kochii*" are very similar. In Ethiopian material the outer coronal pouches usually have two small, erect, deltate teeth on the margins of each lobe, whereas in "*C. kochii*" the margin of the pouch is usually finely toothed. The erect, deltate teeth are sometimes vestigially present in "*C. kochii*" as well.

In *O. sacculata*, generally, the inner corona lobes are extremely variable in their orientation. In Ethiopian material they are adpressed to the backs of the anthers and then either remain horizontal or become erect near the tips. In Somalian and Djibouti material they are more variable, from horizontal to adpressed to the backs of the anthers only near the base and then erect, and sometimes wholly erect. Quite a bit of this variation is caused by the anthers sometimes remaining in a more or less erect position against the style-head, which then forces the inner lobes to be erect as well (e.g., Fig. 34G).

18. Orbea tubiformis (E. A. Bruce & P. R. O. Bally) Bruyns, Aloe 37: 76. 2001. *Caralluma tubiformis* E. A. Bruce & P. R. O. Bally, J. Cact. Succ. Soc. Amer. 13: 167. 1941. *Pachycymbium tubiforme* (E. A. Bruce & P. R. O. Bally) M. G. Gilbert, Bradleya 8: 21. 1990. *Angolluma tubiformis* (E. A. Bruce & P. R. O. Bally) Plowes, Excelsa 16: 105. 1994.—TYPE: KENYA. Uaso Nyiro River, near Archer's Post [N 0037 DA], 00°39′N, 37°40′E, *Copley sub Bally S 33* (holotype: K!; isotype: ZSS).

Small succulent, not rhizomatous. Stems 8–15 cm long, 0.8–1.2 cm in diameter (excluding teeth), shortly decumbent, grey-green flecked with purple-brown; tubercles 10–18 mm long, arranged roughly into 4 obtuse rows along stem with a slight groove between them, ascending, conical, acuminate to a very fine point, without stipular denticles. Inflorescences 1–2 per stem near apex, each with 1 (–2) flower(s), peduncle absent, with 1–2 deltate acute bracts 1.0–1.5 mm long; pedicel 5–8 mm long, 2–3 mm in diameter, erect, holding flower facing upwards, grey-green with narrow purple markings. Sepals 4–5 mm long, 1.0–1.5 mm wide at base, ovate-lanceolate, acuminate. Corolla 1.8–2.5 cm long, 2–2.5 cm in diameter, campanulate; outside grey-green with narrow raised longitudinal purple stripes; inside brown to dark purple-brown, covered with fine white bristles up to 3 mm long, sometimes each bristle arising from a low papilla, sometimes somewhat rugulose; tube 8–10 mm long, 8–12 mm in diameter, cupular; lobes 10–12 mm long, 6–7 mm wide at base, ascending to spreading, deltate, acute, with recurved eciliate margins. Corona 4.0–6.5 mm tall, 7–8 mm in diameter, purple-brown, without basal stipe; outer lobes 3.0–3.5 mm long, 2.0–2.5 mm wide, each forming a deep rounded pouch between anthers, partially closed up at mouth; inner lobes 1.0–2.5 mm long, adpressed to backs of

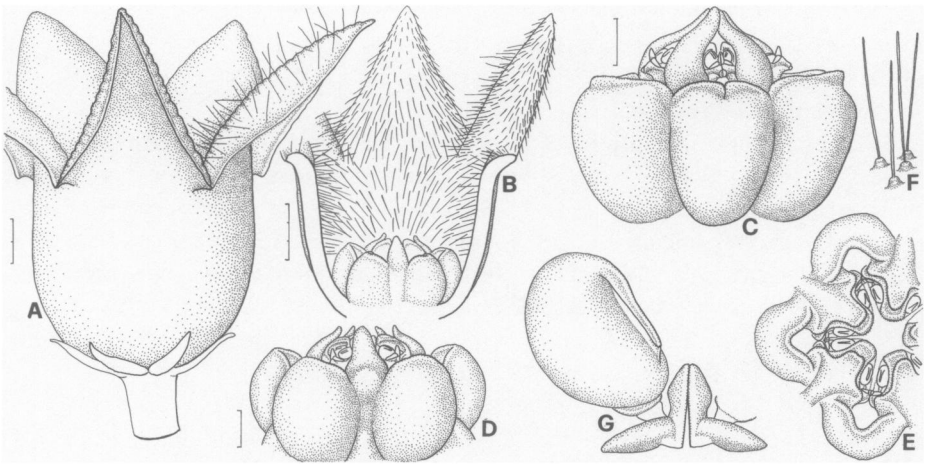

FIG. 37. *Orbea tubiformis*. A. Side view of flower. B. Side view of dissected flower. C, D. Side views of gynostegium. E. Face view of (most of) gynostegium. F. Papillae on inside of lobes. G. Part of pollinarium. Scale bars: A, 2 mm; B, 3 mm; C, 1 mm; D, E, 1 mm (at D); F, 0.5 mm (at B); G, 0.25 mm (at B). [Based on: A, C, *Copley sub Bally S 33*; B, D, E, ex hort. de Boer; F, *Renney sub Bally 16601*.]

anthers and sometimes rising up slightly connivent in center, dorsiventrally flattened, lanceolate and acute to short and truncate from a broad base. Figs. 4B, 37.

Distribution (Fig. 36). Kenya; 600–1000 m.

Orbea tubiformis is only known from a few collections from the arid country between Mt Kenya and Lake Turkana. Plants occur in stony (lava) areas with very sparse scrub and sometimes with many other species of stapeliads (Bruce & Bally 1948).

ADDITIONAL SPECIMENS EXAMINED. **Kenya.** [N 0335] 137 km S of Lokitaung [-BC], *Carter & Stannard 101* (K); without locality, *Renney sub Bally 16601* (K).

Orbea tubiformis is closely related to *O. sacculata*. It differs from that species in that the corolla has longer bristles inside, and the pouches formed by the outer corona lobes are lower, more rounded, and somewhat constricted towards the mouth. The guide-rails in both species are exceptionally short, with a widely flared mouth, although they are not flared as much as in *O. deflersiana*.

19. Orbea deflersiana (Lavranos) Bruyns, Aloe 37: 74. 2001. *Caralluma deflersiana* Lavranos, J. S. African Bot. 29: 103. 1963. *Pachycymbium deflersianum* (Lavranos) M. G. Gilbert, Bradleya 8: 22. 1990. *Angolluma deflersiana* (Lavranos) Plowes, Excelsa 16: 106. 1994.—TYPE: YEMEN. [South Yemen] 1 mi W of Lodar [N 1345 DD], *Lavranos 1788* (holotype: K!; isotypes: PRE! ZSS!).

Small succulent forming diffuse mats up to 30 cm in diameter, not rhizomatous. Stems 3.5–8 cm long, 0.8–1.2 cm in diameter (excluding teeth), decumbent, grey-green flecked with darker green to purple-brown; tubercles 7–15 mm long, arranged very roughly into 4 obtuse rows along stem ± without grooves between them, spreading to ascending, conical, tapering to a very slender tip, without stipular denticles. Inflorescence 1 per stem near apex,

of 1–2 flowers developing in gradual succession ± without a peduncle, with a few acuminate bracts ± 2 mm long at base; pedicel 4–12 mm long, 3.0–3.5 mm in diameter, erect and holding flower facing upwards, pale green. Sepals 5–7 mm long, 2 mm wide at base, lanceolate, acute. Corolla 1.8–3 cm long, 1.5–3 cm in diameter, tubular-campanulate; outside cream-green, sometimes longitudinally flecked with purple-brown; inside pinkish towards base, the rest dark purple-brown, covered with fine papillae; tube 5–15 mm long, 7–10 mm in diameter, deeply cupular but pentagonal towards mouth; lobes 9–20 mm long, 6–9 mm wide at base, ascending to spreading, ovate-lanceolate, mostly narrowly deltate and convex above, the margins reflexed, eciliate. Corona 6.5–8.0 mm tall, 6–8 mm in diameter, without basal stipe; outer lobes ± 1 mm long, pouch-like, the rim of the pouch lower in the center than at the sides where rising up to join the bases of inner lobes, rim sometimes notched in the middle, the pouch usually filling completely with nectar, purple-black, occasionally with a spreading ridge below the base of each inner lobe (behind anther); inner lobes 2.5–3.5 mm long, adpressed to backs of anthers and rising somewhat towards center where often touching at tips, linear, becoming slightly broader and thicker towards apex, dorsiventrally flattened, obtuse and sometimes somewhat tuberculate towards apex, purple-black to maroon and often paler towards apex. Figs. 4A, 38.

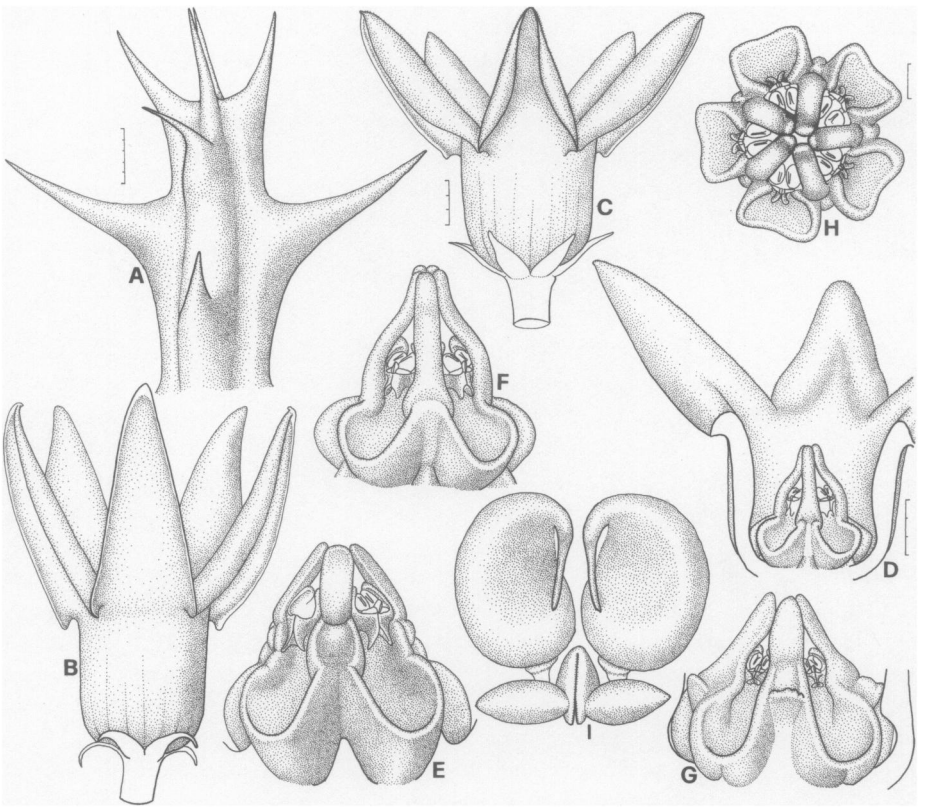

FIG. 38. *Orbea deflersiana.* A. Portion of stem. B, C. Side views of flower. D. Side view of dissected flower. E–G. Side views of gynostegium. H. Face view of gynostegium. I. Pollinarium. Scale bars: A, B, 5 mm (at A); C, 3 mm; D, 3 mm; E–H, 1 mm (at H); I, 0.25 mm (at A). [Based on: A, *Noltee 342B* (no voucher); B, E, *Lavranos 1788*; C, D, F, H, I, *Noltee 313* (no voucher); G, *Müller-Hohenstein & Deil 1963*.]

Distribution (Fig. 36). Saudi Arabia, Yemen; 200–1900 m.

Orbea deflersiana has proved to be widely distributed in the southwestern corner of the Arabian Peninsula, from the southernmost part of Saudi Arabia to the southern parts of Yemen, where it is widespread and quite frequent (Wood 1997).

Plants are usually found in rocky areas among *Acacia* trees and other succulents from the plains at the foot of the escarpment into the foothills.

ADDITIONAL SPECIMENS EXAMINED. **Saudi Arabia.** [N 1743] Near Al Aridah [-AA], *Collenette 2223* (E). **Yemen.** [N 1543] 10 km E of Al Maghrabah [-BB], *Řičánek & Hanáček* 232 (E). [N 1443] Jebel Bura [-DC], *M.-Hohenstein & Deil 1963* (E).

Orbea deflersiana differs from the other species with tubular flowers, except *O. huernioides* (i.e., *O. denboefii*, *O. distincta*, *O. sacculata*, and *O. tubiformis*), by the tall, relatively broad inner corona lobes (with a usually rather rounded, obtuse apex) that tower well above the anthers and the very shallow pouches formed by the outer lobes beneath the guide-rails. *Orbea huernioides* shares some of these features, but its flowers are nutant, and the pouch formed by each outer corona lobe is closed off by a flap of tissue.

Orbea deflersiana is extremely variable florally. The flowers may be between 18 and 30 mm long and the corolla tube from 5 to 15 mm long. When the corolla tube is short, it may only just equal the gynostegium, whereas in some specimens it is up to twice as long as the gynostegium is tall. The corona lobes are fairly variable in length and breadth, and the outer lobes may also give rise to a small transverse ridge behind the inner lobes. The anthers are generally ascending (rather than flat on the style-head, see Fig. 4A) and consequently the inner lobes (which are adpressed to their backs) rise up towards the center.

In *O. deflersiana* the short guide-rails are usually extremely widely flared in the proximal half, so that only in the distal half do they form the usual tight rail. Such broad guide-rails are also characteristic of *Caralluma solenophora* Lavranos, but are not known elsewhere in *Orbea*.

20. Orbea circes (M. G. Gilbert) Bruyns, comb. nov. *Caralluma circes* M. G. Gilbert, Cact. Succ. J. Gr. Brit. 40: 48. 1978. *Pachycymbium circes* (M. G. Gilbert) M. G. Gilbert, Bradleya 8: 22. 1990. *Angolluma circes* (M. G. Gilbert) Plowes, Excelsa 16: 110. 1994. *Orbea dummeri* subsp. *circes* (M. G. Gilbert) Bruyns, Aloe 37: 74. 2000.—TYPE: ETHIOPIA. Sidamo, 6 km E of Wachida [N 0439 CA], 04°35′N, 39°05′E), *Gilbert 2288* (holotype: K!; isotype: ETH).

Small succulent forming diffuse mats up to 30 cm in diameter, not rhizomatous. Stems 3.5–8 (–20) cm long, 0.8–1 cm in diameter (excluding teeth), decumbent, grey-green to green flecked with purple-brown; tubercles 5–15 mm long, arranged very roughly into 4 obtuse rows along stem with a slight groove between them, spreading to ascending, conical, acuminate (to a very fine point) to slightly laterally flattened, without stipular denticles. Inflorescences 1–3 per stem near apex, each of 1–3 flowers developing in gradual succession ± without a peduncle, sometimes with 1 or more very short bracts <1 mm long; pedicel 6–12 mm long, 2 mm in diameter, erect and holding flower facing upwards, pale green. Sepals 2–5 mm long, 1.5–2.0 mm wide at base, ovate to ovate-lanceolate, acute. Corolla ± 3 cm in diameter, shallowly campanulate; outside pale green and faintly purplish on lobes; inside green to olive-green, with many very stout ± truncate papillae up to ± 0.5 mm long on lobes and on sides of tube, each usually tipped with a transparent

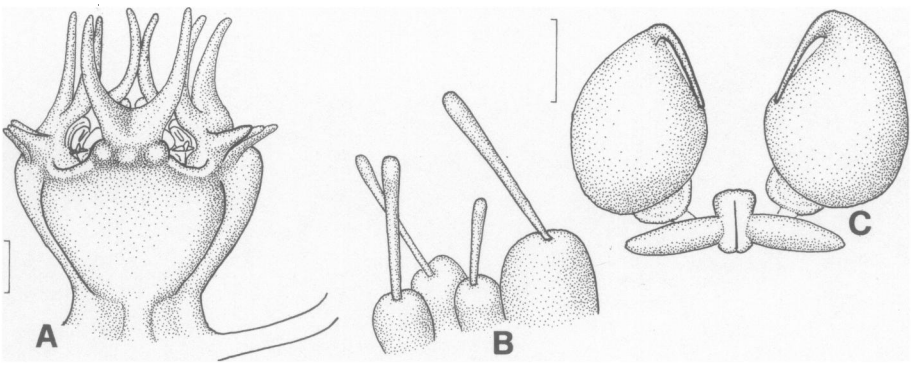

FIG. 39. *Orbea circes.* A. Side view of gynostegium. B. Papillae borne on inside of lobes. C. Pollinarium. Scale bars: A, 1 mm; B, 0.5 mm (at C); C, 0.25 mm. [Based on *Gilbert 2288.*]

somewhat clavate bristle up to 1.5 mm long; tube 5 mm long, 12 mm in diameter, broadly cupular, radially rugulose on base; lobes 10–12 mm long, 6–8 mm wide at base, ascending, ovate, acute, with the eciliate margins folded back in distal half and thus convex distally. Corona ± 6.5 mm tall, 5 mm in diameter, ivory, smooth, raised above base of tube on a narrow strongly pentagonal stipe; outer lobes 3–4 mm tall, forming a deep pouch along sides of column, spreading slightly at mouth, with 3–4 small spreading teeth behind inner lobes; inner lobes ± 3 mm long, ± rectangular near base, dorsiventrally strongly flattened, adpressed to backs of anthers and much exceeding them, 2–3-toothed at apex; outer teeth ± 2 mm long, erect and almost cylindrical, often connivent with teeth from adjacent lobes; inner tooth (if present) <1 mm long, ± horizontally spreading towards center of flower. Fig. 39.

Distribution (Fig. 40). Ethiopia; 1100–1200 m.

Orbea circes is only found in the southernmost portion of the Sidamo Province of Ethiopia, relatively close to the northern border of Kenya.

In these areas it grows in various kinds of *Acacia*-scrub, together with a variety of other succulents (Gilbert 1978).

ADDITIONAL SPECIMEN EXAMINED. **Ethiopia.** [N 0540] 75 km from Neghelli towards Filtu [-AB], 05°11′N, 40°15′E, *Gilbert 3450* (K).

As Gilbert (1978) remarked, the flowers *O. circes* and *O. dummeri* are very similar, but there are several important differences separating the two species, most of which he noted. The inside of the flowers in both species is markedly papillate, more so than in any other species of *Orbea*. A careful examination of the corolla shows that these papillae continue to the edge of the flat base of the tube in *O. dummeri*, but only part of the way into the tube in *O. circes*. The papillae themselves are much broader and stouter in *O. circes* than in *O. dummeri*, in which they are always cylindrical.

In *O. dummeri* the outer corona lobes are conspicuous on the side of the gynostegium and spread away from the top of the deep pouch that they enclose. In *O. circes* the outer corona lobes do not project beyond the mouth of this pouch, but behind the inner lobes they give rise to several small spreading horns. In *O. dummeri* the inner lobes are divided towards their tips but spread horizontally on top of the gynostegium. Their

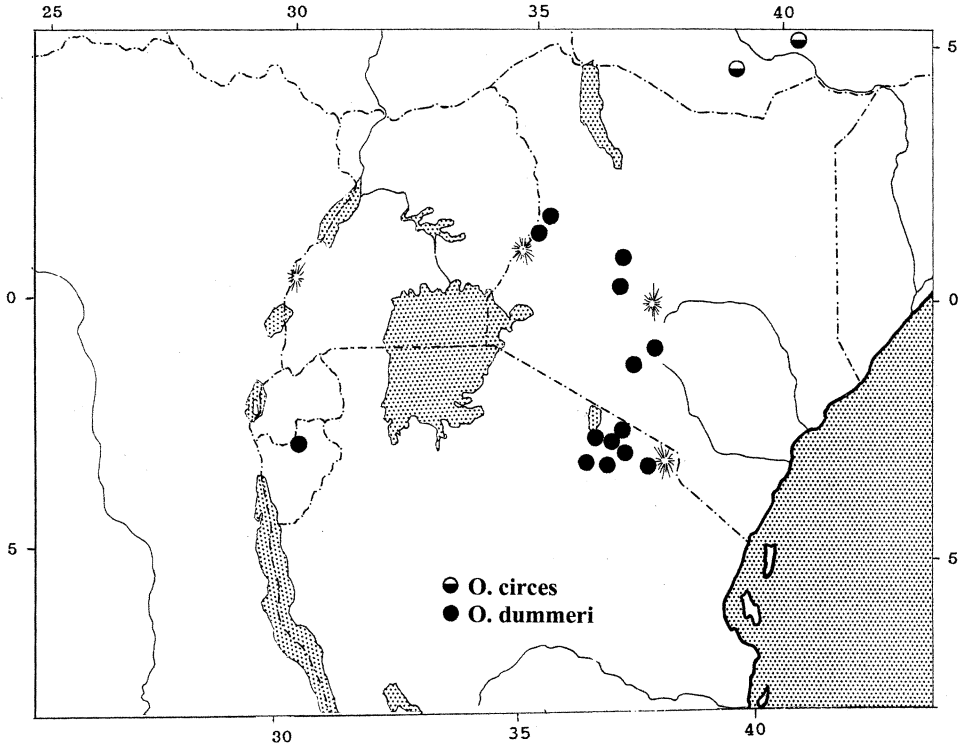

FIG. 40. Distribution of *Orbea circes* and *O. dummeri*.

unusual shape in *O. circes*, with erect, connivent horns, is shown in Fig. 39A. In addition, the gynostegium is conspicuously narrowed towards the base of the outer corona lobes in *O. circes*, but it is cylindrical and rather wider towards the base in *O. dummeri*.

21. Orbea dummeri (N. E. Brown) Bruyns, Aloe 37: 74. 2001. *Stapelia dummeri* N. E. Brown, Gard. Chron., ser. 3, 61: 132. 1917. *Caralluma dummeri* (N. E. Brown) A. C. White & B. Sloane, J. Cact. Succ. Soc. Amer. 12: 82. 1940. *Pachycymbium dummeri* (N. E. Brown) M. G. Gilbert, Bradleya 8: 22. 1990. *Angolluma dummeri* (N. E. Brown) Plowes, Excelsa 16: 110. 1994.—TYPE: UGANDA. Bukoba distr., cultivated locally, *Dummer s.n.* (holotype: K!).

Small succulent forming diffuse mats up to 30 cm in diameter, not rhizomatous. Stems 3.5–8 (–20) cm long, 0.8–1 cm in diameter (excluding teeth), decumbent, grey-green to green flecked with purple-brown; tubercles 5–15 mm long, arranged very roughly into 4 obtuse rows along stem with a slight groove between them, spreading to ascending, conical, acuminate (to a very fine point) to slightly laterally flattened, sometimes with small stipular denticles near apex. Inflorescences 1–3 per stem near apex, each of 1–3 flowers developing in gradual succession ± without a peduncle, sometimes with 1 or more very short bracts <1 mm long; pedicel 6–12 mm long, 2 mm in diameter, erect and holding flower facing upwards, green to red. Sepals 2–5 mm long, 1.5–2.0 mm wide at base, ovate to ovate-lanceolate, acute. Corolla 3.2–4.5 cm in diameter, shallowly campanulate;

outside pale green to reddish; inside olive-green, with many erect stout cylindrical obtuse papillae up to 1.5 mm long on lobes and on sides of tube (maximum length slightly beyond middle of lobes), each usually tipped with a transparent bristle up to 3 mm long; tube 2–5 mm long, ± 10 mm wide, broadly and shallowly cupular, radially rugulose on base; lobes 12–16 (–20) mm long, 4–9 mm wide at base, spreading, ovate, acute, with the ciliate margins folded back in distal half and thus distally convex. Corona 4–5 mm tall, 5–6 mm in diameter, cream, slightly papillate, raised slightly above base of tube on short very strongly pentagonal stipe; outer lobes 3–4 mm tall, forming a deep pouch along sides of column (the pouch gradually filling with nectar), spreading, channelled above, bifid into spreading narrowly deltate lobules 0.5–1.5 mm long, sometimes with 1–2 smaller lobules between adjacent ones, without teeth behind inner lobes; inner lobes 1–2 mm long, ± square, dorsiventrally strongly flattened, adpressed to backs of anthers and somewhat exceeding them, 1–4-toothed at apex, the teeth ± 1 mm long, horizontal and crossing one another above the center of the flower to somewhat divergent, without dorsal projection, laterally confluent towards base with outer lobes. Fig. 41.

Distribution (Fig. 40). Burundi, Kenya, Tanzania, Uganda; 950–1600 m.

Orbea dummeri is common and widespread in Kenya, though restricted to the higher and drier parts. In Tanzania it is found to the north of Lake Manyara and west of Kilimanjaro, i.e., mainly along the Rift Valley.

Plants have been observed on low limestone or lava outcrops, sometimes around or on the rims of small craters. These spots, which generally have very shallow soils, are often devoid of trees, but *O. dummeri* may also occur among scattered trees or among much stunted shrublets of *Acacia*, often in the company of *Caralluma arachnoidea*, *C. speciosa*, or *O. denboefii*, and with various small, spiny species of *Euphorbia*.

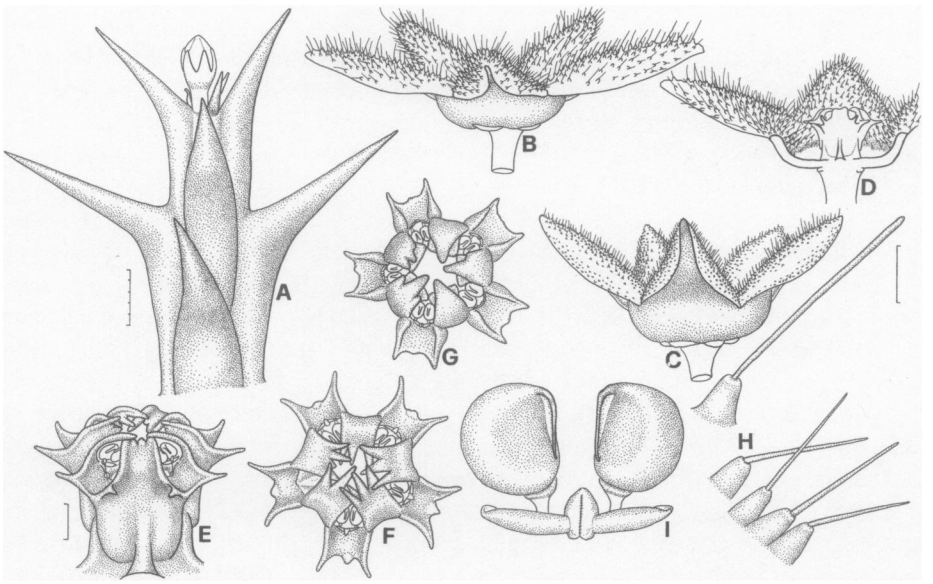

FIG. 41. *Orbea dummeri.* A. Apex of stem with flower bud. B, C. Side views of flower. D. Side view of dissected flower. E. Side view of gynostegium. F, G. Face views of gynostegium. H. Papillae borne on inside of corolla around mouth of tube. I. Pollinarium. Scale bars: A–D, 5 mm (at A); E–G, 1 mm (at E); H, 0.5 mm; I, 0.25 mm (at H). [Based on: A, B, D–F, H, I, *Liede 3150,* Rumuruti, Kenya; C, G, *Richards 24277.*]

ADDITIONAL SPECIMENS EXAMINED. **Burundi.** [0229] Nyakisozi [-DD], Ngozi distr., *Reekmans 3051* (BR). **Kenya.** [N 0036] 10 km SE of Rumuruti [-BA], *Carter & Stannard 630* (K); 50 km N of Rumuruti [-DA], *Hartmann 6620* (K). [N 0134] NE of Mt Elgon (-B), *Tweedie 1114* (K). [N 0135] Kuchelebai [-CA], Turkana distr., *Bally S1* (K). [0136] Nairobi [-BD], *Verdcourt 455* (K); Langata (-B), *Archer sub EAH 12110* (K). [0137] Athi River [-AB], 20 miles beyond Thika, *Richards s.n.* (K). **Tanzania.** [0235] Near Ol Doinyo Lengai [-DD], *Bruyns 8705* (S). [0236] Ketumbaine Mtn [-CD], *Richards 24277* (K); Longido Mtn [-DA], *Richards s.n.* (K). [0335] 10 km N of Mtowambu [-BD], *Bruyns 8712* (K); 10 km E of Mtowambu [-BD], *Bruyns 8713* (MO); Manyara Nat. Park at turning to Chara Chara [-B/D], *Richards 24715* (K); escarpment above Lake Manyara [-D], *Richards s.n.* (K). [0336] S of Arusha [-AD], *Bruyns 8709* (E); W of Ngare Nanyuki [-BA], *Bruyns 8698* (BOL). [0337] Near Moshi [-AD], *Richards s.n.* (K). Between Lumi River and Taveta, *Greenway 4600* (K). Nyasasi, Ngare Nanyuki road, *sub K 34188* (K).

Orbea dummeri and *O. circes* differ from all other species of *Orbea* by the striking greenish flowers with a broad and often quite short tube with a flattish base; the tube is lined with prominent stout papillae, each tipped with a slender, translucent bristle up to 3 mm long. The gynostegium sits, rather isolated, in the middle of this tube on what appears to be a relatively tall stipe; however, in section it is revealed that the stipe is actually short, and each outer corona lobe encloses a deep pouch reaching nearly to the base of the gynostegium. The ridges that begin on the gynostegium between these pouches extend across the relatively flat floor of the corolla tube in a manner not seen in any other species. The differences between this species and *O. circes* (no. 20) are discussed under the latter.

In *O. dummeri* the outer corona lobes spread at the mouth of the pouch formed by their lower parts and are bifid towards their apex. In this species the inner lobes are adpressed to the backs of the anthers and usually are divided towards the apex into several finger-like lobules that intertwine over the style apex or spread upwards and outwards.

22. Orbea denboefii (Lavranos) Bruyns, Aloe 37: 74. 2001. *Caralluma denboefii* Lavranos, J. Cact. Succ. Soc. Amer. 55: 119. 1983. *Pachycymbium denboefii* (Lavranos) M. G. Gilbert, Bradleya 8: 22. 1990. *Angolluma denboefii* (Lavranos) Plowes, Excelsa 16: 106. 1994.—TYPE: KENYA. 6–10 km ENE of Oloitokitok [0237 DC], 1350 m, *den Boef sub Lavranos 21027* (holotype: EA, not located, fide Newton, 1994).—KENYA. Near Oloitokitok, *Foresti 824* (neotype, designated by Newton, 1998: K).

Small succulent forming diffuse clumps, not rhizomatous. Stems 6–15 (–20) cm long, 0.8–1.2 cm in diameter (excluding teeth), decumbent, grey-green flecked with darker green to purple-brown; tubercles 7–15 mm long, arranged very roughly into 4 obtuse rows along stem with a shallow groove between them, spreading to ascending, conical, tapering to a very fine point, occasionally with stipular denticles. Inflorescences 1–4 per stem mainly in distal half, each with 1–3 flowers, peduncle absent, with 1–2 small acuminate bracts; pedicel 6–12 mm long, 2 mm in diameter, spreading and then sometimes ascending or descending, holding flower facing upwards to downwards. Sepals 4–8 mm long, 1 mm wide at base, lanceolate, acute. Corolla 1–1.7 cm long, 2.2–3.5 cm in diameter, campanulate; outside cream with fine longitudinal brown stripes; inside pale to golden-yellow or olive-green (or yellow suffused with brown), becoming paler towards base of tube, slightly longitudinally rugulose on lobes, glabrous or with low papillae on lobes and on side of tube, each papilla usually tipped with a transparent bristle up to 1.5 mm long; tube 5–12 mm long, 5–8 mm in diameter, cupular, circular around mouth, becoming pentagonal towards base; lobes 7–13 mm long, 4.5–7.0 mm wide at base, ascending to spreading,

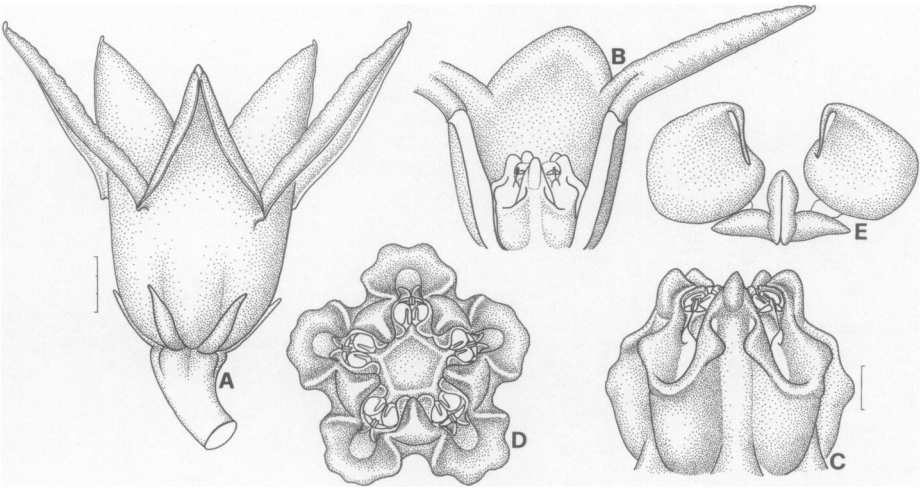

FIG. 42. *Orbea denboefii*, Kenya. A. Side view of flower. B. Side view of dissected flower. C. Side view of gynostegium. D. Face view of gynostegium. E. Pollinarium. Scale bars: A, B, 3 mm (at A); C, D, 1 mm (at C); E, 0.25 mm (at A). [Based on: *Heath & Powys 790.*]

lanceolate, acute, convex, the margins reflexed, eciliate. Corona 3.6–5.0 mm tall, 4.5–6.5 mm in diameter, without basal stipe, yellow; outer lobes ± 2 mm long, forming a deep pouch below guide-rails, the rim of the pouch lower in the center than at the sides where rising to join bases of inner lobes, margin often somewhat folded outwards just behind inner lobes; inner lobes 1–2 mm long, adpressed to backs of anthers and usually exceeding them, sometimes rising in the center, deltate to linear-deltate, dorsiventrally flattened to dorsally considerably swollen, obtuse. Figs. 42, 43.

Distribution (Fig. 44). Kenya, Tanzania; 700–1500 m.

Orbea denboefii was first collected in Kenya near Oloitokitok near the northern foot of Kilimanjaro in 1980 and has subsequently also been recorded in the same area (Newton 1994, 1998). It occurs as well in the adjoining part of Tanzania, where it is widespread from west of the Usambara Mountains to near Lake Natron.

To the west of the Usambara Mountains plants are found in flat, fairly densely vegetated areas with loamy soils among small bushes and among trees of *Euphorbia cooperi* A. Berger, *E. robecchii* Pax, *Acacia*, *Balanites*, and *Commiphora*, and on small bare rocky outcrops (limestone or sandstone) with stunted *Acacia* bushlets and other small spiny shrubs, sometimes with *O. distincta*, *Caralluma arachnoidea*, *C. priogonium*, *C. speciosa*, and *Edithcolea grandis*. Along the Rift Valley *O. denboefii* grows among lava rocks with small acanthaceous shrublets and grass tufts, often with *O. dummeri*, spiny species of *Euphorbia*, and *Aloe*.

ADDITIONAL SPECIMENS EXAMINED. **Kenya.** Galana River, Nov 1985, *Heath & Powys 790* (K). **Tanzania.** [0235] Near Ol Doinyo Lengai [-DD], *Bruyns 8705a* (S). [0336] S of Arusha [-AD], *Bruyns 8709a* (E, K). [0337] W of Lake Jipe [-DA], *Bruyns 8683* (E); near Lembeni [-DC], *Bruyns 8679* (BOL, K, MO).

Like *O. deflersiana*, *O. distincta*, *O. huernioides*, *O. sacculata*, and *O. tubiformis*, *O. denboefii* has a deeply campanulate flower with the corolla tube usually at least as long as

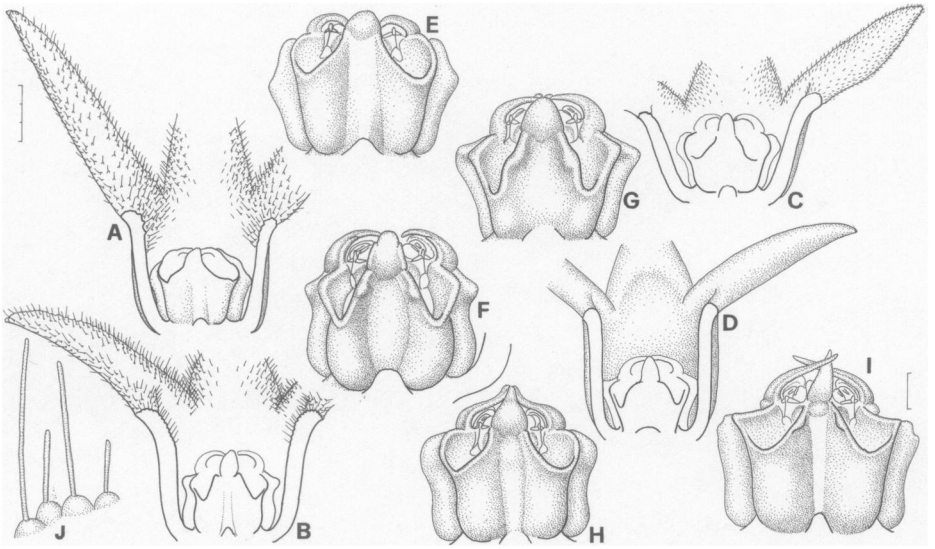

FIG. 43. *Orbea denboefii*, Tanzania. A–D. Side views of dissected flower, showing varying depth and shape of corolla tube. E–I. Side views of gynostegium. J. Papillae borne on adaxial surface of corolla lobes. Scale bars: A–D, 3 mm (at A); E–I, 1 mm (at I); J, 0.5 mm (at A). [Based on: A, E, J, *Bruyns 8705a;* B, F, H, *Bruyns 8709a*; C, D, G, I, *Bruyns 8679*.]

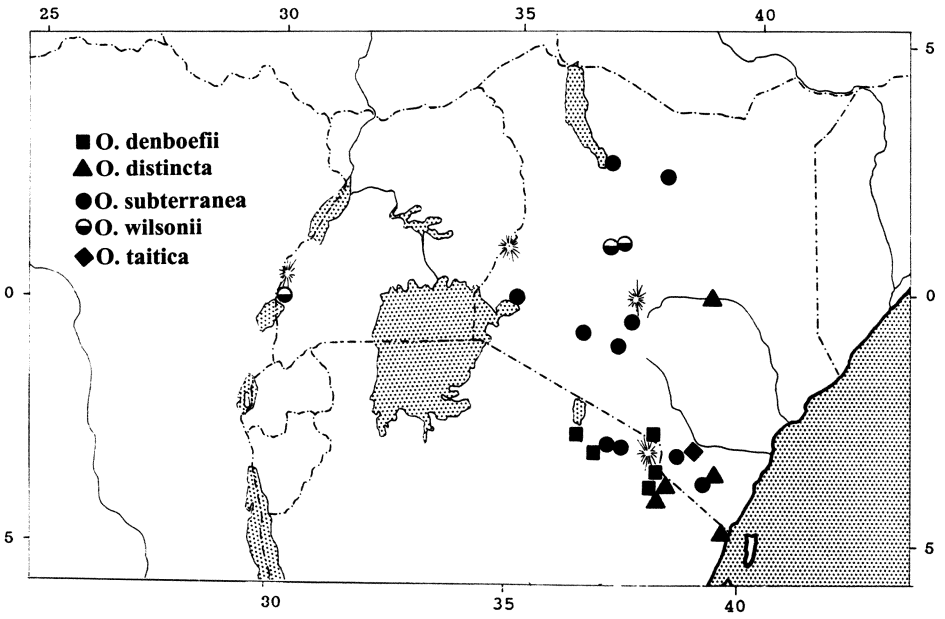

FIG. 44. Distribution of *Orbea denboefii*, *O. distincta*, *O. subterranea, O. taitaica,* and *O. wilsonii*.

broad. All of these species also have deeply saccate outer corona lobes; only in *O. huernioides* is this cavity closed by an additional flap of tissue. *Orbea denboefii* differs from *O. deflersiana*, *O. distincta*, and *O. huernioides* by the much shorter inner corona lobes (without the dorsal extensions of *O. distincta*) and by the smaller, yellow flowers (though those of *O. distincta* may occasionally also be yellow). In *O. sacculata* and *O. tubiformis* the gynostegium is considerably broader than in *O. denboefii*. *Orbea denboefii* often grows with *O. dummeri*, and vegetatively the two cannot be separated reliably. *Orbea dummeri* has a much broader flower with a broad, flat base to the corolla tube, a differently shaped gynostegium on a conspicuous stipe, and much coarser papillae on the corolla.

The flowers in the original collection of *O. denboefii* were said to be nodding and deep yellow, but in more recent collections they have been paler yellow to olive-green or even suffused with brown towards the tips of the lobes. In one prolific habitat near the Usambara Mountains flowers varied from nodding to facing upwards, while on some other plants they were only facing upwards. Flowers of Kenyan material have always been found to be smooth inside, whereas those of plants in Tanzania range from smooth to covered with low papillae, each tipped with a bristle. The original description of the corona is imprecise, and this structure was not illustrated in the original publication. The corona lobes vary somewhat in shape, as shown in Figs. 42 and 43. The inner lobes are occasionally distinctly thickened along their backs in the manner of *O. distincta*, and they vary from quite broad to just as narrow as in *O. sacculata*.

23. Orbea distincta (E. A. Bruce) Bruyns, Aloe 37: 74. 2001. *Caralluma distincta* E. A. Bruce, Hooker's Icon. Pl. 35: t. 3415. 1940. *Pachycymbium distinctum* (E. A. Bruce) M. G. Gilbert, Bradleya 8: 22. 1990. *Angolluma distincta* (E. A. Bruce) Plowes, Excelsa 16: 106. 1994.—TYPE: TANZANIA. Umba Steppe distr., between Moa and Mwakijembi [0439 CC], *Greenway 4260* (holotype: K!).

Small succulent forming diffuse clumps to 30 cm in diameter or more, not rhizomatous. Stems 6–10 cm long, 0.5–1.2 cm in diameter (excluding teeth), decumbent with the apex upturned, grey-green flecked with darker green to purple-brown; tubercles 10–20 mm long, arranged very roughly into 4 obtuse rows along stem ± without a groove between them, spreading to ascending, conical and slender, tapering to a fine point, sometimes with stipular denticles. Inflorescence 1 per stem near apex, of 1–2 flowers developing in gradual succession ± without a peduncle; pedicel 5–11 mm long, 1.5–3.0 mm in diameter, erect and holding flower facing upwards. Sepals 5–7 mm long, 1.5–2.0 mm wide at base, lanceolate, acute. Corolla 3–4.2 cm long, 3–3.5 cm in diameter, tubular-campanulate; outside pale pinkish white with thin longitudinal purple stripes; inside brown and lightly rugulose on lobes, changing gradually to smooth and pale yellow in the tube, sometimes wholly pale yellow, with a dense patch of fine downward-pointing white hairs (up to 0.5 mm long) in the lower 5 mm of the tube; tube 13–16 mm long, 8–12 mm in diameter (inside), cupular, slightly narrowed towards mouth, with the sides distinctly thickened about 5 mm from the base, with deep indentations in the base filling up the area below the outer corona lobes; lobes 15–28 mm long, 6–10 mm wide at base, ascending, ovate-lanceolate to narrowly deltate, convex above, the margins reflexed, eciliate. Corona 5–7 mm tall, 6–8 mm in diameter, purplish brown towards base, otherwise pale brown, without basal stipe; outer lobes ± 2 mm long, forming a deep pouch well below guide-rails, usually with a notch in middle of rim, sometimes with a small spreading obtuse tooth behind inner lobes; inner lobes 2–3 mm long,

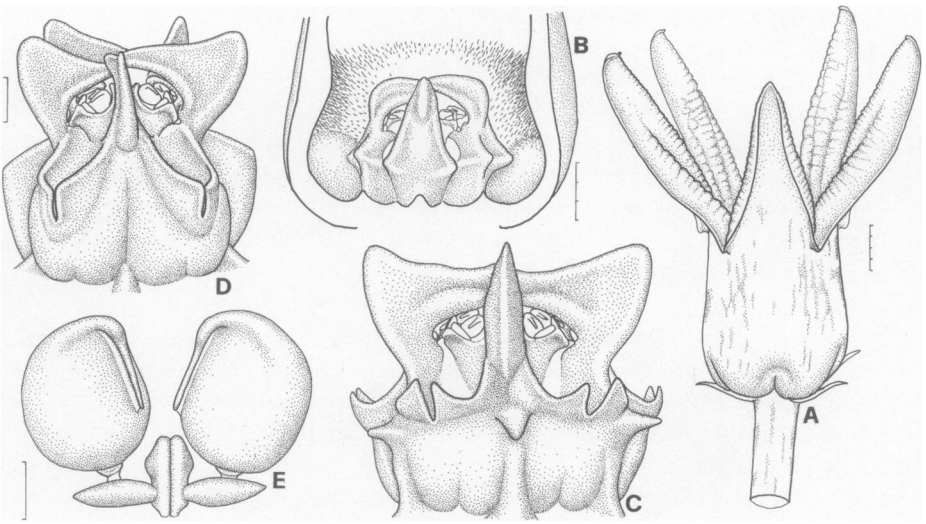

FIG. 45. *Orbea distincta.* A. Side view of flower. B. Side view of base of dissected flower. C, D. Side views of gynostegium. E. Pollinarium. Scale bars: A, 4 mm; B, 3 mm; C, D, 1 mm (at D); E, 0.25 mm. Drawn from: A, B, *Bruyns 8676*; C, E, *Bally 12682*; D, *Ritchie sub Bally S 52*.]

adpressed to backs of anthers (for the entire length, or only near the base and then ascending to meet in the center) and exceeding them to touch at the apex, with a laterally flattened often wing-like longitudinal dorsal ridge 0.5–1.5 mm tall. Fig. 45.

Distribution (Fig. 44). Kenya, Tanzania; 30–1200 m.

Orbea distincta is a relatively rare species known from the northeastern corner of Tanzania (where it is only recorded to the east of the Pangani River) and the adjacent part of southern Kenya, with a single record from much further to the north in Kenya near Garissa.

Plants of *C. distincta* grow in the shelter of low bushes (often spiny members of the Acanthaceae) among scattered trees (*Euphorbia robecchii*, *Acacia*, *Balanites*, etc.), usually in flattish areas but also on hills, in sandy to loamy soils.

ADDITIONAL SPECIMENS EXAMINED. **Kenya.** Taita distr., *Bally B 12682* (ZSS). [0038] Kosi [-B], Garissa distr., *Richie sub Bally S 52* (ZSS). [0338] Kivuko hill near Buchuma [-DB], *Dodds s.n.* (BOL). **Tanzania.** [0337] Lake Jipe [-DA], *Bruyns 8684* (K); near Lembeni [-DC], *Bruyns 8676* (MO).

Orbea distincta is unique among the species of *Orbea* in bearing a longitudinal ridge along the back of the inner corona lobes, which can form quite a prominent feature of the top of the gynostegium. In shape, the flowers resemble those of *O. deflersiana*, *O. sacculata*, and *O. tubiformis*, but this coronal feature immediately distinguishes *O. distincta*. A further unusual character is the dense patch of short but quite obvious, white, downward-pointing hairs in the lower part of the corolla tube. These hairs are supplemented by five inward protrusions of the base of the corolla tube, which more or less fill the area below the outer corona lobes. These various contrivances do not completely fill the spaces around the corona, but must assist in concentrating the attention of visiting insects on the areas around the guide-rails.

The flowers of *O. distincta* are among the most impressive in size among the northern species of *Orbea*, but they seem to be very short-lived, remaining open for 1 to 2 days only. They emit a relatively faint bad odor.

The inside of the flower in *O. distincta* is usually bicolored, with the brown color on the lobes fading to pale yellow in the tube, though flowers that are wholly yellow are known.

In *O. distincta*, as in *O. deflersiana*, the outer corona lobes slope downwards opposite the guide-rails, so that the rails are more exposed than they are in *O. sacculata* and *O. tubiformis*. Yet, they are similarly short in all these species (and in *O. denboefii*), and in all of them they spread away from the axis of the gynostegium (unlike the position in *O. huernioides*).

24. Orbea carnosa (Stent) Bruyns, Aloe 37: 73. 2001. *Caralluma carnosa* Stent, Bull. Misc. Inform. 1916: 42. 1916. *Pachycymbium carnosum* (Stent) L. C. Leach, Excelsa Taxon. Ser. 1: 71. 1978.—TYPE: SOUTH AFRICA. Transvaal: Zilikaat's Nek, *Pole Evans 11020* (holotype: PRE!).

Dwarf succulent, usually consisting of several small clumps connected by ± horizontal rhizomes, sometimes forming dense to diffuse clumps 6–50 cm in diameter. Stems 4–15 cm long, 1–2 cm in diameter (excluding teeth), stout, erect to spreading from short-horizontal to extensively subterranean base, grey-green to reddish mottled with red to purple; tubercles (6–) 10–15 mm long, laterally flattened, joined into 4 narrowly obtuse continuous wing-like rows along stem with a deep groove between rows, forming a spreading to slightly decurved, acute, laterally flattened, broadly to narrowly deltoid tooth, usually with pair of small denticles near apex. Inflorescences 1–6 (–10) per stem mainly in distal half, each with 1–2 (–3) flowers developing in rapid succession, peduncle absent, with 1–3 lanceolate acute bracts 1–2 mm long; pedicel (1–) 2–6 (–12) mm long, 1–2 mm in diameter, spreading to descending, the flower often nodding. Sepals 2.5–5.0 mm long, 1.0–1.5 mm wide at base, ovate to lanceolate, acuminate. Corolla 0.6–2 cm in diameter, campanulate, fleshy (0.5–1.5 mm thick in tube); outside pale green spotted with purple to uniformly pink or cream; inside irregularly rugulose, with scattered erect spikelike papillae up to 1 mm long, uniformly yellow or maroon to pale brown or maroon with irregular reticulated cream markings or whitish with dark purple flecks; tube 2.5–4.0 mm long, 4–7 mm in diameter, cupular, pentagonal, mouth constricted by inward-pointing annulus, nearly to completely containing gynostegium; lobes 3–5 mm long, 6–8 mm wide at base, deltate-ovate, acute, rigidly spreading to ascending, with a spreading fold in each sinus and a few small rigid clavate cilia up to 1 mm long along margin near base. Corona 3–4 mm tall, 4 mm in diameter, cream with purple-red patches, with a very short stipe or sessile; outer lobes erect then spreading, the spreading part entire and truncate-emarginate to deeply bifid into narrowly deltate lobules, fused laterally ± in the middle to inner lobes to form an urceolate cup exceeding the anthers, channelled along middle; inner lobes ± 1 mm long, adpressed to backs of anthers and slightly exceeding them, ± linear, truncate to acute, often very thick with a thick obtuse dorsal gibbosity. Fig. 46.

Distribution (Fig. 58). Botswana, Mozambique, South Africa, Swaziland, Zimbabwe; 300–1400 m.

Orbea carnosa differs from most species of *Orbea* in southern Africa by the rhizomatous habit and broadly deltoid and prominent teeth on the stems; the fairly small, campanulate flowers have a thick corolla and erect outer corona lobes, producing a

somewhat urceolate structure around the inner lobes and anthers. The stems and flowers are similar in shape to those of *O. subterranea* and *O. wilsonii* (including the strongly rhizomatous habit), but *O. carnosa* differs from these in the shape of the outer corona, which forms a pouch between the bases of the inner lobes.

The main differences listed by Leach and Plowes (1967) between *Caralluma carnosa* and *C. keithii* are: corolla 6–10 mm in diameter in *C. carnosa*, 10–20 mm in *C. keithii*; corolla always deep maroon with or without markings in *C. keithii*, and pollinia broader in *C. keithii*. Yet, "*C. keithii*" has been found with pale brown and even yellow flowers ("*Pachycymbium lancasteri*"), and occasionally brownish flowers occur in "*C. carnosa*"; thus, flower color is not a distinguishing character. Although the flowers of "*C. carnosa*" are often smaller than in "*C. keithii,*" there is no discontinuity in the size of the flowers, and the two taxa are therefore separated mainly by their pollinaria. These are more or less as broad as long in "*C. keithii*" and generally smaller and slightly longer than broad in "*C. carnosa*." The two taxa are distributed allopatrically, and so the rank of subspecies seems the most appropriate.

KEY TO THE SUBSPECIES OF ORBEA CARNOSA

Corolla 0.6–1 cm in diameter, lobes 2–5 mm wide.	24a. *O. carnosa* subsp. *carnosa*.
Corolla 1–2 cm in diameter, lobes 6–8 mm wide.	24b. *O. carnosa* subsp. *keithii*.

24a. Orbea carnosa subsp. **carnosa.**

Pedicel 1–3 mm long, 1 mm in diameter. Sepals 2.5–4.0 mm long, 1.0 mm wide at base. Corolla 0.6–1 cm in diameter; inside white, cream, greenish to brown with irregular (usually small) maroon to red markings; lobes 4–5 mm long, 2–5 mm wide at base, margins rarely with few small rigid cilia. Corona ± 2.0–2.5 mm tall, 3 mm in diameter. Fig. 3G.

Distribution (Fig. 58). South Africa; 1000–1400 m.

Orbea carnosa subsp. *carnosa* is endemic to the northern part of South Africa, where it is of restricted distribution in the Transvaal from Pretoria and Rustenburg northwestwards to the Waterberg and west of this to near Ellisras.

Subspecies *carnosa* generally seems to be found on sandstone mountains and hills, though plants have been seen on granite slabs near Potgietersrust. Specimens mainly grow under small bushes and in grass clumps on exposed, rocky outcrops. Rather more rarely they occur in open, stony spots among trees.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** TRANSVAAL: [2327] Goedgedacht [-DC], *Bruyns 6542* (BOL). [2427] Malmanieshoek [-BA], *Hardy 936* (PRE), *Leach 12152* (K, SRGH); Krantzberg [-BC], *Codd & Erens 2064* (PRE), *Codd 3740a* (PRE), *Erens s.n.* (PRE), *Knobel s.n.* (PRE); Jan Trichardt's Pass [-BD], *Bruyns 7782* (K). [2428] Vaalwater [-AC], *Theron s.n.* (PRE); Zaaiplaats Tin Mine [-BB], *Bruyns 7779* (MO). [2527] Hartebeespoort Dam [-DB], *Mogg s.n.* (PRE).

Subspecies *carnosa* differs from subsp. *keithii* in that the stems usually are a paler grey-green and may have slightly longer, narrower teeth. They are very variably rhizomatous, and some specimens seen near Ellisras formed dense clumps up to 30 cm across, more or less without underground runners. These were growing in the flats at the foot of a hill, reasonably sheltered by trees. Plants on more exposed spots are much more

rhizomatous and usually consist only of small groups of stems connected by subterranean runners.

24b. Orbea carnosa subsp. **keithii** (R. A. Dyer) Bruyns, comb. et stat. nov. *Caralluma keithii* R. A. Dyer, Fl. Pl. South Africa 15: t. 600. 1935. *Pachycymbium keithii* (R. A. Dyer) L. C. Leach, Excelsa Taxon. Ser. 1: 71. 1978.—TYPE: SWAZILAND. Ubombo Mtns, *Keith sub PRE 19790* (holotype: PRE!).

Caralluma fosteri Pillans in A. C. White & B. Sloane, Stapelieae, ed. 2, 1: 292. 1937.—TYPE: SOUTH AFRICA. Transvaal: Lydenburg distr., *Foster sub BOL 21311* (holotype: BOL!).

Caralluma schweickerdtii Obermeyer, Bothalia 3: 250. 1937.—TYPE: SOUTH AFRICA. Transvaal: between Waterpoort and Soutpan, *Obermeyer, Schweickerdt & Verdoorn 411* (holotype: PRE!).

Pachycymbium lancasteri Lavranos, J. Cact. Succ. Soc. Amer. 56: 196. 1984.—TYPE: SOUTH AFRICA. Transvaal: Kruger Park, Letaba distr., *Percy-Lancaster 1431* (holotype: NBG!).

Pedicel 2–6 (–12) mm long, 1.5–2.0 mm in diameter. Sepals 3–5 mm long, 1.5 mm wide at base. Corolla 1–2 cm in diameter; inside uniformly yellow or maroon to pale brown or maroon with irregular reticulated cream markings; lobes 3–5 mm long, 6–8 mm wide at base, margins commonly with small rigid cilia. Corona 3–4 mm tall, 4 mm in diameter. Figs. 3B, 46.

Distribution (Fig. 58). Botswana, Mozambique, South Africa, Swaziland, Zimbabwe; 300–1200 m.

In Zimbabwe subsp. *keithii* is known from Harare eastwards to Mutare and southwards to the vicinity of Beit Bridge. In South Africa it has been collected north of the Soutpansberg, in the eastern Transvaal, and in northern Natal. It has been recorded in parts of Mozambique adjacent to the Ubombo Mountains of Swaziland and in the eastern corner of Botswana east of Selebe Phikwe (Hargreaves 1998).

Generally subsp. *keithii* seems to grow on stony ground, usually in flat areas but sometimes on slopes or even the summits of hills in soils derived from sandstones, igneous rocks, or calcrete. Plants may be found in the open among stones or in the shelter of small shrubs and grass tufts or alongside *Colophospermum mopane* or *Acacia* trees.

ADDITIONAL SPECIMENS EXAMINED. **Mozambique.** [2531] Ressano Garcia [-BD], *Leach 5525* (SRGH). **South Africa.** NATAL: [2732] Jozini Dam [-AC], *Strey 4627* (PRE); Mkuzi [-CA], *Bruyns 4453* (BOL). [2830] Nqutu [-BA], *Gerstner 794* (BOL). [2831] Mahlabetini [-AB], *Gerstner 3900* (PRE).—TRANSVAAL: [2229] between Waterpoort & Zoutpan [-CD], *McLoughlin s.n.* (PRE), *Obermeyer et al. 411* (PRE), *Verschuur s.n.* (PRE); Delft, Mopane [-DB], *Bruyns 7672* (K); ± 40 km N of Louis Trichardt [-DB], *Plowes 2601* (NH); 4 km E of Wyllies Poort [-DD], *Bruyns 6576* (BOL). [2230] Messina [-AC], *Leach 12066* (K); 24 km NE of Wyllies Poort [-CC], *Bruyns 6590* (BOL). [2231] Punda Milia [-CA], *Codd 5946* (PRE). [2328] Ga-Mankodi [-BA], *Bruyns 6558* (BOL); 16 km S of Marken [-CB], *Rossouw 61* (NBG). [2429] 42 km SE of Pietersburg [-BC], *Bruyns 4470* (BOL). [2430] Penge [-AD], *Bruyns 2040* (NBG); Penge Mine [-AD], *During sub PRE 7200* (PRE); Mica [-BB], *Braine* (NBG); 10 km E of Burgersfort [-CB], *Bruyns 6614* (BOL); Buffelsvlei [-CD], *Leach & Bayliss 12101* (K, PRE, SRGH); Marone [-CD], *Codd 7720* (PRE). **Swaziland.** [2631] 20 miles S of Stegi [-DD], *Keith 19790* (PRE). **Zimbabwe.** [1730] Rocky outcrop near Lake MacIlwaine [-DD], *Leach 15108* (SRGH). [1832] Manyika Tribal trust-land, Inyanga Distr., *Plowes 2608* (BM, K, PRE); Umtali [-DC], *Chase 4214* (BM, SRGH), *Leach 10590* (SRGH), *Leach 9815* (PRE, SRGH). [1931] 4 miles S of Gutu [-CC], *Leach 10544* (SRGH). [1932] 16 miles SSW of Umtali [-BA], *Plowes 2161* (PRE), *Plowes 2572* (BOL, PRE); Nyahuni Riv.,

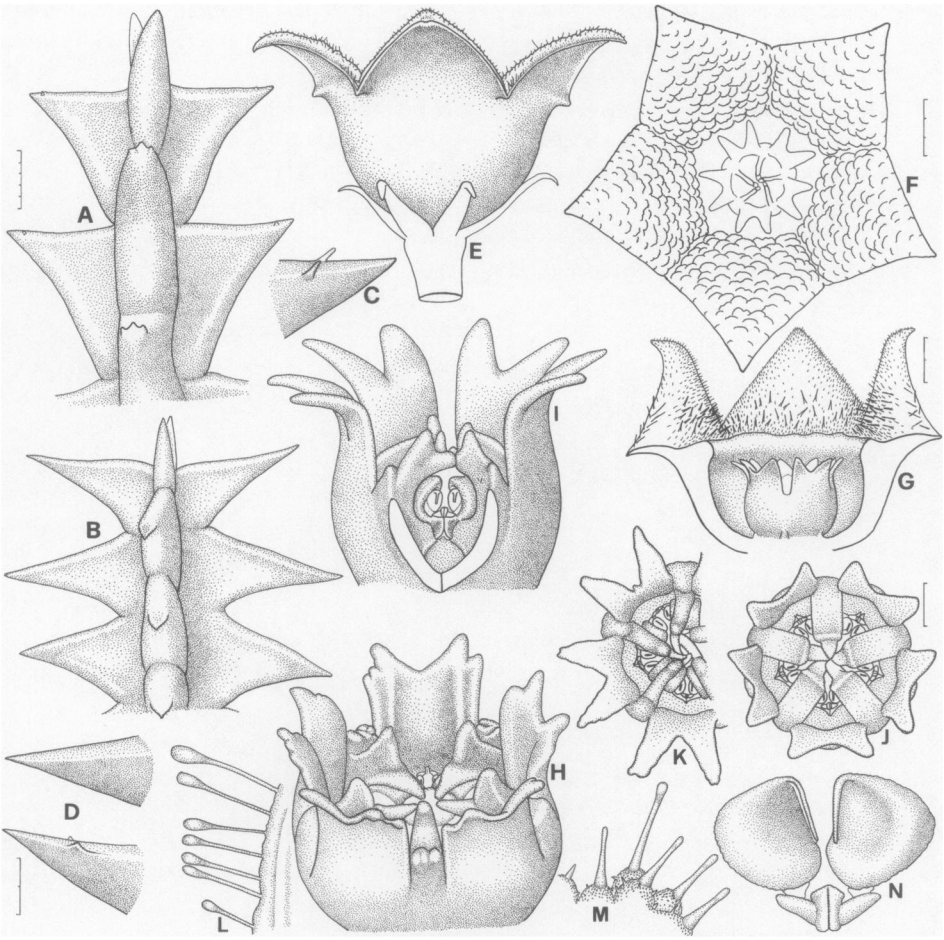

FIG. 46. *Orbea carnosa* subsp. *keithii* A, B. Portions of stem. C, D, Leaf rudiments; both at D from same stem. E. Side view of flower. F. Face view of flower. G. Side view of dissected flower. H. Side view of gynostegium. I. Side view of gynostegium with one outer corona lobe removed. J, K. Face views of gynostegium. L. Papillae borne near base of lobe along margins, farthest from interior of flower. M. Papillae borne at middle of lobe on inside of corolla. N. Pollinarium. Scale bars: A, B, 5 mm (at A); C, D, 2 mm (at D); E, F, 3 mm (at F); G, 2 mm; H, I, 1 mm (at D); J, K, 1 mm (at J); L, M, 0.5 mm (at D); N, 0.25 mm (at D). [Based on: A, C, H, L, M, *Bruyns 4453*; B, D, *Bruyns 6558*; G, J, *Bruyns 2040*; E, F, I, K, N, *de Kock s.n.,* Gutschwa Kop, 2531 AC.]

25 miles SSW of Umtali [-BC], *Plowes 2574* (BOL, PRE); Odzi River, Maranke Res. [-CD], *Plowes 2576* (SRGH). [2230] Near Beitbridge [-AA], *Rushworth 479* (SRGH).

As in subsp. *carnosa*, in subsp. *keithii* the inside of the corolla is densely covered with an irregular reticulation of raised ridges. These are covered in a variety of papillae: the epidermal cells are spikelike, and some are longer than others but also spikelike, whereas still others are very much larger, tapering from a thick base and then swelling again towards the tip. There is often a row of clavate hairs near the margins of the lobes near the base. These hairs are rigidly fixed and not at all vibratile. In the center, containing the corona, is a small pentagonal tube around whose mouth the corolla is variably raised and

thickened into an annulus. In populations around Wyllies Poort (north of the Soutpansberg) the annulus can be practically absent to quite conspicuous, but the type of *Pachycymbium lancasteri* has a fairly obvious annulus.

The outer corona lobes rise steeply inside the corolla tube and much exceed the anthers. In many cases, towards its apex each lobe may be shallowly to deeply cleft into two spreading lobules. When the lobes are entire, they can be very similar to those in such species as *O. lutea*, differing mainly in ascending steeply rather than spreading from lower down. The inner lobes are extremely variable in shape. Usually each consists of a small lobe adpressed to the anther (mostly completely hiding and sometimes exceeding it), which is dorsally very much thickened and adorned with various small appendages. This thickened dorsal portion fills the gaps left between the outer lobes, so that together they form the characteristic cuplike corona of this species, which contains the anthers.

Pachycymbium lancasteri was described from a single plant that had yellow flowers, a more than usually prominent annulus, and a conspicuously urceolate corona. Since pale brown flowers have been seen in subsp. *keithii*, yellow could be viewed as a further color variant in subsp. *keithii*. The annulus, too, is variably present in subsp. *keithii*. The outer corona is also very variable, and Leach and Plowes (1967) mention an even more extreme case, where it formed a "crenulate margined, complete urceolate cup." Therefore, *P. lancasteri* falls within the range of variation of subsp. *keithii*.

25. Orbea subterranea (E. A. Bruce & P. R. O. Bally) Bruyns, Aloe 37: 76. 2001. *Caralluma subterranea* E. A. Bruce & P. R. O. Bally, J. Cact. Succ. Soc. Amer. 13: 165. 1941. *Pachycymbium baldratii* subsp. *subterraneum* (E. A. Bruce & P. R. O. Bally) M. G. Gilbert, Bradleya 8: 24. 1990. *Angolluma subterranea* (E. A. Bruce & P. R. O. Bally) Plowes, Excelsa 16: 119. 1994.—TYPE: KENYA. Sagalla, *Joanna sub Bally S4* (holotype: K!).

Angolluma lenewtonii Lavranos, Asklepios 73: 15. 1998.—TYPE: KENYA. Marsabit Distr., Mt Kulal [N 0236 DB], 1500 m, 16 Nov 1992, *Newton et al. 4148* (holotype: K!).

Small succulent forming clusters of stems connected by underground rhizomes. Stems 2–10 cm long, 0.5–1.5 cm in diameter (excluding teeth), decumbent to erect above ground from horizontal rhizomes up to 20 cm long, pale green with purple-brown mottling; tubercles 5–17 mm long, arranged into 4 somewhat wing-like rows along stems with a groove between them, spreading and slightly ascending, laterally flattened to conical and narrowly deltoid, slender and attenuating to a fine tip, slightly flattened above for 3–4 mm from tip, often with 1–2 small stipular denticles 3–4 mm from tip. Inflorescences 1–8 per stem mostly in distal half, each with 1–3 flowers opening in gradual succession, peduncle absent, with a few bracts <1 mm long, each with slight lateral ridges below middle; pedicel 1–2 (–10) mm long, 1 mm in diameter, ascending to spreading, holding flower facing upwards to slightly downwards. Sepals 2–5 mm long, 1.0–1.5 mm wide at base, ovate-lanceolate, acuminate. Corolla 0.8–1.7 cm in diameter, rotate; outside pale green suffused with brown; inside purple-brown to pink occasionally suffused with yellow, rarely yellow, covered (except in tube) by small conical papillae, each tipped with a bristle up to 1 mm long; tube 1–2 mm long, 3–4 mm in diameter, shallowly bowl-shaped, sometimes slightly thickened at mouth; lobes 3–7 mm long, 2–4 mm wide at base, spreading to slightly reflexed, ovate-deltate to narrowly lanceolate, acute, convex above, the margins reflexed and often with slender rigid cilia up to 1 mm long to eciliate. Corona 2–3 mm tall, 2.5–4.5 mm in diameter, without basal stipe,

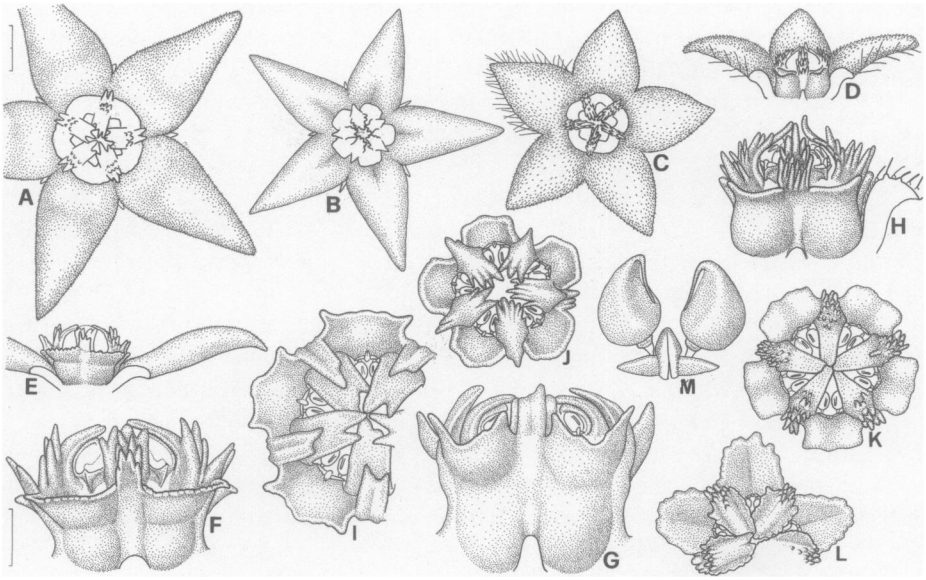

FIG. 47. *Orbea subterranea* A–C. Face views of flower. D, E. Side views of flower with two corolla lobes removed. F–H. Side views of gynostegium. I–L. Face views of gynostegium. M. Pollinarium. Scale bars: A–E, 2 mm (at A); F–L, 1 mm (at F); M, 0.25 mm (at F). [Based on: A, E, F, *Joanna sub Bally S4*; B, J, *Ossent sub EAH 12106*, pedicels 10 mm long; C, D, H, *Joy Bally sub Bally S159*; G, I, *Joanna sub Bally S20*; K, M, *Newton 4109*, Nairobi; L, *Newton et al. 4148*.]

dark purple becoming paler towards base; outer lobes 1.0–2.0 mm long, forming a deep pouch between inner lobes, often notched in middle or crenulate, laterally confluent with lowest dorsal ridge on inner lobes; inner lobes ± 1.5 mm long, adpressed to backs of anthers and sometimes meeting in center, dorsiventrally flattened, with many cylindrical and acute to ridge-like adpressed to erect to spreading protuberances dorsally towards base, deltate to ± rectangular, divided into 1–4 ± cylindrical teeth towards obtuse apex. Fig. 47.

Distribution (Fig. 44). Ethiopia (?), Kenya, Tanzania, Uganda (?); 900–1600 m.

Orbea subterranea is found in Kenya and the northern part of Tanzania. Gilbert (1978) mentions that it has been found in southern Ethiopia and northeastern Uganda, but no specimens have been located from these areas. In Tanzania *O. subterranea* is mainly known from around the western foot of Kilimanjaro, whereas in Kenya it is widely distributed from the southeast to the north near Lake Turkana.

Orbea subterranea is found in a wide variety of habitats. Around Ngare Nanyuki in Tanzania it occurs among lava stones in flat to gently sloping areas with very scattered *Acacia* trees and short grass, in the company of other succulents, such as *Euphorbia similiramea* Carter, *Kleinia gregorii* (S. Moore) C. Jeffrey and *K. petraea* (R. E. Fries) C. Jeffrey, *Orbea dummeri*, and *Sarcostemma vanlessenii* Lavranos. Bally recorded it on rocks with *Selaginella* on Mt Kasigau in southern Kenya.

ADDITIONAL SPECIMENS EXAMINED. **Kenya.** [N 0237] Marsabit [-BD], *Joy Bally sub Bally S 159* (K). [0034] 3 miles from Kisumu towards Kakamega [-BA], *Joy Bally sub Bally S 30* (K). [0036] Lake Naivasha [-CC], *Maguis sub Hepper & Field 5108* (K). [0037] Sagana [-CA], *Joanna sub Bally S 20* (K). [0136] Ngong Hills [-B], *Bally S 13* (K); Nairobi Game Park [-B], *Gilbert s.n.* (K); Langata [-B], *Ossent sub EAH 12106* (K);

Mbagathi Gorge [-B], near Nairobi, *Bally S 42* (K). [0338] Maktao [-AC], *MacArthur sub Bally S 42* (K); Mt Kasigau [-DC], *Bally 12695* (K), *12284* (K). **Tanzania.** [0336] W of Ngare Nanyuki [-BA], *Bruyns 8699a* (BOL); Ngare Nanyuki [-BB], *Richards 26597* (K); E of Ngare Nanyuki [-BB], *Bruyns 8695* (BOL). Ormutangi Plain, *Richards 24997* (K).

Orbea subterranea is most similar to *O. wilsonii* and *O. carnosa*; for separation from *O. wilsonii* see that species (no. 26). It differs from *O. carnosa* in that the corolla is not quite as fleshy and the corolla tube is shorter. The respective illustrations (Figs. 46, 47) demonstrate the differences in the gynostegia.

In Kenya and Tanzania, *O. subterranea* shares its rhizomatous habit with *O. laikipiensis*, *O. vibratilis*, and *O. wilsonii*. The stems, with broadly deltoid and laterally flattened tubercles, are most similar in appearance to those of *O. wilsonii* (and *O. carnosa* from southern Africa). As in all these species (*O. carnosa* included), stipular denticles are intermittently present on many of the tubercles. Sometimes they are clearly toothlike, but they may also appear as a small ridge alongside the base of the leaflet.

Orbea subterranea is particularly variable in the length of the pedicels, in the size of the corolla, and in the size and shape of the corona. The corona can be up to 4.5 mm in diameter. The outer lobes may form a continuous rim connecting the bases of the inner lobes but may also spread outwards as five distinct teeth of very variable shape (e.g., *Ossent sub EAH 12106*, *Newton et al. 4148*). The inner lobes are variable in their apical shape, but even more so in their dorsal excresences: these may be almost entire and deltate with a single dorsal horn, which may spread or even be adpressed to the back of the lobe itself, but there may also be many cylindrical dorsal protuberances.

The recently described *Angolluma lenewtonii* deserves some comment. The description was not very detailed and little explanation as to the differences from other species was given. The stems of *A. lenewtonii* bear a very close resemblance to those of *O. carnosum*, even more so than in some specimens of *O. wilsonii* and in many other plants of *O. subterranea*, with narrowly deltoid, laterally flattened tubercles forming wing-like rows along the stem. This resemblance is heightened by the very rhizomatous nature, by the intermittent presence of stipular denticles on the tubercles, and also by the manner in which the small flowers are borne in small fascicles most of the way along the stem. These characters match those listed by Leach (1978) in his circumscription of *Pachycymbium*, and Lavranos's placing of this taxon in *Angolluma* is puzzling. I failed to find any characters that may be used to distinguish between *O. subterranea* and *A. lenewtonii*. In particular the latter was supposed to be "hairy," but the small papillae, bearing an apical bristle, that cover the surface of the corolla are found in most flowers of *O. subterranea* as well. In addition, in material collected by Joy Bally (*Bally S 159*, K) from the Marsabit area these "hairs" are much smaller and finer than in *A. lenewtonii*, whereas all the other details of the flowers are the same. There is a considerable range of shapes to be seen in the outer and inner coronas of *O. subterranea*, and that in *A. lenewtonii* merely has slightly longer and more irregularly edged lobes. *Orbea subterranea* is well known to be especially variable in the Marsabit area (c.f. also Brandham, 1978, and the material gathered by Bally). Consequently, *A. lenewtonii* is reduced to synonymy.

26. Orbea wilsonii (P. R. O. Bally) Bruyns, Aloe 37: 76. 2001. *Caralluma wilsonii* P. R. O. Bally, Candollea 21: 371. 1966. *Pachycymbium wilsonii* (P. R. O. Bally) M. G. Gilbert, Bradleya 8: 22. 1990. *Angolluma wilsonii* (P. R. O. Bally) Plowes, Excelsa 16: 110. 1994.—TYPE: UGANDA. Toro Distr., about 30 mi S of Kasese,

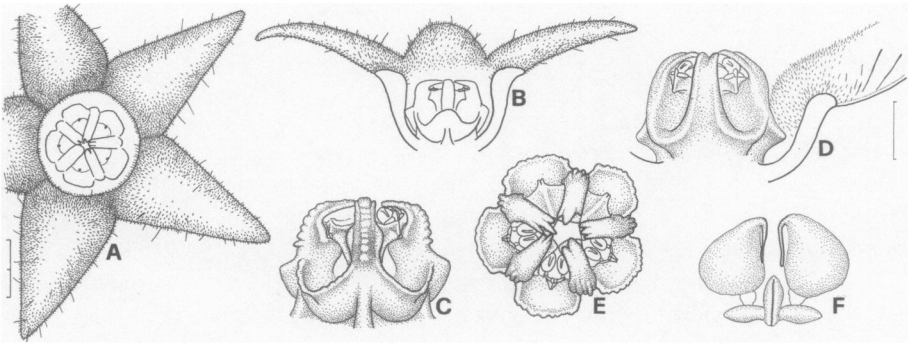

FIG. 48. *Orbea wilsonii.* A. Face view of flower. B. Side view of dissected flower. C, D. Side views of gynostegium. E. Face view of gynostegium. F. Pollinarium. Scale bars: A, B, 2 mm (at A); C–E, 1 mm (at D); F, 0.25 mm (at D). [Based on: A-C, E, *Taylor sub Bally 14004*; D, F, *Dodds 1*.]

Lokitunyala near Mweya Lodge [0029 BB], Ruwenzori National Park, 1963, *Wilson 13* (holotype: K!).

Small rhizomatous succulent. Stems 5–6 cm long, 0.5–1.2 cm in diameter (excluding teeth), decumbent, grey-green with maroon mottling; tubercles 4–20 mm long, deltoid or laterally flattened, arranged into 4 often somewhat wing-like rows along stem with a groove between them, ascending to spreading, sometimes with 1–2 small stipular denticles 3–4 mm from tip. Inflorescences 1–5 per stem near apex, each of 1–3 (–6) flowers developing in gradual succession ± without a peduncle, with a few slender bracts to 0.75 mm long; pedicel 1–3 mm long, 1 mm in diameter, spreading to ascending with flower facing partly upwards. Sepals 1.5–3.5 mm long, 1 mm wide at base, narrowly ovate-lanceolate, acuminate. Corolla 1.2–1.5 cm in diameter, shallowly campanulate; outside pale grey-green with maroon streaks; inside finely papillate and with scattered longer bristles to 1 mm long, pale yellow to maroon with small scattered almost circular maroon to dark maroon spots, becoming white in base of tube; tube 1.0–2.5 mm long, 3–6 mm in diameter, cupular, containing lower half to whole of gynostegium, with the corolla slightly thickened at mouth; lobes 3.5–5.0 mm long, 2.0–3.5 mm wide at base, spreading, ovate-deltate, acute, convex above, the margins reflexed, eciliate. Corona 2–3 mm tall, 2.5–3.0 mm in diameter, with a very short basal stipe, red to dark purplish maroon becoming white around base; outer lobes shallowly pouch-like near base of gynostegium between inner lobes with slightly spreading entire mouth; inner lobes ± 1 mm long, adpressed to backs of anthers and slightly exceeding them, dorsiventrally flattened and dorsally somewhat rugose, obtuse to deeply emarginate. Fig. 48.

Distribution (Fig. 44). Kenya, Uganda; 1000–1950 m.

Very little is known about the range of this species. Wilson's type specimen came from southwestern Uganda, but the species has never been collected there again, and Gilbert (1990) even suggested that Wilson's collection might have come from elsewhere. Recent collections are few, though there is a photograph in Schulz and Powys (1998: 13) of a plant from somewhere in the Laikipia district of Kenya.

ADDITIONAL SPECIMENS EXAMINED. **Kenya.** [N 0036] Lake Kisima, half-way between Maralal and Suguta Marmor [-DD], *Taylor sub Bally 14004* (K); Muge Ranch, near Suguta Marmor [-DC], *Dodds 1* (BOL).

The tubercles on the stem in *O. wilsonii* may be conspicuously deltoid or laterally flattened. In this respect, they can be similar to those of *O. carnosa* subsp. *keithii* and some plants of *O. subterranea*, and are not as rounded and conical as is usual in the species from East Africa. Yet, as in *O. subterranea*, they may also be small and quite inconspicuous, which is the case in the material cited above collected by Dodds.

The flowers are also of a similar size in both *O. subterranea* and *O. wilsonii*, and in both species the inner surface of the corolla may be bristly (this is especially variable in *O. subterranea*). In *O. subterranea* the inside of the flower is uniformly colored and is not known to have the round, darker spots that are apparently unique to *O. wilsonii*. In *O. wilsonii* the depth of the corolla tube is variable, so that sometimes it contains the entire gynostegium, but in plants from Rumuruti only the lower half is included in the tube. In *O. subterranea* at least the top of the gynostegium always seems to protrude from the tube. In *O. wilsonii* the outer corona lobes are rather lower on the gynostegium than in *O. subterranea*, forming only a shallow pocket, and the inner lobes rise steeply to be pressed to the backs of the anthers. The inner corona lobes are also not ornamented with dorsal ridges and excrescences, as are typically (though not always) found in *O. subterranea*.

The original publication of *Caralluma wilsonii* was accompanied by the citation of a single specimen (*Wilson 13*), which is acceptable as an indication that this was the holotype. Consequently (ICBN, 1994, Art. 37.3), the name was validly published by Bally in 1966 (c.f. Bally & Carter 1974; Gilbert 1990).

27. Orbea semitubiflora (L. E. Newton) Bruyns, Aloe 37: 76. 2001. *Angolluma semitubiflora* L. E. Newton, J. Cact. Succ. Soc. Amer. 65: 198. 1993.—TYPE: TANZANIA. Kisite crater [0236 CC], 02°49′S, 36°00′E, *Newton 3419* (holotype: K!; isotype: EA).

Small succulent forming diffuse clumps to 15 cm in diameter, glabrous throughout, rhizomatous. Stems 3–8 cm long, 0.7–1 cm in diameter (excluding teeth), ± slender, decumbent and often subterranean for up to 15 cm then erect above ground, grey-green with irregular maroon flecks; tubercles 4–12 mm long, arranged into 4 rows along stems (joined only near bases), ascending to spreading, conical and tapering to an acute tip, slightly flattened above and often with two lateral stipular denticles. Inflorescences 1–5 per stem near apex, each with 2–7 flowers opening in rapid succession (often 2 open at once) on a very short peduncle (<3 mm long); pedicel 5–9 mm long, 1.5 mm in diameter, ascending to hold flower facing upwards. Sepals 4–5 mm long, 1.5 mm wide at base, ovate-lanceolate, acuminate. Corolla 1.8–2.5 cm in diameter, shallowly campanulate; outside smooth, pale green to pinkish towards tips of lobes and faintly maroon-lined; inside minutely papillate to almost smooth, yellow-green in tube, bright yellow on lobes, sometimes wholly maroon or brown; tube 3–4 mm long, 5–7 mm in diameter, cupular, containing gynostegium, very slightly thickened around mouth; lobes 7–9 mm long, 3–5 mm wide at base, spreading, ovate-lanceolate, acuminate, convex above, the margins reflexed, eciliate. Corona 3–4 mm tall, 4–5 mm wide, without basal stipe, bright yellow to red or brown; outer lobes 1 mm tall in middle rising to 3–4 mm where fused to inner lobes, forming a shallow pouch between inner lobes and much excavated between them; inner lobes <1 mm long, adpressed to backs of anthers but not equalling them, dorsiventrally flattened, deltate, obtuse, sometimes with small horizontally spreading horn between outer lobes. Figs. 2B, 49.

Distribution (Fig. 50). Tanzania; 950–1450 m.

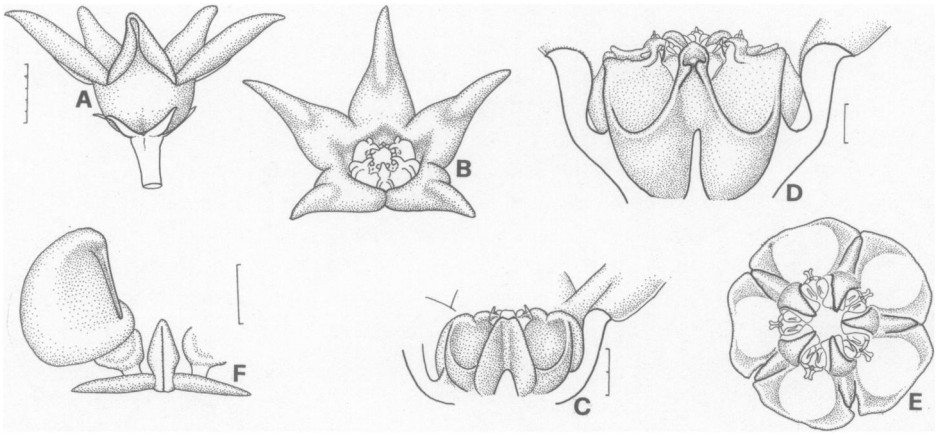

FIG. 49. *Orbea semitubiflora.* A. Side view of flower. B. Oblique face view of flower. C, D. Side views of center of dissected flower. E. Face view of gynostegium. F. Part of pollinarium. Scale bars: A, B, 5 mm (at A); C, 2 mm; D, E, 1 mm (at D); F, 0.25 mm. [Based on: A–C, F, *Newton 3419*; D, E, *Bruyns 8705b*.]

This species is known from the Rift Valley to the north, northwest, and southwest of Arusha in Tanzania; it is also reputed to occur to the south of Lake Victoria (White & Sloane 1937: 1182–4), though no specimens have been located from this area. Plants usually occur on barren and otherwise fairly exposed places among stones and in crevices in lava with occasional small bushes.

ADDITIONAL SPECIMENS EXAMINED. **Tanzania.** [0235] near Ol Doinyo Lengai [-DD], *Bruyns 8705b* (BOL). [0335] Ngorogoro crater [-BA], *Bally S 76* (K). [0336] Ngari Nanyuki [-BB], 12 Apr 1968, *Greenway & Kanuri 13479* (K).

Vegetatively *O. semitubiflora* closely resembles *O. denboefii* and *O. dummeri*, so that these three species mostly cannot be distinguished when not in flower. All three may occur within close proximity of one another in some parts of Tanzania. From both of these species *O. semitubiflora* differs by the much smaller corolla tube and the low gynostegium, whose outer corona lobes are deeply excavated towards the middle. The other species of *Orbea* that grows in the area is *O. subterranea*, and *O. semitubiflora* differs from it by the larger flowers with a deeper corolla tube and the different-looking stems, in which the tubercles are not as strongly laterally flattened and are not as clearly united into rows. Plants of *O. semitubiflora* are mostly much less rhizomatous than those of *O. subterranea*. They are in fact very variable in this feature, and in some of them the stems show no sign of underground growth at all.

Orbea semitubiflora was first observed by B. D. Burtt sometime before 1937 about 160 km S of Lake Victoria. He sent photographs of what is almost certainly this species to White and Sloane (1937: fig. 1231). The next documented collection was made in 1941 by P. R. O. Bally in the Ngorogoro Crater. He found it to be very common and also noted both maroon- and yellow-flowered forms growing together. He regarded this population as a form of *O. subterranea*. Newton's more recent collection, from which the species was described, was of a single plant with yellow flowers, but others with brown flowers have been collected near Lake Natron.

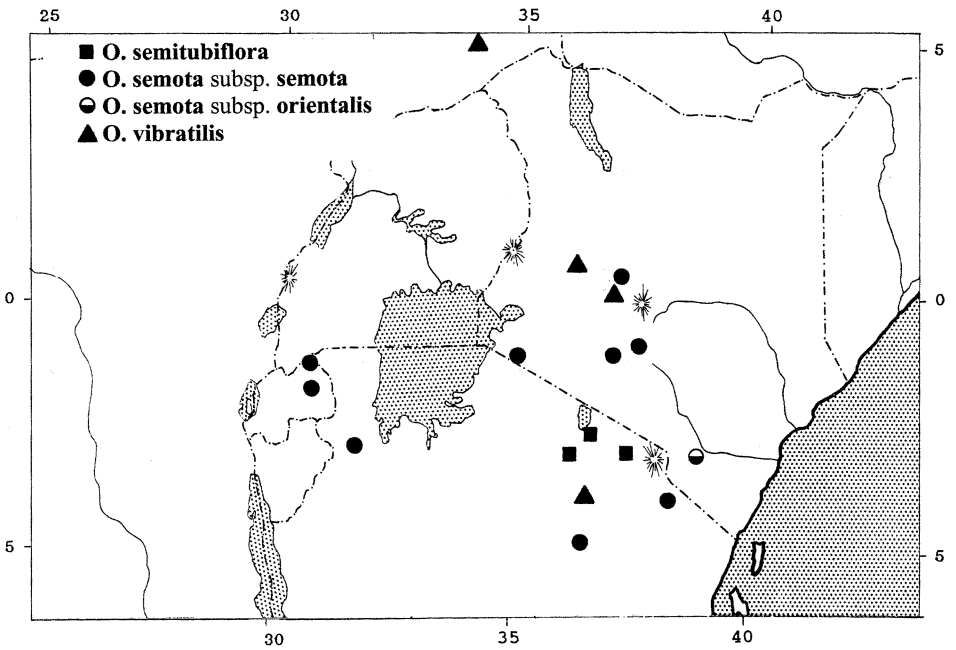

FIG. 50. Distribution of *Orbea semitubiflora*, *O. semota*, and *O. vibratilis*.

28. Orbea taitica Bruyns, sp. nov.—TYPE: KENYA. [0338] Taita Hills [-AD], 1300 m, 4 Dec 1998, *Luke et al. 5561* (holotype: BOL!; isotype: K!).

A O. wilsonii corolla absque pilis papillisque et lobis interioribus coronae planioribus differt, a O. semitubiflora tubo corollae vadosiore, tubo corollae basi coronae adnato discedit.

Small succulent forming diffuse clumps to 15 cm in diameter, glabrous throughout, partly rhizomatous. Stems 3–15 cm long, 0.8–1 cm in diameter (excluding teeth), ± slender, decumbent and often subterranean for up to 15 cm then erect above ground, green with irregular maroon flecks; tubercles 3–7 mm long, arranged into 4 obtuse rows along stems (joined only near bases), ascending, conical and tapering to an acute tip, slightly flattened above, very rarely with one minute lateral stipular denticle towards apex. Inflorescences 1–5 per stem near apex, each with 1–3 flowers opening in gradual succession, peduncle up to 1 mm long, bracts lanceolate; pedicel 2–3 mm long, 1 mm thick, spreading; sepals 1.5–2.0 mm long, 1 mm wide at base, lanceolate, acute. Corolla 1.5–1.7 cm in diameter, ± rotate; outside smooth, pale green and faintly maroon-lined; inside smooth, without bristle-tipped papillae, maroon; tube 2.5 mm long, 4–5 mm in diameter at mouth, cupular, almost containing gynostegium, very slightly thickened around mouth; lobes 5–6 mm long, 3 mm wide at base, spreading, lanceolate, acute, convex above, the margins reflexed, eciliate. Corona ± 3.5 mm tall, ± 4.5 mm wide, without basal stipe, maroon; outer lobes ± 2 mm tall in middle rising to 3–4 mm where fused to inner lobes, forming a pouch

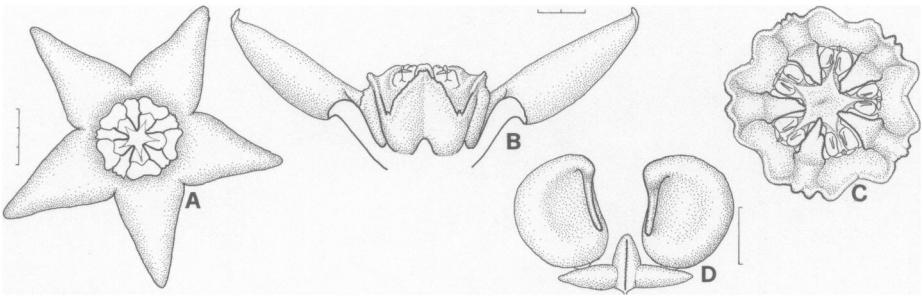

FIG. 51. *Orbea taitica.* A. Face view of flower. B. Side view of dissected flower. C. Face view of gynostegium. D. Pollinarium. Scale bars: A, 3 mm; B, 2 mm; C, 1 mm (at D); D, 0.25 mm. [Based on *Luke et al. 5561*.]

between inner lobes and much excavated between them; inner lobes <1 mm long, adpressed to backs of anthers but not equalling them, dorsiventrally flattened, deltate, obtuse, sometimes with small horizontally spreading horn between outer lobes. Fig. 51.

Orbea taitica is known only from the type collection from the Taita Hills in southeastern Kenya (Fig. 44). Plants were found on a rocky outcrop in seasonally burnt grassland.

This new species is somewhat similar to *O. semitubiflora* and *O. wilsonii*. It is comparatively easy to separate from *O. wilsonii*, because the inside of the corolla lacks the dense covering of fine, hair-like papillae that is typical of *O. wilsonii*; also, the inner corona lobes do not rise up steeply from the level of the outer lobes onto the backs of the anthers. *Orbea taitica* differs from *O. semitubiflora* in that the gynostegium protrudes more from the corolla tube and is less fused to the sides of the corolla tube near the base.

29. Orbea vibratilis (E. A. Bruce & P. R. O. Bally) Bruyns, Aloe 37: 76. 2001. *Caralluma vibratilis* E. A. Bruce & P. R. O. Bally, J. Cact. Succ. Soc. Amer. 13: 179. 1941. *Pachycymbium vibratile* (E. A. Bruce & P. R. O. Bally) M. G. Gilbert, Bradleya 8: 22. 1990. *Angolluma vibratilis* (E. A. Bruce & P. R. O. Bally) Plowes, Excelsa 16: 106. 1994.—TYPE: KENYA. Mariget near Lake Baringo [N 0035 BD], 25 Mar 1940, *A. T. A. Ritchie sub Bally S 35* (holotype: K!).

Dwarf succulent with few stems scattered over an area 15 cm to 2 m in diameter, rhizomatous. Stems 5–10 cm long, 0.5–1 cm in diameter (excluding teeth), erect above ground from horizontal rhizomes up to 1.75 m long, glaucous pale green with purple-brown mottling; tubercles 2–8 mm long, arranged into 4 rows along stems (joined near bases), conical, short and stout, with a slight lateral ridge on either side near base of leaf-rudiment. Inflorescences 1–3 per stem, each with 1–5 flowers opening in gradual succession on a short peduncle (up to 5 mm long), with lanceolate bracts up to 2 mm long, each with lateral ridges below middle; pedicel 1–2 mm long, 1 mm in diameter, ascending to descending, holding flower facing upwards or downwards. Sepals 1.5–3.0 mm long, ± 1 mm wide at base, lanceolate, acuminate. Corolla 0.4–1 cm long, 0.8–1.2 cm in diameter, campanulate; outside pale green; inside purple-brown transversely mottled with yellow-green from lobes sometimes to base of tube (sometimes mottling faint or absent), sometimes transversely rugulose, minutely papillate; tube 3–5 mm long, 3.5–4.0 mm in diameter, cupular, somewhat constricted at mouth by distinct thickening of corolla especially

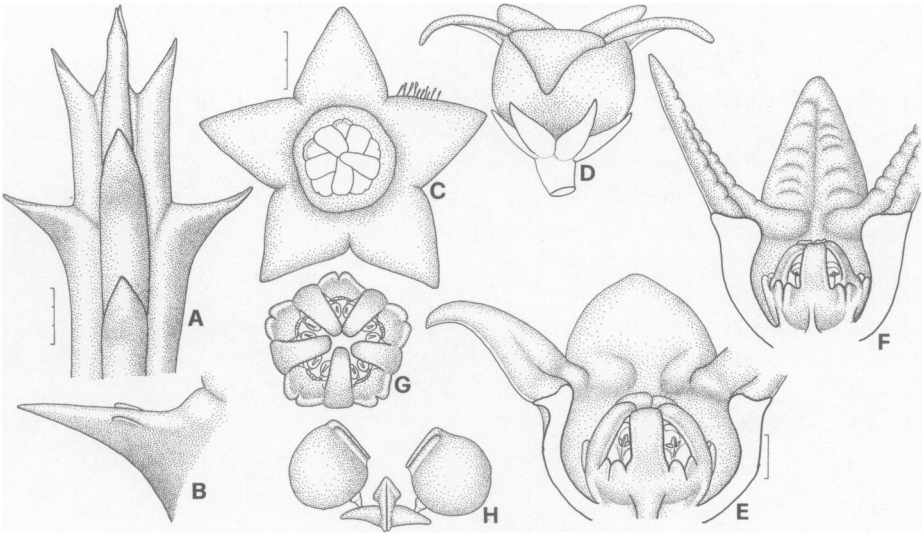

FIG. 52. *Orbea vibratilis.* A. Apex of stem. B. Side view of leaf rudiment with stipular ridge. C. Face view of flower. D. Side view of flower. E, F. Side views of dissected flower. G. Face view of gynostegium. H. Pollinarium. Scale bars: A, 3 mm; B, 1 mm (at A); C, D, F, 2 mm (at C); E, G, 1 mm (at E); H, 0.25 mm (at C). [Based on: A, Rumuruti, *Dodds s.n.*; B, F, *Greenway sub K 6735*; C, D, E, H, *Ritchie sub Bally S 35*; G, *Richards 24856.*]

below bases of lobes; lobes 4–7 mm long, 3–4 mm wide at base, ascending to slightly reflexed from mouth of tube, deltate, acute, convex above, the margins reflexed and with vibratile clavate cilia up to 2 mm long mainly in proximal half. Corona 3 mm tall, 3–4 mm in diameter, without basal stipe, dark purple-black; outer lobes 1.5–2.0 mm long, forming a low pouch between inner lobes, shortly bifid into erect teeth with rounded tips; inner lobes 2 mm long, rising up above anthers and becoming horizontal to meet in center, dorsiventrally flattened, narrowly rectangular to almost lanceolate, obtuse. Fig. 52.

Distribution (Fig. 50). Ethiopia, Kenya, and Tanzania; 1000–1900 m.

Orbea vibratilis is very sparsely recorded and is known from three widely separated areas: southern Ethiopia (Gilbert 1978), the central part of Kenya, and central Tanzania. Plants are usually found in black "cotton" soils in areas that are poorly drained (Gilbert 1978; Schulz & Powys 1998), where they grow among short grasses and scattered *Acacia* trees.

ADDITIONAL SPECIMENS EXAMINED. **Kenya.** [N 0036] Kifuku Ranch [-BA], 00°10′N, 36°35′E, Rumuruti, *Dodds s.n.* (BOL). **Tanzania.** [0336] Tarangire Camp [-CC], Tarangire Nat. Park, *Richards 24856* (K). Without locality, *Greenway sub K 5295* (K), *sub K 6735* (K).

Orbea vibratilis is separated from all other species of *Orbea* in the region where it occurs by the extremely rhizomatous habit. Plants consist of scattered, erect stems separated by long underground rhizomes, which may be 0.5 m or more long. *Orbea laikipiensis*, *O. subterranea*, and *O. wilsonii* are all rhizomatous, but the underground parts never reach this length, and the parts above the ground always form small clusters of stems. The stems of *O. vibratilis* are also considerably different in that they bear comparatively short tubercles, rather than the broad, deltoid tubercles that are typical of these other species.

Some of these tubercles have small stipular ridges near the base along the edges, and both these ridges and the shape of the individual stems are reminiscent of those in *O. lugardii*.

In *O. vibratilis* the generally small flowers are borne on very short pedicels and are variable in orientation, from nodding to facing upwards. The corolla tube is usually noticeably constricted at the mouth by considerable thickening of the corolla. This thickening may be confined to five patches just below the base of the lobes, as in Fig. 52E, F, but may also be continuous around the mouth of the tube, as in Fig. 52C (shown also in Schulz & Powys, 1998, p. 189, 190). The corolla lobes bear clavate, vibratile, marginal cilia. Marginal cilia are found sometimes in *O. subterranea*, but here they are slender rather than clavate and are rigidly attached to the corolla rather than vibratile. Another unusual feature is the transverse mottling that is found inside the corolla. Although mottled corollas are fairly common in southern Africa, this becomes rarer as one proceeds into East Africa and north of the equator.

The outer corona lobes form a deep pouch beneath the guide-rails, and there is no extra flap of tissue shutting off the nectarial cavity. The lobes are bifid into small, erect lobules that remain close together. The inner lobes rise up above the anthers and meet in the center, and they have no dorsal outgrowths at all.

30. Orbea miscella (N. E. Brown) Meve, Kakteen. Sukk. 51: 186. 2000. *Stapelia miscella* N. E. Brown, Fl. cap. 4(1): 977. 1909. *Stultitia miscella* (N. E. Brown) C. A. Lückhoff, "S.A.G." 29: 91. 1938. *Pachycymbium miscellum* (N. E. Brown) M. G. Gilbert, Bradleya 8: 28. 1990. *Angolluma miscella* (N. E. Brown) Plowes, Excelsa 16: 120. 1994.—TYPE: SOUTH AFRICA. Cape Province: near Klipplaat, *E. Pillans sub N. S. Pillans 657* (holotype: K!).

Caralluma bredae R. A. Dyer, Fl. Pl. Africa 36: t. 1438a. 1964.—TYPE: SOUTH AFRICA. Cape Province: Rietbron, *v. Breda 708* (holotype: PRE).

Caralluma bredae var. *thomallae* R. A. Dyer, Flow. Pl. Afr. 36: t. 1438b (1964).—TYPE: SOUTH AFRICA. Cape Province: near Mortimer [?], *Thomalla sub PRE 29286* (holotype: PRE!).

Minute succulent forming several small clumps, each 2–10 cm in diameter connected by ± horizontal rhizomes. Stems above ground 1–7 cm long, 0.4–0.8 cm in diameter, very slender, decumbent, sometimes running beneath surface for up to 15 cm, uniformly green to brown- or purple-green; tubercles 1–2 mm long, arranged and partly joined into 4 obtuse angles along stem with a groove between angles, tapering to a short spreading conical acute tooth, without stipular denticles. Inflorescence 1 (–2) per stem near base, of 1–3 flowers developing in gradual succession from a short peduncle, with a few lanceolate bracts 1–2 mm long; pedicels 4–18 mm long, 1.5 mm in diameter, erect, holding flower facing upwards, flecked with brown. Sepals 2–3 mm long, 1 mm wide at base, ovate-lanceolate, acuminate. Corolla 1–1.8 cm in diameter, rotate, deeply lobed, usually evil-smelling; outside smooth, pale green; inside dark purple-brown, lightly to deeply reticulated rugulose but not papillate; tube ± 1 mm deep, containing lower half of gynostegium, formed by a thickened (0.5 mm) raised to incurved pentagonal annulus (sometimes divided into 5 raised ± isolated islands, one below each lobe); lobes 4–7 mm long, 2.5–3.0 mm wide at base, spreading to recurved, ovate-lanceolate to lanceolate, acuminate to acute, convex, the margins reflexed, eciliate. Corona ± 3 mm tall, 2.5–4.5 mm in diameter, raised above base of tube on a short pentagonal stipe (<0.5 mm long), dark purple-brown to nearly black; outer lobes ± 0.5 mm long, 1.0 mm wide at base, spreading to

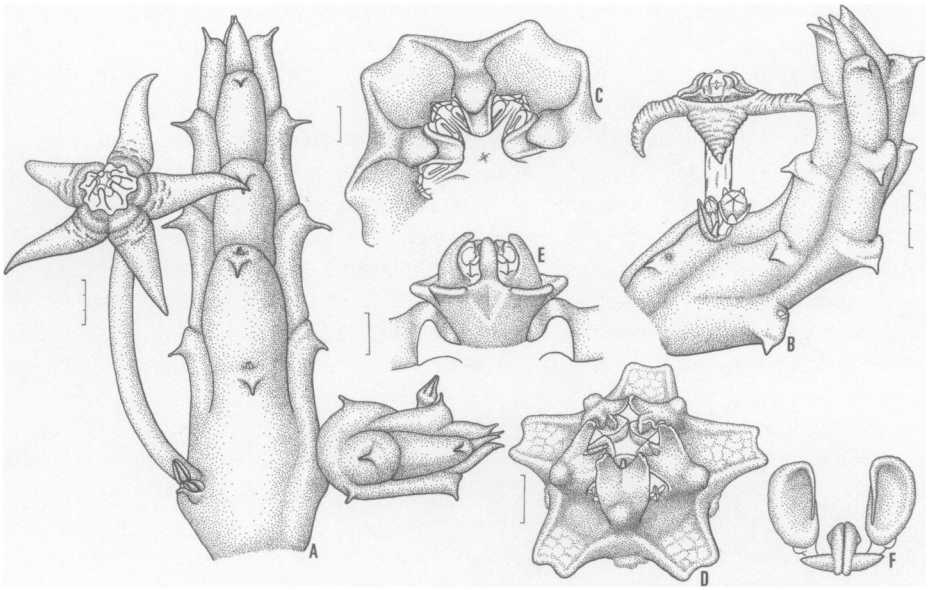

FIG. 53. *Orbea miscella.* A, B. Portions of stem bearing flowers. C, D. Face views of gynostegium. E. Side view of center of dissected flower. F. Pollinarium. Scale bars: A, 3 mm; B, 3 mm; C, 0.5 mm; D, 1 mm; E, 1 mm; F, 0.25 mm (at B). [Based on: A, E, *Bruyns 1578*; B, C, F, *Bruyns 3237*; D, *Bruyns 4250*.]

touch surface of corolla at mouth of tube, ± transversely rectangular with slight to deep deltate notch in apex; inner lobes 0.5–1.0 mm long, adpressed to backs of anthers but usually much shorter than these, slightly to strongly dorsiventrally flattened, ± deltate and obtuse or rarely ± rectangular and broadening towards a deeply emarginate apex, sometimes with a small obtuse dorsal gibbosity near base, joined to outer series dorsally towards base. Figs. 5C, 53.

Distribution (Fig. 13). South Africa; 500–1500 m.

Orbea miscella is widely distributed on the Great Karoo, from Fraserburg northeastwards to Richmond, Hanover, and Cradock, and southeastwards to Willowmore and Steytlerville (Bruyns 1982, 1986).

Specimens of *O. miscella* are usually found in flattish areas on low stony ridges, where they grow among stones and small karroid bushes usually not taller than 30 cm.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** CAPE PROVINCE: [3123] Richmond townlands [-BD], *Bruyns 3237* (BOL). [3222] Beaufort West [-BC], *Louw* (photo only) (NBG). [3224] Graaff Reinet [-BC], *James s.n.* (BOL); 23 km N of Klipplaat [-CD], *Bruyns 4250* (BOL). [3225] Welgedacht [-AB], *Bruyns 1578* (BOL); Cradock [-BA], *James sub BOL 25435* (BOL); Halesowen [-BC], *James s.n.* (BOL). [3323] Kruidfontein [-AB], *Bruyns 4909* (MO); near Miller [-BB], *G. G. Smith 2128* (BOL). [3324] Langveld [-AD], *Bruyns 4919* (BOL); Springbokvlakte [-BD], *Long sub Parks 81/40* (BOL).

Orbea miscella is separated from all other species in *Orbea* with flowers arising towards the base of the stem by the extremely small size of the stems, their uniformly dark color, and the very small size of the flowers, which face upwards.

In *O. miscella* the stems are slender (mostly about 5 mm in diameter) and small (often not more than 2 cm tall), and form small clumps often only 5–8 cm across. In some cases

several of these clumps are connected by rhizomes beneath the ground, which can spread for up to 1.5 cm before emerging again above the surface.

Flowers are produced on a short peduncle, which develops near the base of the stem. They are held facing upwards on a pedicel of extremely variable length and are themselves also very variable in many features. There is usually a thickened annulus around the corona, which may be prominent and divided into 5 discrete "islands" (one below each lobe) but may also be very insignificant. It gives rise to a small corolla tube around the base of the gynostegium. In most cases the surface of the corolla is almost smooth with a few scattered rugosities, but in some flowers the lobes are deeply reticulated-rugulose.

The corona is usually raised up on a slight stipe to protrude beyond the tube. It, too, is very variable in size; for example, the gynostegium of the type is about half the diameter of that in subsequent collections from around Klipplaat. There is often plenty of nectar secreted on the outer lobes.

The stems of this remarkable species bear some resemblance to those of *O. ubomboensis*; they are similarly small, uniformly colored, with very small tubercles but no stipular denticles. In *O. miscella* the usually solitary inflorescence arises near the base of the stem, whereas in *O. ubomboensis* several inflorescences are produced on each stem near its apex. The flowers of the two are similar in size. Although the flower of *O. miscella* is very small, it has the raised, annular thickening forming a small corolla tube that is typical of many species that Leach (1978) included in *Orbea*. This annulus is quite lacking in *O. ubomboensis*. The inside of the corolla in *O. miscella* is sometimes transversely rugulose, but the epidermal cells are not raised from this surface. The respective coronas, while superficially similar, show many differences, and that of *O. miscella*, again small, is more like what is found in *O. verrucosa*, for example. The present analysis places *O. miscella* basal to a clade containing most of the species placed by Leach in *Orbeopsis* and in *Orbea* (Fig. 6).

31. Orbea caudata (N. E. Brown) Bruyns, Aloe 37: 73. 2001. *Caralluma caudata* N. E. Brown, Fl. Trop. Afr. 4(1): 485. 1903. *Orbeopsis caudata* (N. E. Brown) L. C. Leach, Excelsa Taxon. Ser. 1: 68. 1978.—TYPE: MALAWI. Namadzi (Namasi), *Cameron 25* (holotype: K!).

Small succulent forming dense to diffuse clumps up to 50 cm in diameter, not at all rhizomatous. Stems 4–15 cm long, 0.6–1.1 cm in diameter (excluding teeth), slender, erect to decumbent, pale greenish grey to olive-green flecked (sometimes intensely) with red-purple; tubercles 6–25 mm long, arranged loosely into 4 obtuse rows along stem ± without a groove between rows, tapering to a slender conical attenuate spreading to ascending tooth, with 1–2 slight lateral swellings around middle but without denticles, the part above swellings gradually withering away. Inflorescence usually only 1 per stem between middle and apex, of (2–) 3–7 extremely smelly flowers opening ± simultaneously from a slight peduncular swelling, with slender bracts up to 5 mm long; pedicel 9–20 mm long, 1.5–2.0 mm in diameter, horizontal to ascending, pale pink. Sepals 6–7 mm long, 1.5 mm wide at base, lanceolate, acuminate, the apex sometimes slightly reflexed. Corolla 3.5–6 (–9.5) cm in diameter, rotate, very deeply lobed; outside smooth, pale cream-green dotted with purple-red; inside yellow to greenish dotted with purple-brown to maroon to brick-red, becoming fainter and finer towards tips of lobes and coalescing towards center, lightly rugulose becoming coarser at middle of lobes (nearly smooth towards tips and in tube), covered with fine papillae and with coarser clavate to acute papillae in tube; tube

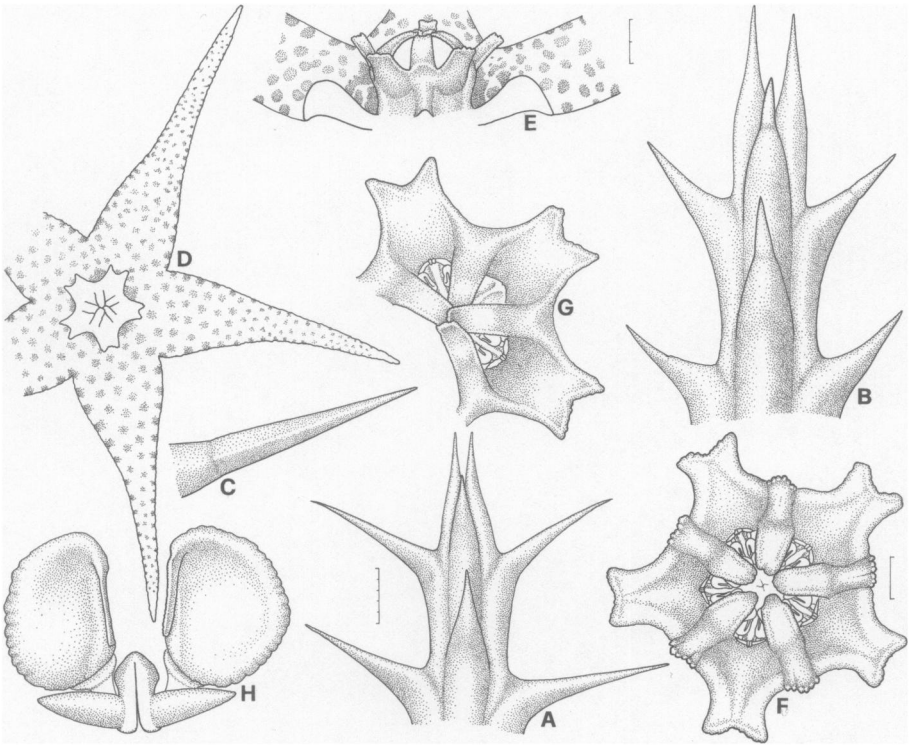

FIG. 54. *Orbea caudata* subsp. *caudata* (B, C) and subsp. *rhodesiaca* (A, D–H). A, B. Portions of stem. C. Leaf rudiments. D. Face view of flower. E. Side view of center of dissected flower. F, G. Face views of gynostegium. H. Pollinarium. Scale bars: A, B, D, 5 mm (at A); C, 2 mm (at A); E, 2 mm; F, G, 1 mm (at F); H, 0.25 mm (at A). [Based on: subsp. *caudata*: B, C, *Bruyns 7756*; subsp. *rhodesiaca*: A, E, *Bruyns 6941*; D, G, *Bruyns 6499*; F, H, *Bruyns 2292*.]

1.5–2.0 mm deep, shallowly bowl-shaped, pentagonal, just containing lower half of gynostegium, with slight thickening of corolla towards mouth; lobes 18–25 (–35) mm long, 5–7 (–11) mm wide at base, spreading, the ovate base tapering gradually to a slender acute tip, convex, the margins reflexed, with scattered slender spathulate purple cilia 1–4 mm long along most of margin except near apex of lobe. Corona 3–4 mm tall, 6–8 mm in diameter, raised above base of tube on a stout obtusely pentagonal deep purple-red stipe; outer lobes 1.5–2.0 mm long, subquadrate, slightly bifid into small obtuse to deltate diverging lobules, ascending, usually held slightly above corolla, purple-red except for broad cream patches on lobules; inner lobes 1.0–1.5 mm long, 0.7–1.0 mm wide, adpressed to backs of anthers and usually exceeding them to meet and overlap in center, dorsiventrally flattened, linear and often somewhat rectangular, obtuse, slightly gibbous on rear and fused laterally to outer lobes, rear and margins and tips purple-red, upper surface cream to white. Fig. 54.

Distribution (Fig. 55). Angola (?), Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia, Zimbabwe; 600–1600 m.

Orbea caudata is a tropical species, which occurs in the Caprivi Strip of northeastern Namibia, probably in the adjacent parts of Angola, in northern Botswana, Zimbabwe, and sporadically further north in Tanzania, Zambia, Malawi, and Mozambique.

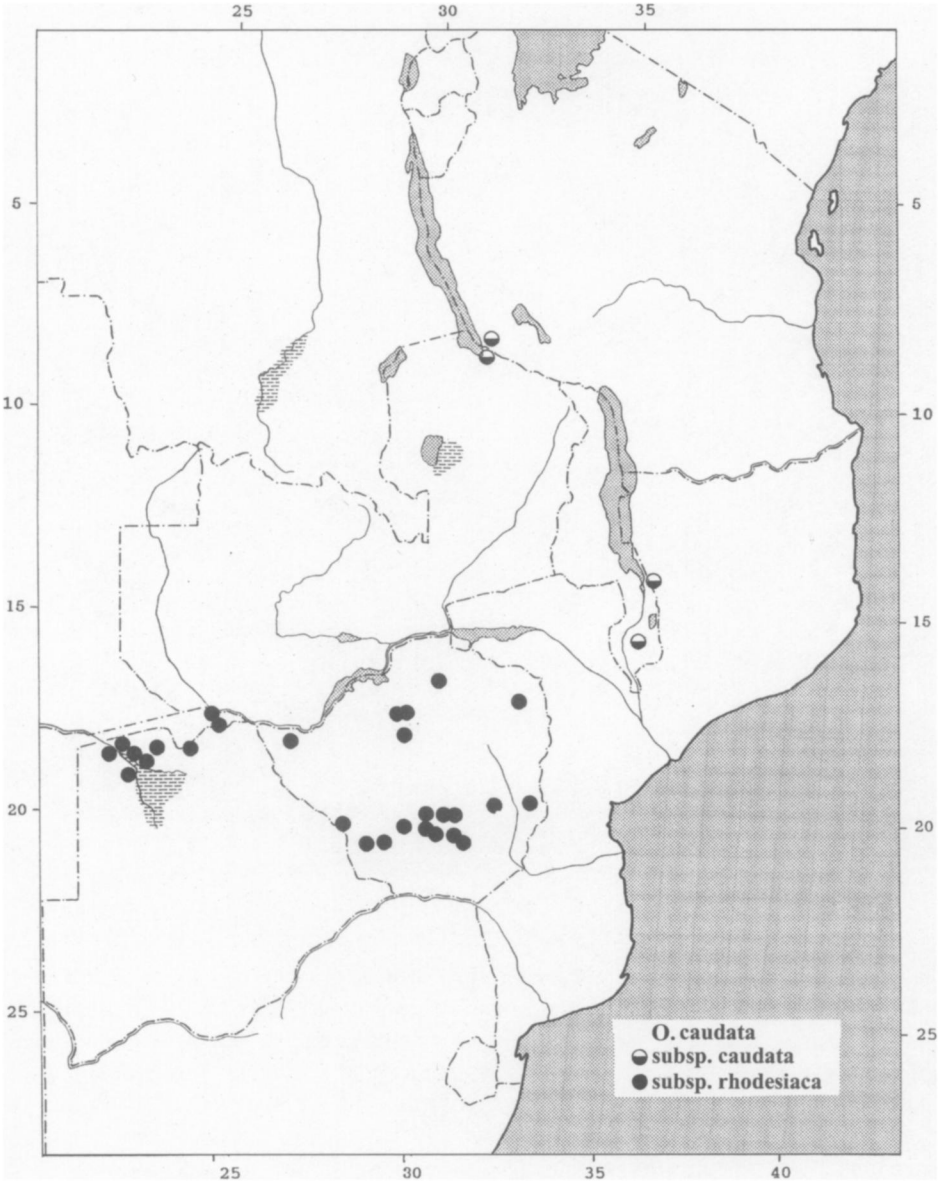

FIG. 55. Distribution of *Orbea caudata*.

This species can easily be distinguished from all other members of the group previously recognized as the genus *Orbeopsis* by the slender, not at all rhizomatous stems with long and narrow tubercles (which are only approached in *O. gerstneri* subsp. *gerstneri*), by the relatively few-flowered inflorescences, and by the exceptionally long corolla lobes. Another reliable but less easily seen difference lies in the short, almost rectangular inner corona lobes. These are flattened on the backs of the anthers, and neither possess dorsal horns nor rise up in the center.

KEY TO THE SUBSPECIES OF ORBEA CAUDATA

Stems olive-green with purplish flecks, tubercles 5–10 mm long.	31a. *O. caudata* subsp. *caudata*.
Stems grey-green with purplish flecks, tubercles 12–25 mm long.	31b. *O. caudata* subsp. *rhodesiaca*.

31a. Orbea caudata subsp. **caudata.**

Caralluma caudata var. *fusca* C. A. Lückhoff in A. C. White & B. Sloane, Stapelieae, ed. 2, 1: 352, 3: 1144. 1937.—LECTOTYPE, here designated: Fig. 287, p. 352, in White and Sloane, Stapelieae, ed. 2, vol. 1. 1937.

Caralluma praegracilis Obermeyer in A. C. White & B. Sloane, Stapelieae, ed. 2, 3: 1161. 1937.—TYPE: SOUTH AFRICA. Natal: Nongoma, *Gerstner 752* (holotype: PRE, not located).—LECTOTYPE, here designated: Fig. 1212, p. 1160, in White and Sloane, Stapelieae, ed. 2, vol. 3. 1937.

Distribution (Fig. 55). Malawi, Mozambique, Tanzania, Zambia; 600–1600 m.

Orbea caudata subsp. *caudata* (Fig. 54B, C) occurs sporadically in south-central Africa and is apparently only common around Mbala in Zambia (Leach 1973), but otherwise is fairly rare. Plants grow on gently sloping granite domes in shallow soil with small grasses, *Aloe*, *Sarcostemma viminale*, and species of *Kalanchoe*.

ADDITIONAL SPECIMENS EXAMINED. **Malawi.** [1333] Lilongwe [-DD], *Reinecke 30* (PRE, SRGH). [1535] Njuli quarry [-CA], *Bruyns 7756* (BOL). **Mozambique.** [1435] Granite rocks near Mandimba, 600 m [-AD], 15 Jan 1937, *Rocha de Torre 4* (PRE). **Tanzania.** [0831] Near border on Mbala–Sumbawanga road (-C), *Leach & Brunton 10078* (BOL, K). **Zambia.** [0831] Near Mbala [-CD], *Richards sub Leach 13296* (K, PRE, SRGH).

31b. Orbea caudata subsp. **rhodesiaca** (L. C. Leach) Bruyns, Aloe 37: 73. 2001. *Caralluma caudata* subsp. *rhodesiaca* L. C. Leach, Bothalia 11: 134. 1973. *Orbeopsis caudata* subsp. *rhodesiaca* (L. C. Leach) L. C. Leach, Excelsa Taxon. Ser. 1: 68. 1978.—TYPE: ZIMBABWE. Mberengwa Distr., S of Mnene Mission, *Leach & Bullock 13145* (holotype: ZSS; isotypes: BM, BOL! BR, K, LISC, PRE, SRGH).

Caralluma chibensis C. A. Lückhoff, S. African Gard. Country Life 25: 56. 1935. *Caralluma caudata* var. *chibensis* (C. A. Lückhoff) C. A. Lückhoff in A. C. White & B. Sloane, Stapelieae, ed. 2, 1: 352. 1937.—TYPE: ZIMBABWE. Chibi, *Jackson sub Lückhoff 182* (holotype: not located).—LECTOTYPE, here designated: upper left hand photograph on p. 56, S. African Gard. Country Life, vol. 25, 1935.

Caralluma caudata var. *milleri* Nel in A. C. White & B. Sloane, Stapelieae, ed. 2, 3: 1158. 1937.—TYPE: ANGOLA. Okavango River, *Miller sub STE 7390* (holotype: not located).—LECTOTYPE, here designated: Fig. 1211, p. 1159, in White and Sloane, Stapelieae, ed. 2, vol. 3. 1937.

Caralluma caudata var. *stevensonii* Obermeyer in A. C. White & B. Sloane, Stapelieae, ed. 2, 3: 1156. 1937.—TYPE: ZIMBABWE. Near Harare, *Stevenson sub Transv. Mus. 34947* (holotype: not located).

Distribution (Fig. 55). Angola (?), Botswana, Namibia, Zimbabwe. 800–1200 m.

Orbea caudata subsp. *rhodesiaca* (Figs. 2A, 54A, D–H) is found further to the south than subsp. *caudata*. It is, as Leach (1973) said, probably the commonest stapeliad in Zimbabwe, and the same is true in the sandy regions north of the Okavango Delta of Botswana, where it is also very plentiful. In Namibia it is known only in the Caprivi Strip in the extreme northeast.

Subspecies *rhodesiaca* is usually found on the floor of relatively open forest, frequently in woodland dominated by *Colophospermum mopane* or *Brachystegia (miombo)*. Specimens are rarely found on granite domes, where they have been seen a few times in southern Zimbabwe among small clumps of the resurrection bush, *Myrothamnus flabellifolius* Welw.

ADDITIONAL SPECIMENS EXAMINED. **Botswana.** [1822] 33 km SE of Shakawe [-AC], *Bruyns 6936* (NBG); Seronga [-CD], *Bruyns 6941* (MO); Gudigua [-DB], *Bruyns 6946* (BOL). [1823] 20 km N of King's Pool [-BC], *Bruyns 6948* (BOL). [1922] Makwenya lodge, Etsha 6 [-AB], *Bruyns 6499* (BOL). **Namibia.** [1724] Near Katima Mulilo [-CB], Feb 1954, *Codd 7595* (SRGH); Zilitenfe [-CD], *Bruyns 2338* (WIND); Muyako [-CD], *Bruyns 2292* (WIND). **Zimbabwe.** [1630] 61 km N of Chinhoyi to Doma [-CC], *Bruyns 7436* (NBG). [1729] 30 km SW of Chinhoyi [-CA], *Bruyns 7449* (BOL); Copper Queen Native Purchase area [-CB], *Bingham 1107* (SRGH). [1826] Wankie [-AD], 3 Feb 1936, *Eyles 7632* (PRE). [1829] 68 km W of Kadoma [-AB], *Bruyns 7456* (NBG). [1931] Moodies Pass [-DC], 15 Feb 1960, *Leach 9761* (SRGH). [1932] 35 km W of Melsetter [-DC], *Percy-Lancaster 11* (SRGH). [2028] Near Mwewe R. near Kezi [-CD], 30 Jan 1966, *E. J. & W. Bullock* (SRGH). [2029] 18 km N of Zvishivane [-BB], *Bruyns 7458* (NBG); 12 miles SW of Zvishivane [-BD], 20 Feb 1960, *Leach 9766* (PRE, SRGH). [2030] Near Mshandike R., 24 km W of Masvingo, [-BA], 12 Jan 1964, *Leach 12059* (PRE); 60 km S of Masvingo [-DA], *Bruyns 7768* (MO); Lundi [-DD], 3 Feb 1936, *Vereker 7632* (SRGH).

32. Orbea melanantha (Schlechter) Bruyns, Aloe 37: 76. 2001. *Stapelia melanantha* Schlechter, Bot. Jahrb. Syst. 38: 50. 1905. *Caralluma melanantha* (Schlechter) N. E. Brown, Fl. cap. 4(1): 885. 1909. *Orbeopsis melanantha* (Schlechter) L. C. Leach, Excelsa Taxon. Ser. 1: 66. 1978.—TYPE: SOUTH AFRICA. Transvaal: stony flats near Sandloop, *Schlechter 4694* (holotype: not located).—SOUTH AFRICA. Transvaal: Bandolierkop, *Leach 9757* (neotype: K!; isoneotypes: KIEL, LMA! PRE! SRGH!).

Caralluma leendertziae N. E. Brown, Ann. Transvaal Mus. 2: 47. 1909.—TYPE: SOUTH AFRICA. Transvaal: Potgietersrust, *Leendertz 1279* (holotype: K!).

Stapelia furcata N. E. Brown, Fl. cap. 4(1): 973. 1909.—TYPE: SOUTH AFRICA. Transvaal: *Todd s.n.* (holotype: K!).

Caralluma rubiginosa Werdermann, Repert. Spec. Nov. Regni Veg. 30: 54. 1932.—TYPE: based on living material cultivated at the Botanical Garden Berlin-Dahlem (no material preserved).

Caralluma melanantha var. *sousae* A. White ex Gomes e Sousa, Moçambique Doc. Trim. 4: 46. 1935.—TYPE: MOZAMBIQUE. Maputo Distr., Mangulane, *Gomes e Sousa s.n.* (holotype: not located).

Caralluma australis Nel in A. C. White & B. Sloane, Stapelieae, ed. 2, 3: 1153. 1937.—TYPE: SOUTH AFRICA. Transvaal: Pietersburg Distr., *Kirsten sub STE 5881* (holotype: NBG!).

Succulent forming mats to 1 m in diameter, not rhizomatous. Stems 3–10 cm long, (1–) 1.5–4 cm in diameter (excluding teeth), usually very stout, decumbent, pale green speckled with red-brown; tubercles 6–15 mm long, laterally flattened, joined into 4 continuous obtuse wing-like angles along stems with a deep groove between angles, tapering to a stout deltoid laterally flattened acute tooth with a small denticle on either side near tip, tip gradually becoming hardened and covered with a yellowish corky layer. Inflorescence 1 (–2) per stem near or above the middle, of 3–13 simultaneously opening flowers from a stout peduncle up to 15 mm long and 6–10 mm in diameter, with lanceolate to ovate laterally-toothed subulate bracts 4–8 mm long; pedicel 15–45 mm long, 3–4 mm in diameter, ascending to spreading. Sepals 6–10 mm long, 2–3 mm wide at base, ovate-

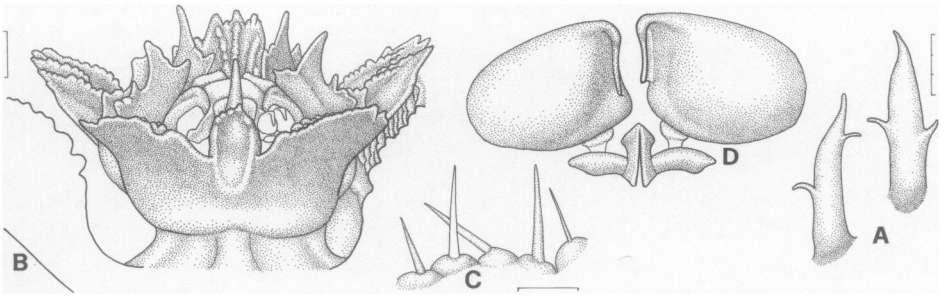

FIG. 56. *Orbea melanantha.* A. Bracts from inflorescence. B. Side view of center of dissected flower. C. Papillae borne on corolla. D. Pollinarium. Scale bars: A, 3 mm; B, 1 mm; C, 1 mm; D, 0.25 mm (at C). [Based on *Bruyns 6536*.]

lanceolate, acuminate. Corolla 4–6.5 cm in diameter, rotate; outside smooth, pale cream suffused with brown; inside deep red-brown to maroon- or purple-black, sometimes finely spotted with yellow, finely rugulose on lobes becoming deeply ± concentrically rugulose in tube, surface finely papillate all over with occasional larger spike-like papillae up to 1 mm long; tube 2.5–4.0 mm deep, short, cupular, containing ± whole of gynostegium, with the corolla much thickened at mouth; lobes 14–18 mm long, 9–14 mm wide at base, broadly deltate-ovate, spreading with tips often reflexed, with vibratile clavate purple cilia 2–5 mm long along margins. Corona ± 3 mm tall, 8–9 mm in diameter, raised above base of tube by a stout pentagonal stipe <1 mm long, red-brown to purple-black; outer lobes 3–4 mm long, 3 mm wide at base, ascending-spreading, flat, ± square (often widening towards apex) with two or more often spreading short apical teeth, above with 2–3 radial raised tuberculate ridges; inner lobes 2–3 mm long, adpressed to backs of anthers for ± half of the anthers' length, then ascending and nearly equalling them, dorsiventrally flattened near base with raised crenulate margins (thus concave there), becoming laterally flattened above, with an erect to slightly recurved dorsal horn just behind the somewhat obtuse ± horizontal apex (apex sometimes absent below dorsal horn), and second dorsal horn occasionally present, with dorsal tuberculate ridges and horns confluent with outer series towards base. Figs. 3F, 56.

Distribution (Fig. 93). Mozambique, South Africa; 50–1700 m.

Orbea melanantha has been recorded in Mozambique relatively close to the coast; however, it is mainly known at altitudes of at least 1000 m in the Transvaal. It occurs from the Soutpansberg southwards and westwards to near Pretoria, towards the edge of the escarpment near Tzaneen, and around Groblersdal. It is often locally very common.

Specimens of *O. melanantha* are found among *Acacia* trees on stony ground with short grasses and some succulents or on shallow soil on granite domes. Those of Mozambique have sometimes been recorded as growing on the floor of open *Brachystegia* forest.

ADDITIONAL SPECIMENS EXAMINED. **Mozambique.** [2532] ± 10 miles N of Moamba [-CA], *Leach 12261* (BOL, K, PRE); Maputo distr. [-DC], *I.I.C.M. 13* (PRE). **South Africa.** TRANSVAAL: [2328] Blauwberg [-BB], *Codd 8777* (K, PRE); Buffelshoek [-BB], *Bruyns 6991* (NBG); Mohlakeng Plateau, Blauwberg [-BB], *Codd & Dyer 9110* (PRE); Kwarriehoek [-CD], *Steyn 50, 80* (PRE); Renosterhoek [-CD], *v. Vuuren sub PRE 10196* (PRE). [2329] Louis Trichardt [-BB], *Schlieben & Strey 8365* (PRE); Bandolierkop [-BD], *Leach 9757* (K, PRE, SRGH); Marabastad [-CD], *v. Son sub Tvl. Mus. 28273* (PRE); Pietersburg Townlands [-CD], *Kirsten 2* (PRE); Munnik [-DB], *Coaton & Hattingh s.n.* (PRE); Nooiensfontein [-DB], *Bruyns 6592* (BOL); 6 miles E of Pietersburg

[-DC], *v. Vuuren 1652* (PRE); Boyne [-DD], *Plowes 2634* (SRGH). [2330] Ephrata near Elim [-AA], *Obermeyer sub Tvl. Mus. 30617* (PRE). [2427] Hoopdal [-AD], *Codd 3722* (PRE); Stokkiesdraai [-BA], *Bruyns 7799* (K); Taaibos [-BB], *Bruyns 7781* (BOL); 10 km N of Thabazimbi [-CB], *Bruyns 6536* (BOL). [2429] Near Nebo [-DD], *Leach & Bayliss 12083* (K, PRE, SRGH). [2528] 2 miles N of Hammanskraal [-AD], *Kies & Bruce 32* (PRE); Onderstepoort [-CA], *Rossouw s.n.* (PRE); Derdepoort [-CB], *Robertson 17* (PRE). [2529] Roossenekal [-BB], *sub Leach 13283* (PRE).

Orbea melanantha is distinguished from all other species of *Orbea*, except *O. lutea*, by its dense clusters of more or less simultaneously opening, uniformly colored, dark, and fairly large flowers. The distinctions between *O. melanantha* and *O. lutea* are not so simple.

Orbea melanantha and *O. lutea* are not easily confused in the Transvaal, where they occur relatively near one another (though they have never been recorded as sympatric). The former has very dark flowers with short, broad lobes, and the latter has larger, bright yellow flowers with much longer and narrower lobes. Yet, *O. lutea* is so variable that, when it is considered over its whole distribution, distinguishing the two species proves to be more difficult. Their respective outer coronas are very similar, and it is mainly by the inner lobes that they can be most reliably separated. In both *O. lutea* and *O. melanantha* each inner corona lobe consists of a thickened part adpressed to the back of the anther, which is usually slightly shorter than the anther. In *O. lutea* there are two laterally flattened dorsal horns behind this structure, one longer one near the apex and a much shorter one behind this but still somewhat above the base. The lobe itself is often barely separable from the larger dorsal horn and is usually visible only as a slight swelling or protuberance at its base.

In *O. melanantha* the lobe itself is again shorter than the anther. Behind its apex is a recurved, usually somewhat cylindrical horn, rarely with another small one slightly behind this. Much lower down dorsally and more or less in series with the outer lobes, the lobe is excavated or furrowed with an irregularly toothed, transverse ridge. This is completely lacking in *O. lutea*.

The stems of *O. melanantha* are relatively short and proportionally very stout. They may be up to 4 cm in diameter and are often not much more than 2–3 times as tall as wide. The flowers emit a dreadful odor of excrement.

33. Orbea albocastanea (Marloth) Bruyns, Aloe 37: 73. 2001. *Stapelia albocastanea* Marloth, Trans. Roy. Soc. South Africa 3: 124. 1913. *Caralluma albocastanea* (Marloth) L. C. Leach, J. S. African Bot. 36: 174. 1970. *Orbeopsis albocastanea* (Marloth) L. C. Leach, Excelsa Taxon. Ser. 1: 65. 1978.—TYPE: NAMIBIA. Maltahöhe, *Marloth 5110* (holotype: PRE!).

Stapelia caroli-schmidtii Dinter & A. Berger, Bot. Jahrb. Syst. 50, Suppl. 592. 1914.—TYPE: NAMIBIA. Flats near Büllsport, *Dinter 2105* (holotype: SAM!).

Small succulent forming mats to 0.5 (–1.0) m in diameter, sometimes rhizomatous. Stems 2–8 cm long, 1–1.6 cm in diameter (excluding teeth), stout, decumbent, often uniformly pale green but sometimes mottled with purple-red; tubercles 2–5 (–9) mm long, laterally flattened, joined roughly into 4 very broadly obtuse angles along stem with a slight groove between angles, tapering to a short conical deltoid acute tooth, sometimes with a pair of small stipular denticles near apex. Inflorescence 1 (–2) per stem near base, of 3–30 flowers opening in succession from a short stout truncate peduncle, the peduncle often branched and least 10 mm long, 3–4 mm in diameter; pedicel (15–) 30–60 mm long,

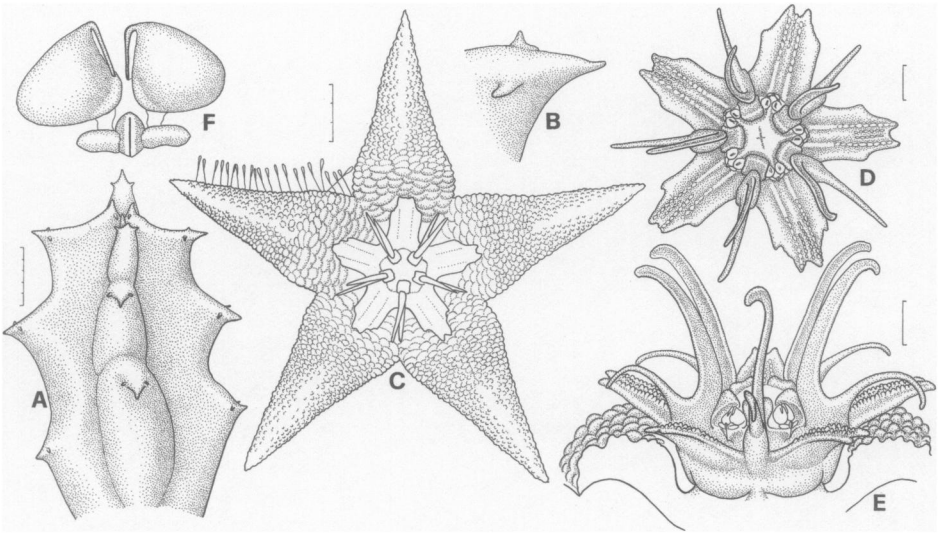

FIG. 57. *Orbea albocastanea.* A. Portion of stem. B. Leaf rudiment. C. Face view of flower. D. Face view of gynostegium. E. Side view of center of dissected flower. F. Pollinarium. Scale bars: A, 5 mm; B, 1 mm (at C); C, 3 mm; D, 1 mm; E, 1 mm; F, 0.25 mm at C. [Based on *Bruyns 3543*.]

1.5–2.0 mm in diameter, ascending to spreading on ground and holding flower facing at least partly upward. Sepals 2.5–3.0 mm long, 1.5 mm wide at base, ovate, acuminate. Corolla 1.8–3 cm in diameter, rotate, deeply lobed; outside smooth pale green with a few small red-brown dots; inside irregularly rugulose-papillate, white to cream, irregularly dotted with purple-brown, the dots becoming finer around corona; tube ± 1.5 mm long, 4–7 mm in diameter, shallowly cupular, containing base of gynostegium, the corolla distinctly thickened around mouth; lobes 6–12 mm long, 4–5 mm wide at the ovate base, tapering to an acute tip, spreading, convex, the margins reflexed and with scattered spathulate cilia up to 2.5 mm long. Corona ± 6 mm tall, 8 mm in diameter, raised only very slightly above base of tube on a very short stipe; outer lobes 2.0–2.5 mm long, 1.5–2.0 mm wide at base, ascending-spreading, ± rectangular with a deeply notched apex, upper surface with two or more raised radial tuberculate ridges (usually darker brown between them and cream or pinkish outside them); inner lobes 4–5 mm long, adpressed to backs of anthers for half of the anthers' length, then erect and somewhat recurved above, laterally flattened, linear narrowing slightly to obtuse apex, with a spreading-recurved terete dorsal horn near base ± 2 mm long, fused laterally at base to outer series, cream to brown. Figs. 5B, 57.

Distribution (Fig. 58). Namibia; 1200–1700 m.

Orbea albocastanea is only known from Namibia, where it is found in two apparently disjunct areas. One of these is from the southeastern foot of the Naukluft Mountains to west of Maltahöhe. The other is situated roughly 300 km to the southeast in and around the Great Karas Mountains.

In the Great Karas Mountains *O. albocastanea* has been seen several times from the foothills of the mountains up to some of the higher plateaus, on soils derived from sandstones or granite. It generally grows on stony ground under small bushes and can become

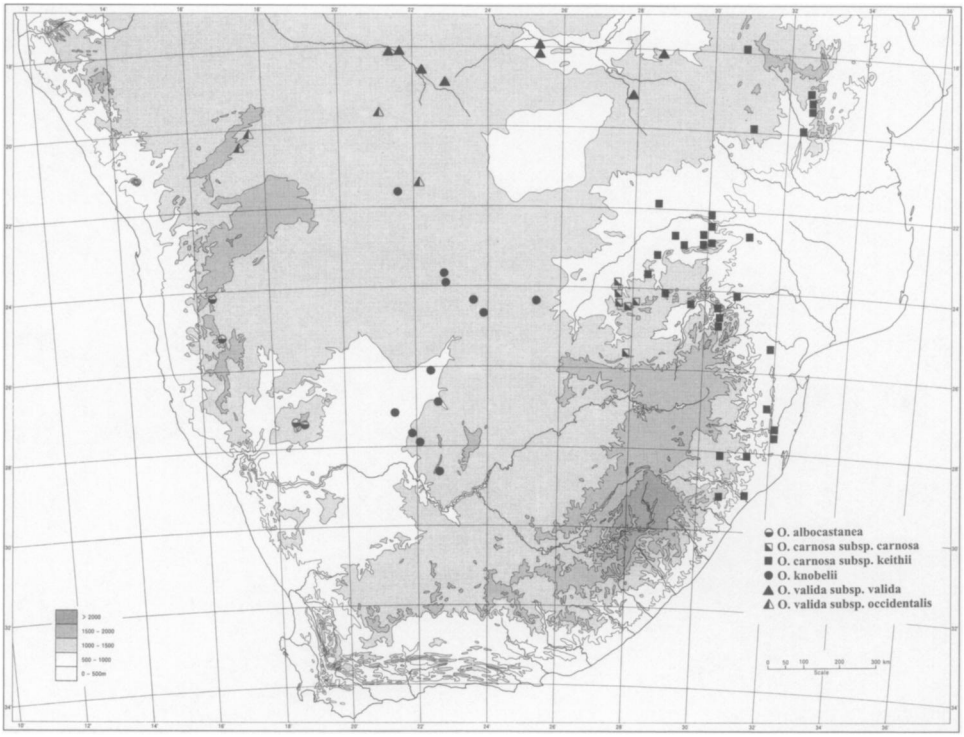

FIG. 58. Distribution of *Orbea albocastanea*, *O. carnosa*, *O. knobelii*, and *O. valida*.

locally quite common. Specimens recently collected to the west of Maltahöhe grew in a flat patch under very short bushes on calcrete.

ADDITIONAL SPECIMENS EXAMINED. **Namibia.** [2516] W of Maltahöhe [-BA], *Bruyns 5667* (BOL). [2718] E of Noachabeb [-BC], *Bruyns 5771* (MO); Garis [-BD], *Bruyns 3528* (BOL, WIND); Narudas Süd [-BD], *Pearson 8471* (PRE); Sandmund [-BD], *Bruyns 3543* (NBG, WIND).

Orbea albocastanea and *O. knobelii* are unique among the species included by Leach in *Orbeopsis* (i.e., those in *Orbea* with densely flowered inflorescences) for the unusual cream to white color of the corolla. The only other species of *Orbea* in which this coloration is found is *O. ciliata*, to which these two are not closely allied.

The differences between *O. albocastanea* and *O. knobelii* lie in the longer pedicels, the more strongly convex and consequently more lanceolate corolla lobes, and the longer dorsal horn on the inner corona lobes in *O. albocastanea*.

Leach (1970) considered that *O. albocastanea* and *O. knobelii* were "very closely related" but that "the discontinuities apparent . . . are sufficient to warrant the retention of specific status." He saw no material of *O. albocastanea* other than the two dried specimens of Marloth and Pearson. More recent collections have shown that *O. albocastanea* is considerably more variable than those specimens indicated, and some of the differences Leach noted no longer apply.

Orbea albocastanea has now also been found to be rhizomatous, as was known for *O. knobelii* (Leach 1970). Also, although the outer corona lobes were believed to be

± 2 mm long in *O. albocastanea* and ± 3 mm long in *O. knobelii* (Leach 1970: 159; 1978: 63), they can actually be longer in *O. albocastanea* than in *O. knobelii* (see Fig. 57). Furthermore, Leach recorded the inner corona lobes in *O. albocastanea* as "filiform"; however, as also illustrated, they are strongly laterally flattened instead. Leach also gave their dorsal projection as "suberect," but in recent collections examined they were found to be spreading to recurved. Thus, the characterization "spreading often subhorizontally" (Leach 1978: 63) that was given for *O. knobelii* applies just as well to some flowers of *O. albocastanea*.

34. Orbea knobelii (Phillips) Bruyns, Aloe 37: 75. 2001. *Stapelia knobelii* Phillips, Fl. Pl. South Africa 10: t. 363. 1930. *Caralluma knobelii* (Phillips) Phillips, Fl. Pl. South Africa 15: t. 593. 1935. *Orbeopsis knobelii* (Phillips) L. C. Leach, Excelsa Taxon. Ser. 1: 65. 1978.—TYPE: BOTSWANA. Near Molepolole, *Knobel sub PRE 8308* (holotype: PRE!).

Caralluma langii A. C. White & B. Sloane, Stapelieae, ed. 1: 61. 1933. *Caralluma knobelii* var. *langii* (A. C. White & B. Sloane) A. C. White & B. Sloane, Stapelieae, ed. 2, 1: 368. 1937.—TYPE: BOTSWANA. Near Gaberones, *v. Son sub White & Sloane 113* (holotype: not located).—LECTOTYPE, here designated: Fig. 40 in White and Sloane, Stapelieae, ed. 1. 1933.

Caralluma kalaharica Nel in A. C. White & B. Sloane, Stapelieae, ed. 2, 3: 1165. 1937.—TYPE: BOTSWANA. Northwest of Lake Ngami, Tsau, *Nel s.n.* (holotype: not located).—LECTOTYPE, here designated: Fig. 1216 in White and Sloane, Stapelieae, ed. 2, vol. 3. 1937.

Succulent forming clumps to 0.5 m in diameter, often rhizomatous. Stems 3–10 cm long, 1–2.5 cm in diameter (excluding teeth), stout, decumbent and often subterranean for some distance, then erect above ground, often uniformly grey-green but sometimes mottled with red-brown; tubercles 3–6 mm long, joined into 4 very broadly obtuse angles along stem with a slight groove between angles, basally almost cylindrical then tapering to a conical to laterally flattened deltoid acute often ascending tooth, sometimes with stipular denticles. Inflorescence 1 per stem in proximal half, of 3–10 flowers opening in rapid succession from a short peduncle (<10 mm long); pedicel 10–15 mm long, 2.5–3.0 mm in diameter, ascending to spreading and holding flowers facing ± horizontally. Sepals 3–5 mm long, 1.5–2.0 mm wide at base, ovate-lanceolate, acuminate. Corolla 2.5–3.5 cm in diameter, rotate; outside smooth, pale green; inside irregularly rugulose-papillate, white to cream (greenish), irregularly blotched with purple-brown; tube 1.5–2.0 mm long, 6–10 mm in diameter, shallowly cupular, containing base of gynostegium, the corolla distinctly thickened around mouth; lobes 10–14 mm long, 7–10 mm wide at base, ovate, acute, often somewhat reflexed, slightly convex above owing to reflexed margins, with scattered clavate-spathulate cilia up to 3 mm long along margin. Corona ± 5–6 mm tall, 7 mm in diameter, raised only very slightly above base of tube on a very short pentagonal stipe; outer lobes 1.5–3.0 mm long, 2.0 mm wide at base, ascending-spreading, ± square with a notched-truncate apex, upper surface with at least 2 raised radial ridges (area between them usually dark purple-brown, outside of them paler brown to cream); inner lobes 3.5–4.0 mm long, adpressed to backs of anthers for half the anthers' length then erect, laterally flattened but becoming broader towards base, linear narrowing to obtuse apex, with a spreading terete dorsal horn ± 1 mm long near base, fused to outer series near base, dark brown below becoming paler towards apices. Fig. 59.

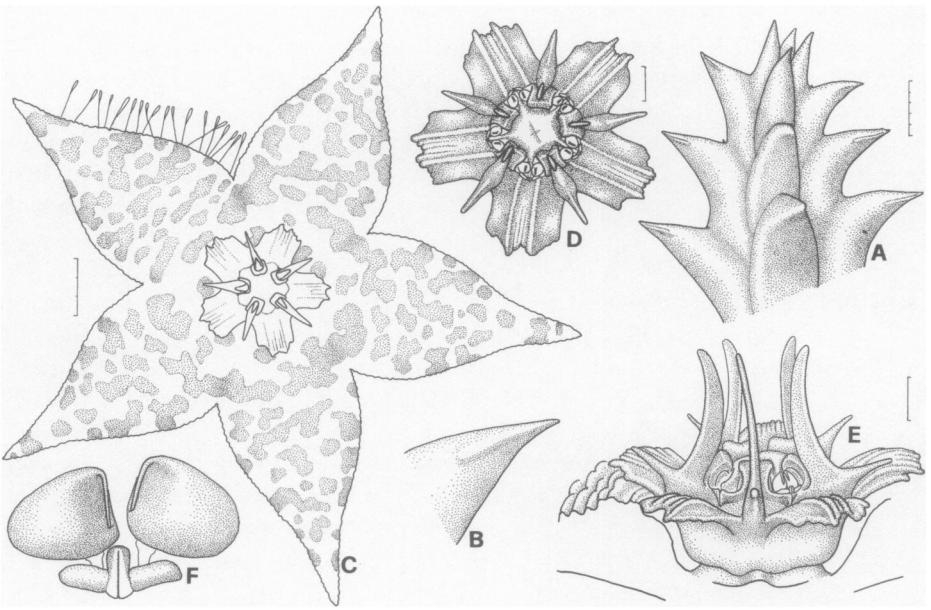

FIG. 59. *Orbea knobelii.* A. Portion of stem. B. Leaf rudiment. C. Face view of flower. D. Face view of gynostegium. E. Side view of center of dissected flower. F. Pollinarium. Scale bars: A, 5 mm; B, 1 mm (at C); C, 3 mm; D, 1 mm; E, 1 mm; F, 0.25 mm (at C). [Based on *Bruyns 3472*.]

Distribution (Fig. 58). Botswana, South Africa; 900–1100 m.

Orbea knobelii is exclusively a species of the Kalahari "desert," and it occurs fairly widely in southern Botswana and in the northern Cape.

This species may be found growing in deep, fine sand among bushes and small trees (usually species of *Grewia* or *Acacia*), and under these circumstances plants are widely scattered and fairly rare. It also occurs sometimes on low calcrete banks around pans among or under small *Acacia* bushes and other shrublets. In such cases it may become locally quite common.

ADDITIONAL SPECIMENS EXAMINED. **Botswana.** [2121] Ghanzi [-DA], *Story 5090* (PRE). [2322] Kang Pan [-DB], *Bruyns 6449* (NBG); 34 km E of Kang [-DD], *Bruyns 6453* (BOL). [2423] 39 km W of Sekoma [-BC], *Bruyns 6445* (NBG); Sekoma Pan [-DB], *Bulawayo Museum* (SRGH). [2425] 12.5 miles NW of Molepolole [-AD], *Codd 8921* (PRE). [2622] Tsabong [-AB], *de Winter 7481* (PRE). **South Africa.** CAPE PROVINCE: [2622] 78 miles NW of Kuruman [-DC], *Leistner 2215* (KMG). [2721] 14 miles W of Kuruman [-AB], *Leistner 2226* (KMG, PRE); Lang Pan [-DB], *Leistner 2080* (K, KMG, PRE). [2722] Pearson's Hunt [-CC], *Bruyns 3472* (NBG). [2822] Poufontein [-DA], *Cooke sub KMG 7956* (KMG).

Orbea knobelii is very similar to *O. albocastanea* (no. 33); the features distinguishing them are discussed under the latter. Both of these species are unusual among those included by Leach (1978) in *Orbeopsis*, because of the manner in which the flowers open in succession rather than simultaneously, although they are produced in dense, many-flowered inflorescences. Flowers are produced in much larger numbers in *O. albocastanea* than in *O. knobelii*, and in the former the peduncle may be more substantial than in *O. knobelii*.

35. Orbea lutea (N. E. Brown) Bruyns, Aloe 37: 75. 2001. *Caralluma lutea* N. E. Brown, Hooker's Icon. Pl. 20: t. 1901. 1890. *Orbeopsis lutea* (N. E. Brown) L. C. Leach, Excelsa Taxon. Ser. 1: 64. 1978.—TYPE: SOUTH AFRICA. Cape Province: Griqualand, Klipdrift, *Tuck sub MacOwan 2240* (lectotype, designated by Leach, 1970: K!).

Succulent forming mats to 1 m in diameter or more, occasionally rhizomatous. Stems 3–12 cm long, 1–2.5 cm in diameter (excluding teeth), decumbent, occasionally subterranean for short distances then erect above ground, grey-green mottled with red-brown; tubercles 6–10 mm long, laterally flattened, usually joined into 4 broadly obtuse angles along stem with a groove between angles, tapering to a conical to slightly laterally-flattened deltoid acute spreading tooth, usually with stipular denticles near apex. Inflorescence 1 (–2) per stem in lower half, of 3–30 flowers opening ± simultaneously from a short peduncle, with several subulate bracts; pedicel 12–30 mm long, 3–4 mm in diameter. Sepals 5–8 mm long, lanceolate to ovate-lanceolate, acuminate. Corolla 3.5–6.5 cm in diameter, rotate; outside smooth, pale cream-green; inside irregularly rugulose-papillate except in tube, uniformly yellow to red-brown or blotched with yellow on red-brown to nearly black; tube ± 2 mm deep, shallowly cupular, containing base of gynostegium, the corolla distinctly thickened around mouth; lobes 18–35 mm long, 6–15 mm wide at base, spreading, narrowly lanceolate and attenuate to acute at apex, with vibratile clavate cilia along margins. Corona ± 6 mm tall, 10 mm in diameter, raised slightly above base of tube on short pentagonal stipe <1 mm long, red- to purple-brown or blackish sometimes with yellow edges to outer lobes; outer lobes ± 2 mm long, 3 mm wide at base, subquadrate, nearly contiguous so that 5 lobes almost appear to form a cup with circular edge, with several radial slightly raised ridges on upper surface and darker with secretion between innermost of these, apex truncate-emarginate to toothed; inner lobes 0.8–1.0 mm long, adpressed to backs of anthers for at least half the anthers' length but not exceeding anthers, towards base somewhat dorsiventrally flattened then narrowing and distinctly laterally flattened, with the obtuse indistinct apex pressed to anthers behind which is an erect and somewhat recurved dorsal horn (2.5–3.0 mm long), usually with smaller slender horn behind it, without dorsal gibbosities near base. Fig. 60.

Distribution (Fig. 62). Angola, Botswana, Namibia, South Africa, Zimbabwe; 500–1700 m.

Orbea lutea is very widely distributed in southern Angola, Namibia, Botswana, and the western corner of Zimbabwe, as well as extensively in South Africa from near Pofadder in the northern Cape to Natal.

Two subspecies are recognized, one occurring on the western side of the subcontinent and the other more to the center and to the east. The main difference between them lies in the shape of the corolla lobes. In subsp. *lutea* they are much narrower than in subsp. *vaga*, between 3 and 5 times as long as wide, and gradually narrowing from a slightly ovate base to a slender tip. The stems of subsp. *lutea* are mostly more slender and have longer tubercles than the stout, short-tubercled stems often seen in subsp. *vaga*; they also have more of a tendency to spread by underground runners.

Leach (1970) dealt extensively with *O. lutea* and found it to be quite remarkably variable. There is still a lack of data for the area between Upington and Prieska, where the species is rare and where intermediates between the two subspecies could be expected.

KEY TO THE SUBSPECIES OF ORBEA LUTEA

Corolla lobes ± 3–5 times as long as wide.	35a. *O. lutea* subsp. *lutea*.
Corolla lobes 1.5–2.5 times as long as wide.	35b. *O. lutea* subsp. *vaga*.

35a. Orbea lutea subsp. **lutea.**

Caralluma lateritia N. E. Brown, Fl. Trop. Afr. 4(1): 486. 1903. *Caralluma lutea* var. *lateritia* (N. E. Brown) Nel in A. C. White & B. Sloane, Stapelieae, ed. 2, 1: 373. 1937.—TYPE: BOTSWANA. Ngamiland, Botletle Flats, *Lugard 307* (holotype: K!).

Caralluma vansonii Bremekamp & Obermeyer, Ann. Transvaal Mus. 16: 429. 1935. *Caralluma lutea* var. *vansonii* (Bremekamp & Obermeyer) C. A. Lückhoff, Stapelieae of Southern Africa 62. 1952.—TYPE: BOTSWANA. Nata River, Nkate, *v. Son s.n.* (holotype: PRE!).

Caralluma lateritia var. *stevensonii* A. C. White & B. Sloane, Stapelieae, ed. 2, 1: 371. 1937.—TYPE: ZIMBABWE. Wankie Distr., Matetsi, *Stevenson s.n.* (holotype: not located).

Corolla inside often bright yellow or orange but sometimes dark red-brown speckled with yellow; lobes ± 3–5 times as long as wide, narrowly lanceolate, apex attenuated to acute.

Distribution (Fig. 62). Botswana, South Africa, Zimbabwe; 500–1500 m.

Orbea lutea subsp. *lutea* is widely distributed in South Africa in the northern Cape from Prieska to Olifantshoek and Mafikeng, in the western Orange Free State, and widely in the Transvaal, with an isolated patch between Ladysmith and Greytown in Natal. In Botswana it is known around the low-lying area of the Mkari-kari Pans in the center and in the southeast around Serowe and Gaberones. In Zimbabwe plants have been recorded from the area between Nyamandhlovu and Bulawayo in the west of the country.

This subspecies occurs in a wide variety of generally stony habitats, often on calcrete. Plants may be found under *Acacia* trees but quite often are seen growing in the open.

ADDITIONAL SPECIMENS EXAMINED. **Botswana.** [2024] 20 km N of Seokwane [-CB], *Bruyns 6519* (BOL). [2025] Gwete [-AA], *Smithers s.n.* (SRGH); 47 km W of Nata [-BA], *Bruyns 6982* (BOL); Makarikari Pan [-D], *Compton 28234* (NBG). [2124] between Rakops and Lake Dow, *Wild & Drummond 7224* (K, PRE, SRGH); Rakops, Botletle Flats, Ngamiland [-AB], *Lugard 307* (K); Mopipi [-BB], *Bruyns 6521* (BOL). [2126] ± 40 miles N of Serowe [-CD], *Wild & Drummond 7280* (K, PRE, SRGH). [2226] Serowe [-BC], *Leach & Bayliss 12515* (BR, M, NBG). [2425] Lethlakeng [-AA], *Leach et al. 12489* (B, BOL, KMG); 10 miles S of Gaberones [-DB], *Leach, Bayliss & Lamont 12485* (COI, GRA); Gaberones [-DB], *v. Son sub Tvl Mus. 28755* (PRE); near Ramotswa [-DD], *Leach, Bayliss & Lamont 12483* (BM, BOL, K). [2426] Metsimaklaba, near Gaberones [-AC], *v. Son sub Tvl Mus. 28756* (PRE); ± 11 miles N of Gaberone [-CA], *Leach & Noel 101* (SRGH). [2525] ± 3 miles N of Lobatsi [-BA], *Leach & Noel 122* (GRA, SRGH); ± 7 miles W of Lobatsi [-BA], *Leach, Bayliss & Lamont 12464* (B, BM, GRA); ± 8 miles N of Lobatsi [-BA], *Leach & Noel 212* (SRGH); Pitsani [-BC], *Bayer sub KG 776/74* (NBG); ± 10 miles S of Lobatsi [-BC], *Leach, Bayliss & Lamont 12453* (K, KMG, M); ± 3 miles SE of Lobatsi [-BC], *Leach, Bayliss & Lamont 12472* (BR, M, ZSS). **South Africa.** CAPE PROVINCE: [2525] Phitsani [-CC], *Cole s.n.* (NBG); ± 28 miles NW of Mafikeng [-CC], *Acocks 18760* (PRE); ± 3 miles S of Ramathlabama [-DA], *Leach & Bayliss 12444* (KMG, PRE, K); Mafeking [-DC], *Marloth 4377* (K); ± 3 miles SE of Mafeking [-DC], *Leach & Bayliss 12443* (BOL, LISC); Rooigrond [-DD], *Bayliss 2032* (NBG). [2624] Vryburg [-DC], *Fry s.n.* (BOL, K). [2722] Olifantshoek [-DC], *Leach & Cannell 13803a* (K, S). [2724] Buxton, Taungs [-DA], *Brueckner 1209* (KMG); Taungs Native Res. [-DB], *Brueckner s.n.* (PRE). [2822] Rudesheim [-DD], *Bruyns 4503a* (MO). [2824] Niekerks Rush [-AD], *Duggan-Cronin s.n.* (KMG); Warrenton [-BB], *Adams s.n.* (GRA); 0.5 miles S of Holpan P.O. [-BC], *Leistner 1415* (PRE); Harrisdale [-BC], *Leistner 1412* (KMG); Spytfontein [-DC], *Schweickerdt 1119a* (PRE); near DuToitspan (DD), *W. Tuck sub MacOwan 2240* (SAM); DuToitspan [-DD], *Barkly 40* (K). [2922] 15 miles NW of Prieska [-CB], *Schlieben 8794* (PRE);

Prieska [-DA], *Marloth 3776* (PRE); 7 miles N of Prieska [-DB], *Hall 1689* (NBG). [2923] Mazelsfontein [-BA], *Anderson s.n.* (GRA); Douglas [-BB], *Harries sub Galpin 6308* (PRE).—NATAL: [2829] Ladysmith [-DB], *Morton s.n.* (NBG). [2830] Weenen [-CC], *Thode sub STE 2606* (NBG); between Greytown & Keats Drift [-DC], *Reynolds 1713* (PRE). [2831] Eshowe [-CD], *McLoughlin s.n.* (PRE).—ORANGE FREE STATE: [2627] near Parys [-CD], *Malcolm sub Herb. Moss 19622* (J). [2824] 4 km SW of Warrenton [-BB], *Leistner 1256* (KMG, PRE); Klippiespan Farm [-DD], *Harris s.n.* (NBG). [2826] Brandfort [-CB], *Hall s.n.* (NBG). [2827] Clocolan [-CC], *du Preez 1299* (BLFU). [2925] Entrance to Berglangs [-CA], *Bruyns 6630* (BOL); Fauresmith [-CB], *Dyer 1923* (GRA); Fauresmith Bot. Res. [-CB], *Smith 3957a* (PRE). [2926] Bloemfontein [-AA], *Hanekom 562* (PRE).—TRANSVAAL: [2231] Punda Maria [-CA], *Lang sub Tvl. Mus. 31804* (PRE). [2329] 8 miles N of Pietersburg [-CD], *Bey 47* (SRGH); 15 miles E of Pietersburg [-DC], *Leach 9770* (PRE, SRGH); 6 miles E of Pietersburg [-DC], *v. Vuuren 1653* (PRE). [2331] Letaba [-DC], *Lang sub Tvl. Mus. 30618* (PRE). [2427] Northam [-CD], *Bayliss sub Leach 11990* (SRGH). [2428] Naboomspruit [-DA], *Stent sub PRE 11373* (PRE). [2431] 1 mile E of Skukuza [-DC], *Codd 5487* (PRE). [2526] Zeerust [-CA], *Knobel s.n.* (PRE). [2527] Brits [-DB], *Mogg 14646* (PRE); Xanadu [-DD], *Brain 10375* (SRGH). [2528] 20 miles N of Pretoria [-AD], *Erens 449* (PRE); 3 miles E of Hammanskraal [-AD], *Leach & Bayliss 12065* (SRGH, Z); Wonderboom [-CA], *Pott sub Tvl. Mus. 19211* (PRE). [2725] Kameelpan, Christiana [-CA], *Theron 523* (PRE). [2726] 8 miles S of Makwassie [-AC], *v. Vuuren 1653* (PRE). **Zimbabwe.** [1928] Nyamandhlovo Res. Stn [-CD], *Plowes 1529* (K, PRE, SRGH). [2027] Plumtree [-BD], 20 Oct 1936, *Eyles 8763* (K). [2028] Bulawayo [-BA], Feb 1904, *Eyles 22* (SRGH); ± 15 miles NE of Bulawayo [-BB], Feb 1960, *Leach 5818* (K, PRE, SRGH); Matopos, near Rhodes' Grave [-BC], *Ayres sub Pillans 51* (BOL); Sibenza Hill, near Matopos Mission [-BD], 6 Feb 1966, *Bullock 54* (BR).

The flowers of subsp. *lutea* are very variably colored. In South Africa they are usually various shades of yellow, often very bright yellow and more rarely orange. In most of the material from Botswana flowers are golden-orange to pale reddish brown, whereas in Zimbabwe they are red to dark maroon.

35b. Orbea lutea subsp. **vaga** (N. E. Brown) Bruyns, Aloe 37: 75. 2001. *Stapelia vaga* N. E. Brown, Bull. Misc. Inform. 1895: 265. 1895. *Caralluma vaga* (N. E. Brown) A. C. White & B. Sloane, Stapelieae, ed. 2, 1: 381. 1937. *Orbeopsis lutea* subsp. *vaga* (N. E. Brown) L. C. Leach, Excelsa Taxon. Ser. 1: 65. 1978.—TYPE: NAMIBIA. Ovamboland, Olukonda, *Schinz 2047* (holotype: K!; isotype: Z).

Caralluma nebrownii A. Berger, Notizbl. Königl. Bot. Gart. Berlin 4: 249. 1906.—TYPE: NAMIBIA. Barmen, *Dinter 1502* (holotype: B, destroyed; isotype: K!).

Caralluma brownii Dinter & A. Berger, Deutsch-SWA, Flora Forst- u. landwirtschaftliche Fragm. 113. 1909. —TYPE: unknown.

Caralluma pseudonebrownii Dinter, Neue Pfl. Südw.-Afr. 17. 1914. *Caralluma nebrownii* var. *pseudonebrownii* (Dinter) A. C. White & B. Sloane, Stapelieae, ed. 2, 1: 377. 1937.—TYPE: NAMIBIA. Keetmanshoop, *Dinter 2598* (holotype: SAM!).

Caralluma hahnii Nel in A. C. White & B. Sloane, Stapelieae, ed. 2, 3: 1164. 1937.—TYPE: NAMIBIA. Ovamboland, Ondonga [Ondangua?], *Nel sub STE 7364* (holotype: not located).

Caralluma nebrownii var. *discolor* Nel in A. C. White & B. Sloane, Stapelieae, ed. 2, 1: 380, 3: 1144. 1937.—TYPE: NAMIBIA. Tsamap, *Rusch sub STE 7366* (holotype: BOL!).

Corolla blackish maroon to red-brown mottled finely with yellow (rarely yellow); lobes 1.5–2.5 times as long as wide, oblong-lanceolate, shortly acuminate. Fig. 60.

Distribution (Fig. 62). Angola, Namibia, South Africa; 800–1700 m.

Orbea lutea subsp. *vaga* is found along more or less the whole length of Namibia, east of the Namib and west of the regions covered by Kalahari sands. It also extends into

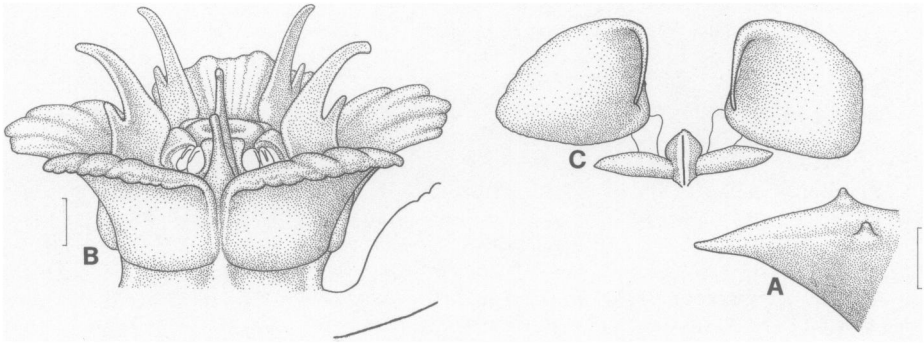

FIG. 60. *Orbea lutea* subsp. *vaga.* A. Leaf rudiment. B. Side view of gynostegium. C. Pollinarium. Scale bars: A, 1 mm; B, 1 mm; C, 0.25 mm (at A). [Based on: A, C, *Bruyns 5231*; B, *Bruyns 5750.*]

a small area of southwestern Angola adjacent to Ovamboland and continues southwards into the northern Cape, where it is known from west of Pofadder to near Upington.

Subspecies *vaga* occurs in a wide variety of habitats, from firm, white sands in Ovamboland, where it grows in the open or alongside *Acacia* trees, to rocky flats and slopes in the Great Karas Mountains under small bushes. Plants are also tolerant of a remarkable range of rainfall as well. Thus, whereas much of Ovamboland receives 4–500 mm of rain per year, subsp. *vaga* can be found in arid areas with a low and unreliable average rainfall of less than 150 mm per year.

ADDITIONAL SPECIMENS EXAMINED. **Angola.** [1614] Huila Distr., ± 4 miles SE of Cahama [-AD], *Leach & Cannell 14039a* (WIND, SRGH). [1615] Onkumbi [-CC], *Schinz 2041* (Z). **Namibia.** [1715] Ogongo [-CB], *v. Jaarsveld 2977* (NBG); ± 12 miles N of Ondangua [-DB], *Leach & Bayliss 13041b* (PRE); Ondangua [-DD], *de Winter & Giess 6880* (WIND, SRGH); ± 3 miles N of Ondangua [-DD], *Leach & Bayliss 13034a* (B, COI, FI); ± 5 miles N of Ondangua [-DD], *Leach & Bayliss 13035* (LMA, MO, Z). [1716] ± 10 miles SE of Ondangua [-CC], *Leach & Bayliss 13032* (G, NBG, WIND). [1816] ± 20 miles SE of Ondangua [-AA], *Leach & Bayliss 13054* (K, PRE, SRGH); ± 25 miles SE of Ondangua [-AB], *Leach & Bayliss 13031* (SRGH, WIND); ± 35 miles SE of Ondangua [-AB], *Leach & Bayliss 13029* (BOL, K, PRE). [2017] Ombujomatemba [-CA], *Bruyns 5534* (BOL). [2115] Omaruru [-BD], *Triebner* (PRE); Klein Spitzkop [-CC], *Giess & Hardy 8470* (WIND); between Gross & Klein Spitzkop [-CC], *Hardy 2150* (PRE). [2216] Otjiswa [-BD], *Dinter ?488* (Z); Friedenau [-DB], *de Winter 2586* (PRE, WIND). [2217] Windhoek [-CA], *Bosch s.n.* (BOL); Bergland [-CC], *Giess 1990* (WIND). [2218] Gobabis [-BD], *Toelken 1079* (PRE). [2316] Isabis [-BC], *Giess s.n.* (WIND); Nauchas [-CB], *Pearson 9499* (BOL, K). [2317] Rehoboth [-AC], *Triebner s.n.* (PRE). [2416] Inachab [-DA], *Dinter 1056* (Z). [2516] Rooiberg S [-BC], *Bruyns 5679* (BOL); Barbi [-DC], *Bruyns 5704* (BOL); Frischgewaagd [-DC], *Bruyns 5729* (K); Kunjas [-DC], *Littlewood s.n.* (NBG); Lovedale [-DC], *Bruyns 5722* (BOL). [2616] Kuibis [-DB], *Hall* (SAM). [2618] Keetmanshoop [-CA], *Dinter 2255* (SAM); *Dinter 2598* (SAM). [2717] Gorges [-CB], *Page s.n.* (BOL). [2718] Gruendoorn [-AD], *Pearson 4350* (BOL, K); Rooiwal [-AD], *Bruyns 5750* (BOL); Garis [-BD], *Bruyns 3527* (BOL, WIND); Klein Karas [-CA], *Hill s.n.* (BOL); S of Noachabeb [-DA], *Bruyns 5790* (BOL). [2818] Eendorn [-DB], *Bruyns 5830* (BOL). [2819] Tsamap [-AA], *Rusch s.n.* (NBG). **South Africa.** CAPE PROVINCE: [2820] Keimoes [-DB], *Strey 3882* (PRE); Kakamas [-DC], *NBG 417/40* (NBG). [2918] Rosynebos [-BB], *Bruyns 5231* (BOL).

In Ovamboland plants of subsp. *vaga* have relatively narrow stems but in the drier parts of Namibia and the northern Cape the stems become thick and stoutly 4-angled, forming large and dense clumps. Very occasionally there are short, subterranean stems, but mostly the growth is wholly superficial.

Flowers of subsp. *vaga* are very striking. They are produced in dense clusters and vary from blackish maroon to red-brown, finely and very irregularly flecked with yellow.

36. Orbea gerstneri (Letty) Bruyns, Aloe 37: 74. 2001. *Caralluma gerstneri* Letty, Fl. Pl. South Africa 16: t. 631. 1936. *Orbeopsis gerstneri* (Letty) L. C. Leach, Excelsa Taxon. Ser. 1: 66. 1978.—TYPE: SOUTH AFRICA. Natal: Magudu [Magut], Feb 1936, *Gerstner 740* (holotype: PRE!).

Small succulent forming dense clumps, often rhizomatous. Stems 3–10 cm long, 0.5–2 cm in diameter (excluding teeth), slender to stout, decumbent, dark grey-green to dark green faintly mottled with red-purple; tubercles 4–13 mm long, arranged into 4 obtuse rows along stem, tapering to a laterally flattened deltoid acute spreading to ascending tooth, rarely with two minute denticles on either side towards apex. Inflorescence 1 (–3) per stem from base to near apex, of 3–8 flowers opening ± simultaneously or in succession from a short peduncle (<2 mm long), with several subulate laterally toothed bracts 2.0–2.5 mm long; pedicel 6–10 mm long, 2.0–2.5 mm in diameter, ascending and holding flowers facing upwards or horizontally. Sepals 5–8 mm long, 1.5–2.0 mm wide at base, lanceolate, acuminate. Corolla 3.5–6 cm in diameter, rotate-campanulate; outside smooth, finely mottled with purple-red on pale cream-green to pale cream-green towards base; inside dark purple-red mottled with cream becoming solid purple-brown in tube, irregularly rugulose-papillate with rugosities disappearing in lower half of tube, rugosities somewhat organized into longitudinal lines on lobes; tube 6–8 mm long, 10 mm in diameter, cupular, pentagonal, with corolla slightly thickened at mouth and sometimes with a raised annulus there; lobes 11–17 mm long, 7–10 mm wide at base, spreading, slightly ovate, deltate to lanceolate, flat above, acute, with clavate vibratile cilia 1.5–2.0 mm long along margins of proximal third. Corona 4.0–4.5 mm tall, 9.0–9.5 mm in diameter, raised above base of tube on short stipe (± 1 mm long), red-brown; outer lobes 2–3 mm long, 1.5–2.0 mm wide at base, ± rectangular, spreading with ascending tips, with two raised radial ridges on upper surface (area between them dark purple-brown), apex deltate to bifid between these ridges, outside them truncate to attenuated into spreading lobules; inner lobes 2.5–3.0 mm long, with lower slightly dorsiventrally flattened portion adpressed to backs of anthers for half the anthers' length, then becoming ± terete and ascending-connivent with a slender to clavate-tuberculate apex, with a dorsal (slightly laterally flattened) horn about halfway up lobe, dorsal gibbosity/hornlets at base partly fused to outer series, brown. Figs. 61, 63.

Distribution (Fig. 62). South Africa, Swaziland. 250–1600 m.

Orbea gerstneri is a poorly known and rare species (Leach 1978), which occurs in the northeastern corner of South Africa and in neighboring Swaziland.

The flowers of *O. gerstneri* are borne in dense, simultaneously opening clusters, but, unlike in *O. knobelii* and *O. lutea*, there is a considerable corolla tube. This feature and the clusters of simultaneously opening flowers separate *O. gerstneri*, *O. huillensis*, and *O. valida* from all other species of *Orbea*. From these two species *O. gerstneri* is separated by the mottled flowers (they are always uniformly colored in *O. huillensis* and *O. valida*), with the corolla lobes flat above (they are always distinctly convex above in *O. huillensis* and *O. valida*). The stems are usually dark green and only faintly mottled (they are always paler green in *O. huillensis* and *O. valida*) and only rarely have stipular denticles (always present and quite conspicuous in *O. huillensis* and *O. valida*). In addition there are differences in the respective coronas: the inner corona lobes of *O. gerstneri* are cylindrical above with a slightly thickened tip, and the dorsal projection extends upwards along the lobe for some distance (in *O. huillensis* and *O. valida* the lobes are mostly distinctly flattened above, and the dorsal projection is restricted to the base of the inner lobe).

The two subspecies of *O. gerstneri* have rather different-looking stems. In subsp. *gerstneri* the stems are slender with longer tubercles and an extensively rhizomatous habit, whereas in subsp. *elongata* they are stouter with more broadly deltoid tubercles and a less vigorously rhizomatous habit, though they are still rhizomatous. The differences in the stems are similar to those seen between the stems of *O. cooperi* and *O. tapscottii* (though neither of these are rhizomatous), or *O. maculata* subsp. *maculata* and subsp. *rangeana*. The flowers differ mainly in the longer corolla tube, corolla lobes, and outer corona lobes of subsp. *elongata*.

KEY TO THE SUBSPECIES OF ORBEA GERSTNERI

Stems slender and very rhizomatous, tubercles arranged loosely into 4 rows along stem; corolla tube 5–6 mm long, outer corona lobes 2.0–3.5 mm long. 36a. *O. gerstneri* subsp. *gerstneri*.
Stems stout and occasionally rhizomatous, tubercles joined into 4 angles along stem; corolla tube 7–9 mm long, outer corona lobes 5–6 mm long. 36b. *O. gerstneri* subsp. *elongata*.

36a. **Orbea gerstneri** subsp. **gerstneri.**

Dwarf succulent forming several often small clumps (3–10 cm in diameter) joined by rhizomes. Stems 3–7 cm long, 0.5–0.7 cm in diameter (excluding teeth), ± slender,

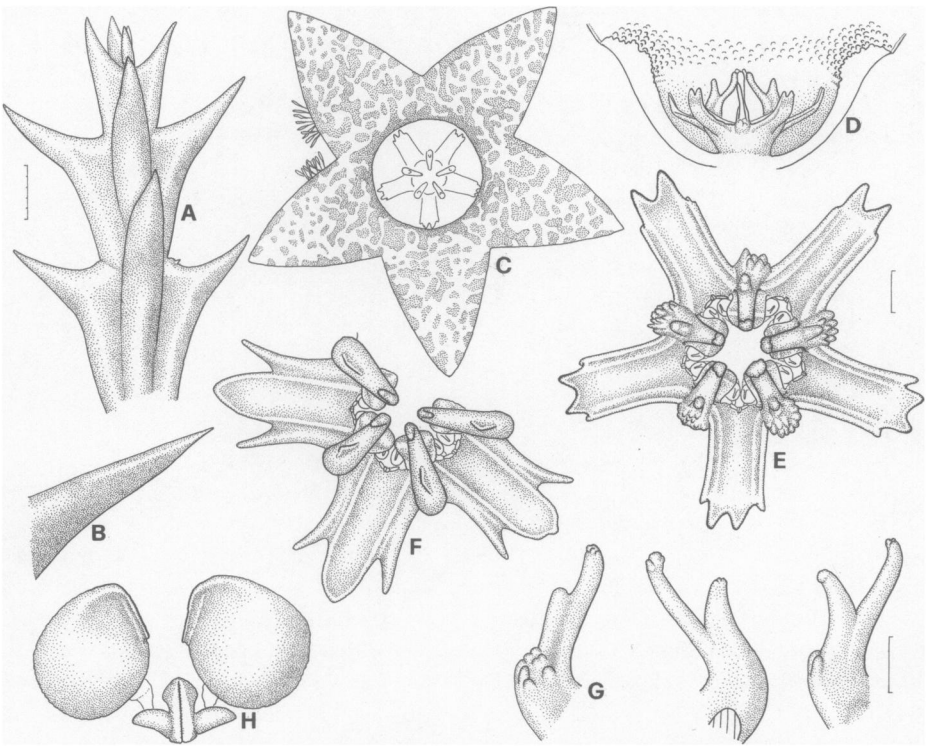

FIG. 61. *Orbea gerstneri* subsp. *gerstneri.* A. Portion of stem. B. Leaf rudiment. C. Face view of flower. D. Side view of center of dissected flower. E, F. Face views of gynostegium. G. Inner corona lobes, from different flowers. H. Pollinarium. Scale bars: A, C, 5 mm (at A); B, 2 mm (at A); D, 3 mm (at G); E, F, 1 mm (at E); G, 1 mm; H, 0.25 mm (at G). [Based on: A, B, F, *Bruyns 4454*; C–E, G, H, *de Kock & Bayer 352*.]

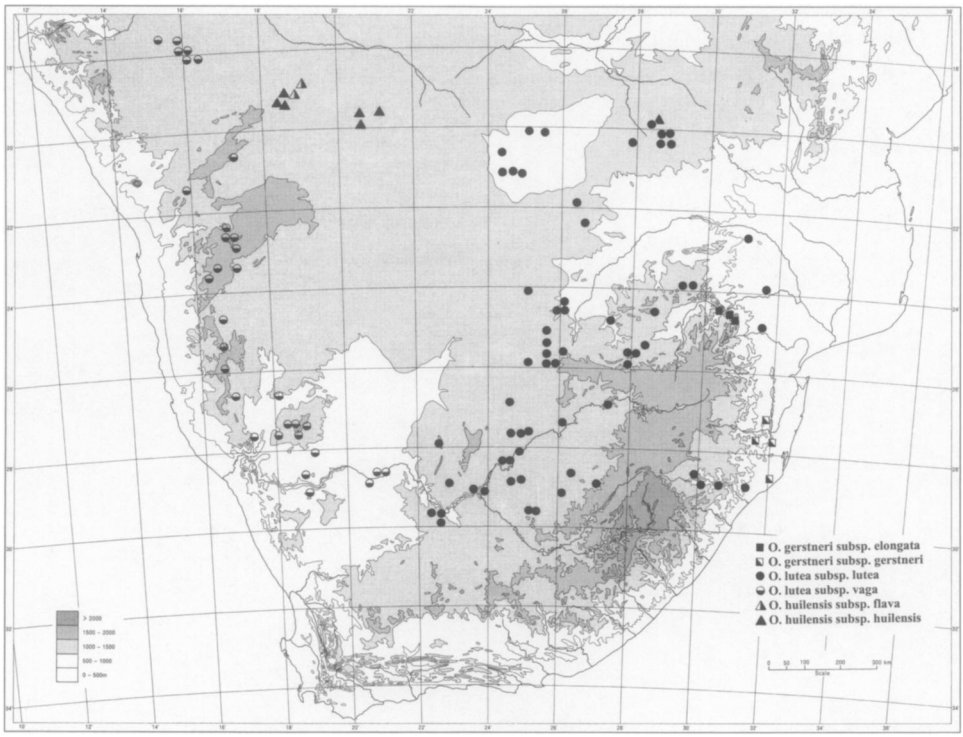

FIG. 62. Distribution of *Orbea gerstneri*, *O. huillensis*, and *O. lutea*.

decumbent and often subterranean for some distance (up to 30 cm), then erect above ground; tubercles 4–13 mm long, arranged loosely into 4 obtuse rows along stem ± without a groove between them, tapering to a prominent horizontally spreading to ascending slender laterally flattened deltate acute tooth. Corolla 3.5–4 cm in diameter; tube 5–6 mm long, 10 mm wide, pentagonal. Outer corona lobes 2.0–3.5 mm long, spreading with ascending tips. Fig. 61.

Distribution (Fig. 62). South Africa, Swaziland; 250–700 m.

Orbea gerstneri subsp. *gerstneri* is known from only a few collections and has been gathered in a relatively small area from Ingwavuma in Swaziland southwards to Magudu, Mkuzi, and near Ulundi in the northern part of Natal. It generally seems to grow in low-lying areas with a scanty cover of trees, in flat, sandy to stony ground.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** NATAL: [2732] Mkusi [-CA], *Bruyns 4454* (BOL, MKUZI). [2832] North of Enseleni [-CA], *de Kock & Bayer 352* (NBG). **Swaziland.** [2731] Cecil Mack's Pass [-BB], *Bayliss 596* (NBG, PRE).

36b. Orbea gerstneri subsp. **elongata** (R. A. Dyer) Bruyns, Aloe 37: 74. 2001. *Caralluma gerstneri* subsp. *elongata* R. A. Dyer, Fl. Pl. Africa. 40: t. 1567. 1969. *Orbeopsis gerstneri* subsp. *elongata* (R. A. Dyer) L. C. Leach, Excelsa Taxon. Ser. 1: 67. 1978.—TYPE: SOUTH AFRICA. Transvaal: hills above Penge, *Phillips sub PRE 30367* (holotype: PRE!).

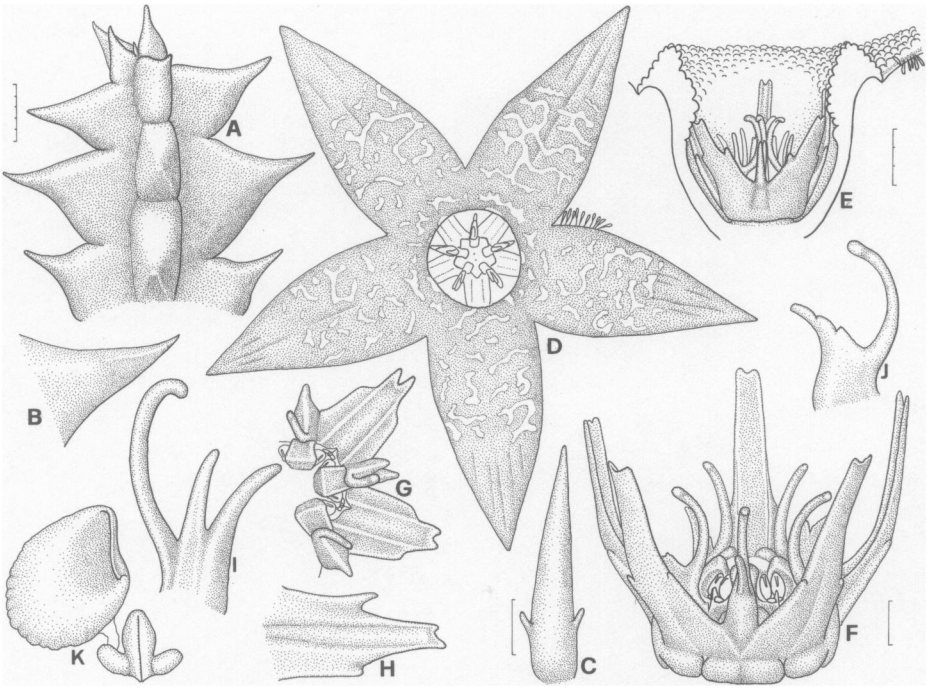

FIG. 63. *Orbea gerstneri* subsp. *elongata.* A. Portion of stem. B. Leaf rudiment. C. Bract from inflorescence. D. Face view of flower. E. Side view of center of dissected flower. F. Side view of gynostegium. G. Face view of part of gynostegium. H. Outer corona lobe. I, J. Inner corona lobes. K. Part of pollinarium. Scale bars: A, D, 5 mm (at A); B, 2 mm (at C); C, I, J, 1 mm (at C); E, 3 mm; F, G, H, 1 mm (at F); K, 0.25 mm (at C). [Based on: A, B, *Bruyns 6601*; C, D, F, G, J, *Bruyns 2042*; E, H, I, K, *Bruyns 6605*.]

Succulent forming clumps 10 cm to 1 m in diameter. Stems 3–10 cm long, 0.6–2 cm in diameter (excluding teeth), stout, sometimes rhizomatous for up to 10 cm; tubercles 4–9 mm long, joined into 4 obtuse angles along stem with a slight to broadly concave groove between angles, tapering to a spreading deltoid acute laterally flattened tooth, sometimes with fine ascending denticles near apex. Corolla 3.5–6 cm in diameter; tube 7–9 mm long, 8–9 mm in diameter, pentagonal to circular at mouth but distinctly pentagonal towards base, the sepals resting on angles of the pentagon outside, inside with small translucent-white papillae on an otherwise purple-brown background, corolla thickened around mouth sometimes into a slightly raised annulus; lobes sometimes becoming greenish towards tips. Outer corona lobes 5–6 mm long, steeply ascending against sides of corolla tube. Figs. 2C, 63.

Distribution (Fig. 62). South Africa; 900–1600 m.

Orbea gerstneri subsp. *elongata* occurs in the mountains of the eastern Transvaal along the Olifants River and its tributary the Blyde River. It was known only from the type locality at Penge, but recent investigations have revealed that it also grows on slopes and hilltops along the western side of the Blyde River Canyon some 60 km southeast of the type locality.

This subspecies also grows in stony places but wedged among stones and clumps of grass on hillsides, often on soils derived from dolomite.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** TRANSVAAL: [2430] Penge [-AD], *Bruyns 2042* (BOL); 34 km NE of Ohrigstad [-DA], *Bruyns 6601* (BOL); Branddraai [-DA], *Bruyns 6605* (K); Moremala [-DB], *Bruyns 7019* (MO).

37. Orbea huillensis (Hiern) Bruyns, Aloe 37: 74. 2001. *Caralluma huillensis* Hiern, Cat. afr. pl. 1(3): 697. 1898. *Orbeopsis huillensis* (Hiern) L. C. Leach, Excelsa Taxon. Ser. 1: 68. 1978.—TYPE: ANGOLA. Huila, Dec 1859, *Welwitsch 4266* (holotype: BM!; isotype: LISU).

Succulent forming diffuse to dense clumps 15 cm to 3 m in diameter, sometimes rhizomatous. Stems 4–30 (–50) cm long, 1.5–3 cm in diameter (excluding teeth), usually massive, decumbent, grey-green usually marbled with red-purple; tubercles 5–25 mm long, joined into 4 (rarely 5) continuous often narrowly obtuse wing-like angles along stem with a deep groove between angles, forming a prominent to very large deltoid laterally flattened spreading acute tooth with two denticles near tip (tip gradually becoming hardened and covered with yellowish corky layer). Inflorescences 1–3 per stem (younger ones only) from base to near apex, each of 5–40 extremely smelly flowers opening ± simultaneously from a stout cylindrical truncate peduncle (± 15 mm long, 5–10 mm in diameter); pedicels 10–45 mm long, 2–3 mm in diameter, horizontal to ascending, with slender lanceolate laterally toothed bracts 4–8 mm long at base. Sepals 5–9 mm long, 2–3 mm wide at base, ovate-lanceolate, acuminate with recurved tips. Corolla 5.5–8.5 cm in diameter, ± rotate, deeply lobed; outside smooth, purplish to pale pink on lobes to cream towards base of tube; inside dark brown, deep maroon, dark purple or yellow, transversely papillate-rugulose; tube 5–7 mm deep, cupular, usually completely containing gynostegium, corolla somewhat thickened at mouth; lobes 20–45 mm long, 5–9 mm wide at base, spreading, narrowly attenuate from ovate base, convex, the margins reflexed and with scattered maroon to white vibratile clavate to spathulate cilia up to 3 mm long or eciliate. Corona 3.5–4.5 mm tall, 5.5–8.0 mm in diameter, raised above base of tube by stout pentagonal stipe 1.0–1.5 mm long, deep purple-brown to orange (in yellow flowers); outer lobes 1.5–3.0 mm long, 1.5–2.5 mm wide at base, spreading to ascending, usually with several radial ridges along inner face some of which extend into various apical teeth, oblong, acute to truncate-dentate or deltate, laterally fused towards base to lower sides of inner lobes; inner lobes 1.5–3.5 mm long, adpressed to backs of anthers then ascending and usually recurved towards the apex, linear, dorsiventrally flattened sometimes only very slightly, becoming terete distally, obtuse to slightly bifid apically, base swollen dorsally above outer lobes into rounded boss or produced into series of spreading teeth. Fig. 64.

Distribution (Fig. 62). Angola, Botswana, Namibia, Zambia, Zimbabwe; 900–1300 m.

Orbea huillensis is found in southern Angola, southern Zambia, Namibia east of Grootfontein, in the northwestern corner of Botswana, and in western Zimbabwe.

Study of the complex surrounding *O. valida* and *O. huillensis* had previously been hampered by the relatively few specimens then available for examination. Leach (1965) was the first to provide any illustrations of *O. valida* and *O. huillensis*. In this paper, he discussed two species, as *Caralluma valida* and *C. gossweileri*, which he considered "closely related" but "readily distinguished" by several features: (1) flowers "very much larger" in *C. gossweileri* with lobes 40–45 mm long, lobes 15–25 mm long in *C. valida*; (2) pedicels 10–15 mm long in *C. valida* and 35–45 mm long in *C. gossweileri* (in respective descriptions), although in the table (Leach 1965: 245) the type of

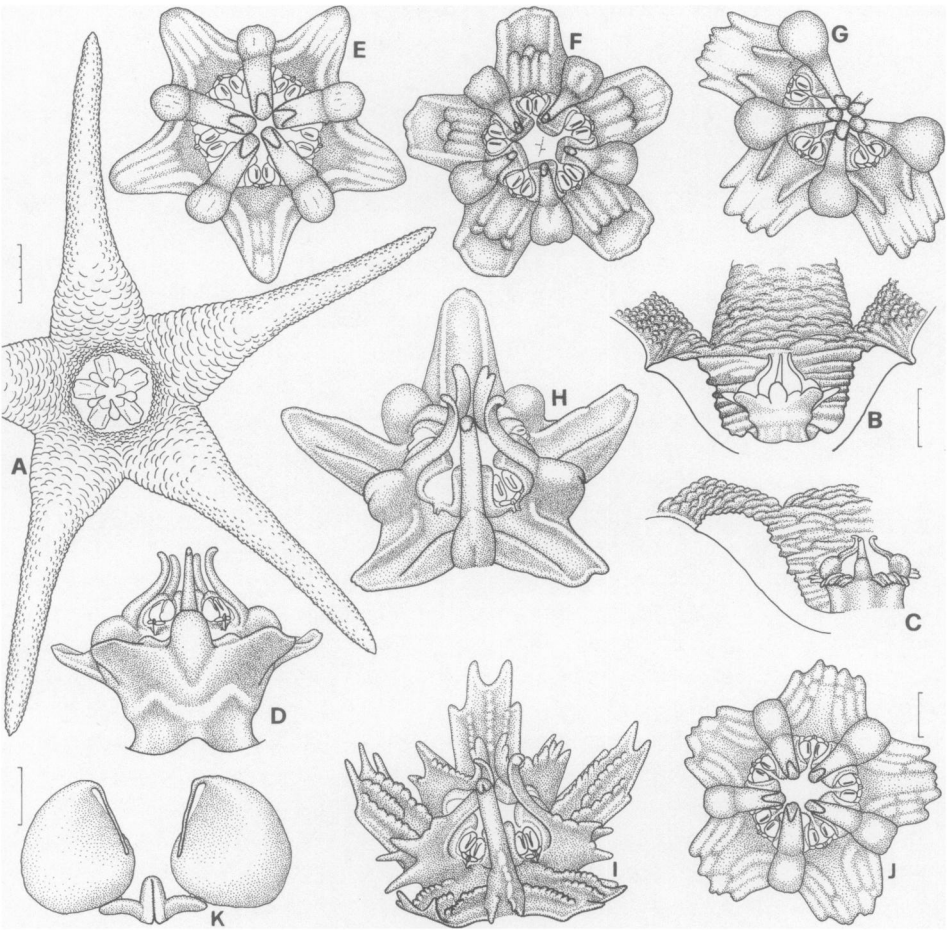

FIG. 64. *Orbea huillensis* subsp. *huillensis* (A–G) and subsp. *flava* (H, I). A. Face view of flower. B, C. Side views of center of dissected flower. D. Side view of gynostegium. E–J. Face views of gynostegium. K. Pollinarium. Scale bars: A, 5 mm; B, C, 3 mm (at B); D–J, 1 mm (at J); K, 0.25 mm. [Based on: A, B, D, F, K, *Bruyns 4133*; C, J, *Bruyns 6480*; E, G, *Bruyns 5525*; H, I, *Bruyns 5522*.]

C. gossweileri is given with pedicels 15–20 mm long, which agrees with S. Moore's description and invalidates this distinction; (3) *C. valida* produces 20–40 flowers in one inflorescence, *C. gossweileri* 6–15 flowers; (4) *C. valida* has vibratile, clavate cilia on the margins of the lobes, *C. gossweileri* lacks these entirely; (5) in *C. valida* the "distinctive inner corona has the lobes gracefully curved in the shape of a coronet" (Leach 1965: 245). In a subsequent paper, Leach (1970) showed that things are far less clear. Here four species were regarded as "closely related," namely *Caralluma gossweileri*, *C. huillensis*, *C. tsumebensis*, and *C. valida*. The characters distinguishing *C. gossweileri* and *C. valida* as listed in the earlier paper were all abandoned, except for the lack of cilia in *C. gossweileri* and the fact that in *C. gossweileri* the "inner lobes of the corona appear . . . to be more or less terete above whereas those of *C. valida* and *C. huillensis* tend to be

somewhat flattened and straplike." Having established that the stems of *C. huillensis* are glabrous as in the others (in the protologue the stems were given as pubescent, but this turned out to be an artifact caused by fungal activity), Leach found that "*C. huillensis* and *C. gossweileri* are very closely related indeed and may eventually prove to be conspecific." He established that small numbers of cilia are present on the margins of the corolla lobes in *C. huillensis* (p. 186) and mentioned that this ciliation "varies considerably in density and is possibly sometimes absent in individual flowers." In *C. tsumebensis* he also established (p. 184) that in the type the "relatively small corolla . . . is quite devoid of the conspicuous ciliation [of *C. huillensis*]." He tentatively included *Story 5312* under *C. tsumebensis* "despite its proportionally wider corolla lobes which are sparsely ciliate." He also reproduced a series of sketches by W. Giess, which showed the corona of *C. tsumebensis*.

Leach was hesitant, because of the paucity of material seen, to take as broad a view of this complex as he did in the complex surrounding *Caralluma lutea*, where "not to have followed this policy would have resulted in the recognition of almost innumerable taxa, since it seems that within some species, not only are no two specimens identical but that the range of variation within even small populations may be almost unbelievably wide" (Leach 1970: 157). In the present situation, the number of specimens seen has often also been few, but, whenever several are found, the variation is also extraordinarily wide (especially in the coronal lobes; see Fig. 64 for *O. huillensis*). In addition, the characters, such as the diameter of the corolla and presence or absence of marginal cilia on the lobes, which Leach considered to be diagnostic, have also proved to be variable and of no particular use in separating some of the taxa.

Investigations of this complex preparatory to this revision revealed the existence of four elements, two of which were known to Leach (corresponding to *C. gossweileri* and *C. valida* of Leach, 1965) and two of which have only been discovered since 1990. As Leach (1970) already suggested, it has proven impossible to separate *C. gossweileri*, *C. huillensis*, and *C. tsumebensis*, and these three are considered to belong to a single taxon, for which the earliest validly published name is *Caralluma huillensis* Hiern.

As noted above, two species, *O. huillensis* and *O. valida*, are recognized in the present account. *Orbea huillensis* is now known to be considerably more variable than realized before, with yellow to deep red or brown flowers, which sometimes have cilia along the margins of the lobes. In all variants, however, the flowers are greater than 5.5 cm in diameter and have narrowly attenuate corolla lobes. Both rhizomatous and non-rhizomatous forms are known.

The size of the stem proved not to be a reliable character with which to distinguish between *O. huillensis* and *O. valida*. Very robust-stemmed plants are found in both species. The very scattered occurrence of *O. huillensis* in areas where *O. valida* is also found further emphasizes the artificiality of this taxonomic solution: in particular, no localities are known where the robust-stemmed, non-rhizomatous forms of both species grow together. If they were regarded as conspecific, the position of the two newly discovered taxa would be difficult to define. On the one hand, *O. huillensis* subsp. *flava* only differs from subsp. *huillensis* in the color of the flower and the thickness of the stems. Since these differences are easily matched within *O. lutea*, for example, and even within *O. lutea* subsp. *vaga*, it is clear that subsp. *flava* should be considered merely as a local variant of *O. huillensis*. On the other hand, *O. valida* subsp. *occidentalis* and *O. huillensis* subsp. *huillensis* have been seen growing together (pers. obs.), and presumably they represent distinct species.

Orbea huillensis is distinguished from *O. valida* by the larger corolla and the narrowly attenuate corolla lobes. The differences that separate it from *O. gerstneri* (no. 36) are discussed under that species.

Many plants of *O. huillensis* and *O. valida* have exceptionally robust stems, in which case it is easy to separate them from the ubiquitous *O. lutea*; however, plants of *O. huillensis* subsp. *flava* and *O. valida* subsp. *occidentalis* are more slender-stemmed. It is then usually the noticeably larger stipular denticles, which are up to 2 mm long, that suggests that one is dealing with a member of the *O. huillensis*/*O. valida* complex rather than with *O. lutea*.

KEY TO THE SUBSPECIES OF ORBEA HUILLENSIS

Stems without underground rhizomes, 2–3 cm in diameter (excluding teeth), corolla brown to maroon inside. 37a. *O. huillensis* subsp. *huillensis*.

Stems with underground rhizomes, 1.5–2 cm in diameter (excluding teeth), corolla yellow inside. 37b. *O. huillensis* subsp. *flava*.

37a. Orbea huillensis subsp. **huillensis.**

Caralluma gossweileri S. Moore, J. Bot. 50: 367. 1912. *Orbeopsis gossweileri* (S. Moore) L. C. Leach, Excelsa Taxon. Ser. 1: 67. 1978.—TYPE: ANGOLA. Forte Princeza Amelia (near Kuvango), *Gossweiler 2098* (holotype: BM!; isotypes: COI, K!).

Caralluma tsumebensis Obermeyer in A. C. White & B. Sloane, Stapelieae, ed. 2, 3: 1163. 1937. *Orbeopsis tsumebensis* (Obermeyer) L. C. Leach, Excelsa Taxon. Ser. 1: 68. 1978.—TYPE: NAMIBIA. Cultivated specimen, Tsumeb, *Nägelsbach sub Transvaal Museum 32820* (holotype: PRE!).

Succulent forming diffuse to dense clumps up to 3 m in diameter. Stems 4–30 cm long, 2–3 cm in diameter (excluding teeth), usually massive, without underground rhizomes; tubercles (10–) 15–25 mm long. Corolla 5.5–8.5 cm in diameter; inside dark brown to deep maroon. Corona deep purple-brown. Fig. 64A–G.

Distribution (Fig. 62). Angola, Botswana, Namibia, Zambia, Zimbabwe; 900–1300 m.

Orbea huillensis subsp. *huillensis* is found in southern Angola, northwestern Botswana, southern Zambia, and western Zimbabwe, and is particularly widespread in northern Namibia to the east of Grootfontein.

Plants usually grow in the shelter of small trees, more rarely in the open and are found on fine, white to black sand, sometimes overlaying calcrete.

ADDITIONAL SPECIMENS EXAMINED. **Angola.** [1513] Huila Distr., Humpata [-AB], *Gossweiler 12612* (LISC); Huila, "Missao de Catolica" [-BA], *Santos 119a* (LISC). **Botswana.** [1921] Kangwa [-CA], *Bruyns 6480* (BOL). **Namibia.** [1918] Nukuwis [-BA], *Strohbach 1453* (WIND); Osmoor [-BC], *Bruyns 4133* (BOL). Grootfontein [-AD], *Bruyns 5525* (BOL). [1920] Tsumke [-DA], *Bruyns 4121* (BOL); 28 km SE of Tsumke [-DC], *Bruyns 4126* (BOL). Gautscha Pan [-DC], *Story 5312* (PRE). **Zambia.** [1625] Livingstone Distr., Machili [-CC], *Fanshawe 5942* (SRGH). Kalumbu, *Mitchell 3012* (BM, K, PRE, SRGH). **Zimbabwe.** [1928] Nyamandhlovu distr. Pasture Research Center [-CD], *sub Plowes 1884* (K, PRE, SRGH).

Plants of subsp. *huillensis* often form clumps over 1 square meter in area, but enormous specimens up to 3 m in diameter have been seen. They have extremely robust stems (up to 50 cm tall and 8 cm across, if one includes the teeth) with very large deltoid teeth along the angles, and they show no tendency to form subterranean runners.

The flowers vary considerably in diameter (from 5.5 to 8.5 cm) and are usually deep maroon to deep brown. They have slender, attenuate lobes and a cupular tube 5–7 mm deep containing the gynostegium completely. On plants in Namibia and Botswana some flowers have a few cilia along the margins of the lobes but most are completely without them.

The outer corona lobes are short, more or less rectangular and spreading, but they are extremely variable in outline and also especially in the ridges and furrows on the upper surface. The inner lobes are relatively slender, slightly flattened to nearly terete, initially adpressed to the backs of the anthers, then rising more or less vertically above them and sometimes connivent in a column in the center. They always have a low, swollen, and rounded dorsal projection in series with the outer lobes.

Plants here assigned to subsp. *huillensis* fit the original description of *Caralluma gossweileri* and correspond closely to material identified by L. C. Leach as *Orbeopsis gossweileri* (e.g., *sub Plowes 1884*, PRE, from Zimbabwe; *Mitchell 3012*, PRE, from Zambia). Determining these specimens with the keys provided by Leach (1970, 1978) also yields this identification. Therefore, *Orbea huillensis* and *C. gossweileri* are treated as conspecific here. Specimens with the flower less than 6 cm in diameter key to *Orbeopsis tsumebensis*; in most details, subsp. *huillensis* fits the description of *Caralluma tsumebensis* as well. In particular the corona is generally identical to that depicted by Giess for *C. tsumebensis* (Leach 1970, Fig. 12), and an examination of the relevant specimen (*sub Plowes 1884*, PRE) showed that the figure in Leach (1965: 248) for *C. gossweileri* is a stylized version of the same structure. Consequently, *Caralluma tsumebensis* is treated as a further synonym.

37b. Orbea huillensis subsp. **flava** Bruyns, Aloe 37: 76. 2001.—TYPE: NAMIBIA. Northeast of Grootfontein, *Bruyns 5522* (holotype: BOL!).

Succulent forming diffuse clumps 15–30 cm in diameter. Stems 4–12 cm long, 1.5–2 cm in diameter (excluding teeth), relatively slender, often with underground rhizomes; tubercles 5–15 mm long. Corolla 7–8.5 cm in diameter; inside yellow. Corona orange. Fig. 64H, I.

Distribution (Fig. 62). Namibia; 1200 m.

Orbea huillensis subsp. *flava* is known only in the northeastern corner of Namibia to the east of Grootfontein. Plants are found in this area in open forest with *Terminalia sericea* and other trees on pale, whitish sands.

ADDITIONAL SPECIMEN EXAMINED. **Namibia.** [1918] E of Rundu road [-BB], *Bruyns 5515* (BOL).

In *O. huillensis* subsp. *flava* the stems are grouped into relatively small clumps and often produce underground rhizomes. They are also considerably smaller and less boldly toothed than those of subsp. *huillensis*.

Florally the two subspecies are only distinguishable by their different colors: the corolla is yellow in subsp. *flava* and the corona is orange. In subsp. *flava* the corolla has not been found to vary much in size and is generally large with plenty of vibratile cilia along the margins of the lobes. In subsp. *flava* the inner corona lobes are much longer than those of subsp. *huillensis* and are usually somewhat bifid apically. Some remarkable variation has been observed in the shape of the excrescences near the base of the inner lobes, and some of this variation is shown in Fig. 64H, I. The lobes range from the swollen, round shape that is typical of subsp. *huillensis* to remarkable, rather more flattened

structures consisting of several, spreading, acute teeth. This variation indicates how cautiously one should view these structures as taxonomically informative.

38. Orbea valida (N. E. Brown) Bruyns, Aloe 37: 76. 2001. *Caralluma valida* N. E. Br., Bull. Misc. Inform. 1895: 264. 1895. *Orbeopsis valida* (N. E. Brown) L. C. Leach, Excelsa Taxon. Ser. 1: 67. 1978.—TYPE: BOTSWANA [?]. *Holub s.n.* (holotype: K!).

Succulent forming diffuse clumps 8–100 cm in diameter, sometimes rhizomatous. Stems 4–20 cm long, 1.5–2.5 cm in diameter (excluding teeth), usually massive, decumbent, grey-green usually marbled with red-purple; tubercles 5–25 mm long, joined into 4 (rarely 5) continuous often narrowly obtuse wing-like angles along stem with a deep groove between angles, forming a prominent to very large deltoid laterally flattened spreading acute tooth with two denticles near tip (tip gradually becoming hardened and covered with yellowish corky layer). Inflorescences 1–3 per stem (younger ones only) from base to near apex, each of 5–40 extremely smelly flowers opening ± simultaneously and borne on a stout cylindrical truncate peduncle (± 15 mm long, 5–10 mm in diameter); pedicels 10–45 mm long, 2–3 mm in diameter, horizontal to ascending, with slender lanceolate laterally toothed bracts 4–8 mm long at base. Sepals 5–9 mm long, 2–3 mm wide at base, ovate-lanceolate, acuminate with recurved tips. Corolla 3.5–4.5 (–5.5) cm in diameter, ± rotate, deeply lobed; outside smooth, purplish to pale pink on lobes to cream towards base of tube; inside deep maroon to pinkish red, transversely papillate-rugulose; tube 2–6 mm deep, cupular to shallowly cupular, mostly completely containing gynostegium, with corolla somewhat thickened at mouth; lobes 15–20 (–25) mm long, spreading, narrowly deltate, convex, the margins reflexed, with scattered maroon to white vibratile clavate to spathulate cilia up to 3 mm long along margins. Corona 3.5–4.5 mm tall, 5.5–8.0 mm in diameter, raised above base of tube by a stout pentagonal stipe 1.0–1.5 mm long, deep purple-brown; outer lobes 1.5–3.0 mm long, 1.5–2.5 mm wide at base, spreading to ascending, usually with several radial ridges along inner face, some of which extend into various apical teeth, oblong, acute to truncate-dentate or deltate, laterally fused towards base to lower sides of inner lobes; inner lobes 1.5–3.5 mm long, adpressed to backs of anthers, then ascending and usually recurved towards the apex, linear, dorsiventrally flattened or sometimes only very slightly so, becoming terete above, obtuse to slightly bifid apically, base swollen dorsally above outer lobes into a rounded boss or produced into series of spreading teeth. Figs. 65, 66.

Distribution (Fig. 58). Botswana, Namibia, Zambia, and Zimbabwe; 900–1500 m.

Orbea valida has been recorded in northeastern Namibia, northern Botswana, southern Zambia, and western Zimbabwe.

In the present revision, *O. valida* is broadly circumscribed, like *O. huillensis*. The flower is 3.5–4.5 cm in diameter, and the narrowly deltate corolla lobes always bear cilia along the margins. The pollinia are always much wider than long; they are more or less as long as wide in *O. huillensis*. In *O. valida* the corolla tube is very variable in depth, far more so than has been observed in *O. huillensis*, and the corona is also variable, so that in some cases it resembles that of *O. huillensis*. Very rhizomatous plants are found in the western portion of the range.

KEY TO THE SUBSPECIES OF ORBEA VALIDA

Stems without underground rhizomes, corolla tube 5–6 mm deep and ± containing gynostegium. 38a. *O. valida* subsp. *valida*.

Stems with underground rhizomes, corolla tube 2–3 mm deep and containing at most lower half of gynostegium. 38b. *O. valida* subsp. *occidentalis*.

38a. **Orbea valida** subsp. **valida.**

Succulent forming diffuse to dense clumps up to 1 m in diameter. Stems 4–20 cm long, 2–2.5 cm in diameter (excluding teeth), massive, without underground rhizomes; tubercles (10–) 15–25 mm long. Corolla 3.5–4.5 (–5.5) cm in diameter; inside deep maroon to dark purple-red; tube 5–6 mm deep, cupular, ± containing gynostegium; lobes with pale cilia along margins. Corona: outer lobes ascending; inner lobes adpressed to backs of anthers then ascending and strongly recurved, dorsiventrally flattened for whole length and sometimes contiguous for some of length, apically obtuse to bifid or even deeply bifid, towards base somewhat dorsally swollen into two gibbosities or with two horns contiguous with outer corona. Fig. 65.

Distribution (Fig. 58). Botswana, Namibia, Zambia, Zimbabwe; 900–1200 m.

Orbea valida subsp. *valida* has been found in Namibia in the Caprivi strip, in Botswana north of the Okavango Delta and eastwards to around Pandamatenga, in western Zimbabwe, and in southern Zambia.

Plants grow in dry, open forest and are often associated with *Colophospermum mopane*.

ADDITIONAL SPECIMENS EXAMINED. **Botswana.** [1822] 60 km SE of Shakawe [-CA], *Bruyns 6938* (BOL); Gudigua [-DB], *Bruyns 6945* (BOL). [1825] 57 km N of Pandamatenga [-AB], *Bruyns 6963* (BOL). **Namibia.** [1821] Dikundu, 19.5 km S of Andara [-AB], *Giess 11371* (WIND); Mutsiku, 5 miles E of Bagani [-BA], *Kohler sub Giess 9207* (WIND). **Zambia.** [1527] Mazabuka Distr., Siamambo Forest Res. [-DC], *White 7420* (FHO, SRGH). [1622] Shangambo, Siwelewele [-AD], *Codd 7485* (PRE). **Zimbabwe.** [1828] Gokwe Distr., Charama Plateau [-BA], *Bingham 762* (SRGH). [1927] Lupane Distr., Bembesi River [-BB], *Leach 5811* (K, PRE, SRGH).

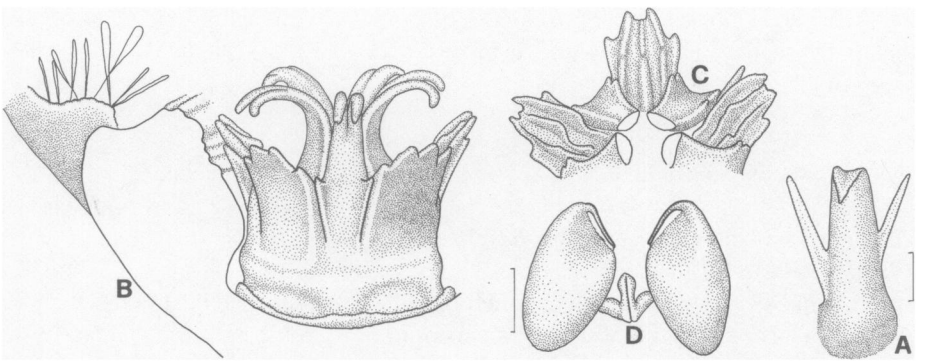

FIG. 65. *Orbea valida* subsp. *valida.* A. Bract from inflorescence. B. Side view of center of dissected flower. C. Face view of part of gynostegium. D. Pollinarium. Scale bars: A-C, 1 mm (at A); D, 0.25 mm. [Based on *Bruyns 6963*.]

Orbea valida subsp. *valida* has a robust habit and stout, boldly toothed stems, like *O. huillensis* subsp. *huillensis*, which form large clumps on the surface of the soil; the plants are not at all rhizomatous.

The maroon to dark purple-red flowers measure 3.5–4.5 cm across, and have narrowly deltate lobes and a cupular tube 5–6 mm deep containing the corona. There are pale, often whitish, vibratile, clavate cilia all along the margins of the lobes.

The corona has steeply ascending outer lobes. The inner lobes are dorsiventrally flattened for their whole length, rising in a column above the center, then broadly spreading towards the apex, which is often quite deeply bifid. In some plants the inner lobes may be quite tightly pressed against one another in their proximal parts. Near the base each lobe is dorsally considerably swollen; this swelling may be somewhat bifid or may take the form of teeth pressed to the side of the outer corona. In such cases there is much reduced access to the guide-rail. This unusual arrangement is not found in subsp. *occidentalis* or in either of the subspecies of *O. huillensis*, although in some flowers of *O. huillensis* subsp. *flava* (e.g., Fig. 64I) the dorsal base of the inner corona is similarly ornamented. In *O. huillensis* the inner corona lobes vary from strap-like (though usually not as broad as in *O. valida* subsp. *valida*) to nearly terete.

38b. Orbea valida subsp. **occidentalis** Bruyns, Aloe 37: 76. 2001.—TYPE: BOTSWANA. NE of D'Kar, *Bruyns 6465* (holotype: BOL!).

Succulent forming diffuse clumps 8–20 cm in diameter, joined by underground rhizomes up to 20 cm long. Stems 4–15 cm long, 1.5–2 cm in diameter (excluding teeth), relatively slender; tubercles 5–15 mm long. Corolla 4–4.5 cm in diameter; inside pinkish red; tube 2–3 mm deep, shortly conical, containing at most the lower half of the gynostegium; lobes with dark red cilia along margins. Corona: outer lobes spreading; inner lobes adpressed to backs of anthers then ascending and recurved, dorsiventrally flattened near base and almost terete towards the apex, obtuse, towards base dorsally swollen just above outer lobes into a rounded boss. Fig. 66.

Distribution (Fig. 58). Botswana, Namibia; 1000–1500 m.

Orbea valida subsp. *occidentalis* occurs in Namibia east of the Waterberg and continued eastwards into Botswana, where it has been found near Kangwa (no specimen) and Ghanzi.

In these areas it grows among *Terminalia sericea*, *Commiphora*, and other trees on red to orange sands.

ADDITIONAL SPECIMEN EXAMINED. **Namibia.** [2017] E of Waterberg [-BA], *Bruyns 5529* (BOL).

The stems of *O. valida* subsp. *occidentalis* are much more slender than those of subsp. *valida*. The plants are strongly rhizomatous, and the clumps remain comparatively small. Underground runners may spread from their parent plant for up to 20 cm.

In this subspecies the corolla is pinkish red rather than the deeper color found in subsp. *valida*, but it still has an awful smell of old excrement. The tube is much shorter than in subsp. *valida*, and the cilia along the margins of the lobes are darkly colored rather than pale and are scattered all the way along the margins of the lobes.

The outer corona lobes in subsp. *occidentalis* are more spreading than in subsp. *valida* and are extremely variable in shape. The inner lobes have the characteristic rounded dorsal boss near the base, also found in *O. huillensis*, but the lobes themselves are broader

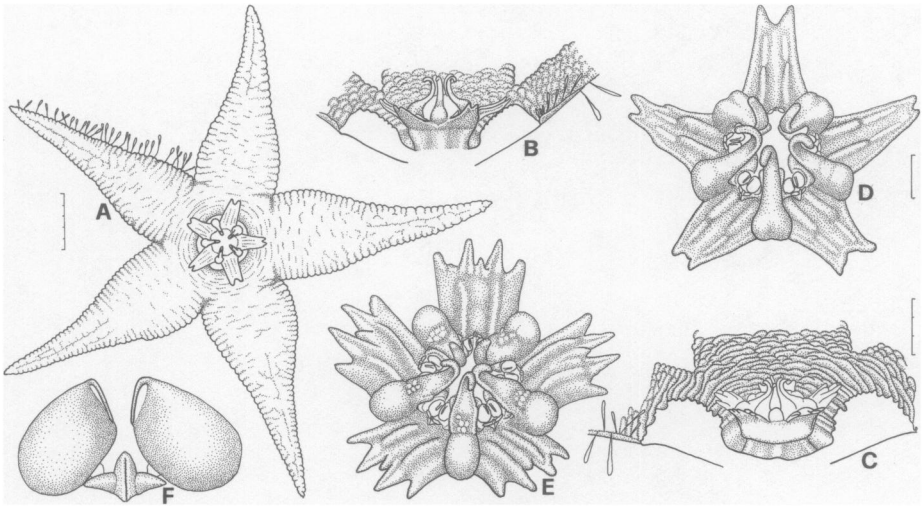

FIG. 66. *Orbea valida* subsp. *occidentalis*. A. Face view of flower. B, C. Side views of center of dissected flower. D, E. Face views of gynostegium. F. Pollinarium. Scale bars: A, 5 mm; B, C, 3 mm (at C); D, E, 1 mm (at D); F, 0.25 mm (at C). [Based on: A, B, D, F, *Bruyns 6465*; C, E, *Bruyns 5529*.]

than usually seen in that species, though narrower than in subsp. *valida*. The considerable difference in the shape of the dorsal excrescences on the inner corona between subsp. *occidentalis* and subsp. *valida* is not considered to be taxonomically important in view of the variation seen in the one collection of *O. huillensis* subsp. *flava* (Fig. 64H, I), where some flowers had coronas similar to those of in subsp. *valida* and others like those in subsp. *occidentalis*.

39. Orbea ciliata (Thunberg) L. C. Leach, Kirkia 10: 291. 1975. *Stapelia ciliata* Thunberg, Prodr. 1: 47. 1794. *Podanthes ciliata* (Thunberg) Haworth, Syn. pl. succ. 34. 1812. *Tromotriche ciliata* (Thunberg) Sweet, Hort. Brit., ed. 2: 358. 1830. *Diplocyatha ciliata* (Thunberg) N. E. Brown, J. Linn. Soc. Bot. 17: 168. 1878.—TYPE: SOUTH AFRICA. Cape Province: between Roggeveld Mtns and Paardeberg, *Thunberg & Masson 6327* (holotype: UPS).

Succulent forming mats 10–50 cm in diameter, not rhizomatous. Stems 4–8 (–12) cm long, 1.5–2.5 cm in diameter (excluding teeth), stout and often nearly cylindrical, shortly decumbent, green heavily marked with purple-brown to nearly entirely purple-brown; tubercles 5–8 mm long, conical, arranged loosely into 4 very broadly obtuse rows along stem ± without a groove between rows, tapering to a spreading conical acute tooth with a pair of minute stipular denticles shortly below apex, both apex and denticles obsolescent with age. Inflorescence 1 per stem arising near base ± without a peduncle, of 1 (–2) flowers; pedicel 10–25 mm long, 3–4 mm in diameter, spreading with ascending apex, holding flower facing upwards close to ground, heavily streaked with purple-brown on green. Sepals 6–8 mm long, 3 mm wide at base, ovate-acuminate. Corolla 7–11 cm in diameter, rotate to shallowly bowl-shaped; outside smooth, pale green-dotted and streaked with reddish purple, usually with 5 slightly raised darker veins along lobes; inside cream to pale

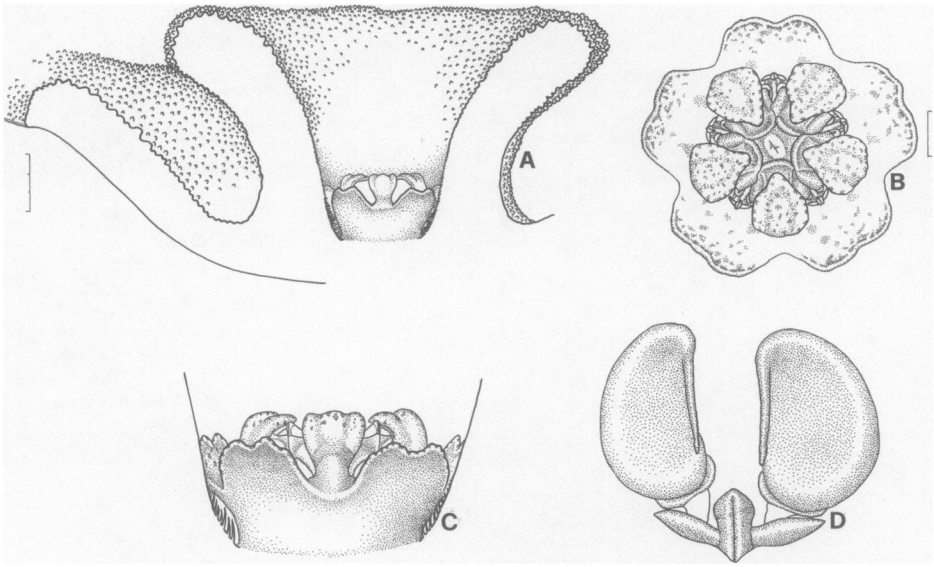

FIG. 67. *Orbea ciliata.* A. Side view of center of dissected flower, showing the very tall annulus. B. Face view of gynostegium. C. Side view of gynostegium. D. Pollinarium. Scale bars: A, 3 mm; B, C, 1 mm (at B); D, 0.25 mm (at A). [Based on *Bruyns 4332*.]

greenish yellow, covered (more densely towards base) with small papillate ± transverse ridges, papillae tipped with purple-red; tube shallowly bowl-shaped, towards base with a broadly funnel-shaped annulus 8–11 mm tall with spreading (to recurved) thickened sometimes slightly pentagonal rim and walls 2–3 mm in diameter, annulus papillate like inside of corolla but inside more darkly colored (uniformly dark purple in ring at base around corona and there densely covered with short stiff acute erect purple bristles); lobes 28–32 mm long, 14–20 mm wide at base, ovate-acuminate, spreading to strongly reflexed, with a dense row of vibratile clavate white cilia 3–4 mm long along margins. Corona ± 2.5 mm tall, 4.5 mm in diameter, raised very slightly above base of tube on a stout obtusely pentagonal heavily purple blotched stipe, cream to pale yellow sparsely dotted with purple mainly towards margins; outer lobes ± 0.7–2.0 mm long, 2.0–2.5 mm wide at base, subquadrate, irregularly obtuse to emarginate or sometimes bidentate, pale yellow sparsely dotted with purple, ascending-spreading, usually pressed against sides of narrow tube formed by base of annulus; inner lobes 0.6–1.0 mm long, adpressed to backs of anthers but shorter than these, ± ovate, acute, somewhat gibbous on rear. Figs. 1F, 3E, 67.

Distribution (Fig. 89). South Africa; 600–1200 m.

Orbea ciliata is found in several apparently disjunct areas in the western part of the Cape Province, along the eastern boundary of the winter-rainfall region.

Plants of *O. ciliata* usually grow in flat areas under bushes, often under spiny species of *Ruschia* (of the succulent Aizoaceae).

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** CAPE PROVINCE: [3019] Noute [-DC], *Bruyns 7949* (BOL). [3119] Oorlogs Kloof [-AC], *Compton 9647* (NBG); 10 km N of Calvinia [-BC], *Bruyns 4332* (PRE); Kliprug [-CB], *Bruyns 6050* (K). [3221] Abraham's Kraal [-DD], *Pillans s.n.* (BOL). [3319] Karoopoort [-BA], *Hardy 50* (PRE); 10 km E of Karoopoort [-BB], *Bruyns 6265* (MO); 11 km N of Karoopoort [-BB], *Stayner s.n.*

(NBG); ± 13 km N of Karoopoort [-BB], *Hall s.n.* (NBG); turn-off to Rooifontein, N of Karoopoort [-BB], *Hiemstra 183a* (NBG). [3322] Vyevlei [-AA], *Leach 16892* (NBG); Tierberg [-AB], *Bruyns 3694* (BOL).

Orbea ciliata has stout stems, which are mostly not more than four times as tall as thick, and they are impossible to separate from the stems of *O. namaquensis*. Florally these two species are quite different; with its large, creamy, ciliate flowers with a very tall annulus, *O. ciliata* is unmistakable. The background color of the flower is cream to faintly greenish yellow, which is an unusual coloration in the stapeliads.

Probably the most unusual feature of the flower is the remarkably large annulus. The corolla itself is bowl-shaped, with spreading lobes. Near the base of this bowl there is another thick, funnel-shaped, corolla-like structure, which is usually nearly as tall as the corolla tube is deep. This structure is a much enlarged annulus; this is the largest and most prominent annulus found anywhere in the stapeliads. Towards its base it becomes narrow, and the rather small corona fits closely into it, with the outer lobes pressed against its sides. In coloring the corona matches the corolla closely.

40. Orbea halipedicola L. C. Leach, Excelsa Taxon. Ser. 1: 40. 1978.—TYPE: MOZAMBIQUE. Between Buzi and Gorongoza Rivers, *Ambrose sub Leach 12396* (holotype: SRGH!; isotypes: PRE! LISC).

Orbea halipedicola subsp. *septentrionalis* L. C. Leach, Excelsa Taxon. Ser. 1: 43. 1978.—TYPE: MOZAMBIQUE. Gorongoza Park, 14 May 1972, *Tinley s.n.* (holotype: SRGH!).

Small succulent forming diffuse clumps up to 2 m in diameter, often rhizomatous. Stems 5–15 cm long, 0.4–0.7 cm in diameter (excluding teeth), slender, decumbent, green and often streaked with brown; tubercles 7–12 mm long, arranged into 4 obtuse rows along stem, tapering to a slender conical-acute ascending to slightly incurved tooth flattened above near apex, with a pair of short ascending denticles 2–3 mm below apex. Inflorescence 1 per stem near base, of 1–3 flowers developing in gradual succession on a peduncle <5 mm long, with a few tiny bracts up to 2 mm long; pedicel 20–30 mm long, ± 2 mm in diameter, spreading with upturned apex so flower faces upwards near ground. Sepals 4–6 mm long, 2.0–2.5 mm wide at base, narrowly ovate and acuminate. Corolla 3–4.2 cm in diameter, rotate; outside pale creamy green, smooth and obscurely 3–5-nerved; inside with small acute papillae especially towards apex of lobes and on annulus, otherwise smooth and not rugulose, deep red to red- or purple-brown with irregular yellow to whitish markings; tube formed by a ± circular and slightly to strongly convex annulus 1.5–2.5 mm tall and 8–9 mm wide, with spreading obtuse and sometimes slightly recurved margin; lobes 14–16 mm long, 7–10 mm wide at base, spreading, ovate, shortly acuminate, convex above especially towards base, the margins folded downward and with vibratile clavate (later spathulate) white to purple-red cilia 1–2 mm long in the proximal half of the lobe. Corona 5 mm tall, 5.0–6.5 mm in diameter, raised on a stout slightly pentagonal stipe nearly 2 mm long; outer lobes ± 2 mm long, 1.5 mm wide at base, spreading, slightly recurved to rest on rim of annulus, ± subquadrate, often thickened along middle, sometimes with two raised radial ridges forming a central trough leading to a fleshy tooth, truncate and irregularly dentate, dark purple-brown; inner lobes 3–4 mm long, ± 1 mm wide at base, adpressed to backs of anthers, becoming erect and sometimes connivent distally, dorsiventrally flattened, narrowing to terete distally, sometimes with a slightly clavate and obscurely rugulose apex, dorsally gibbous and forming towards the base a pair

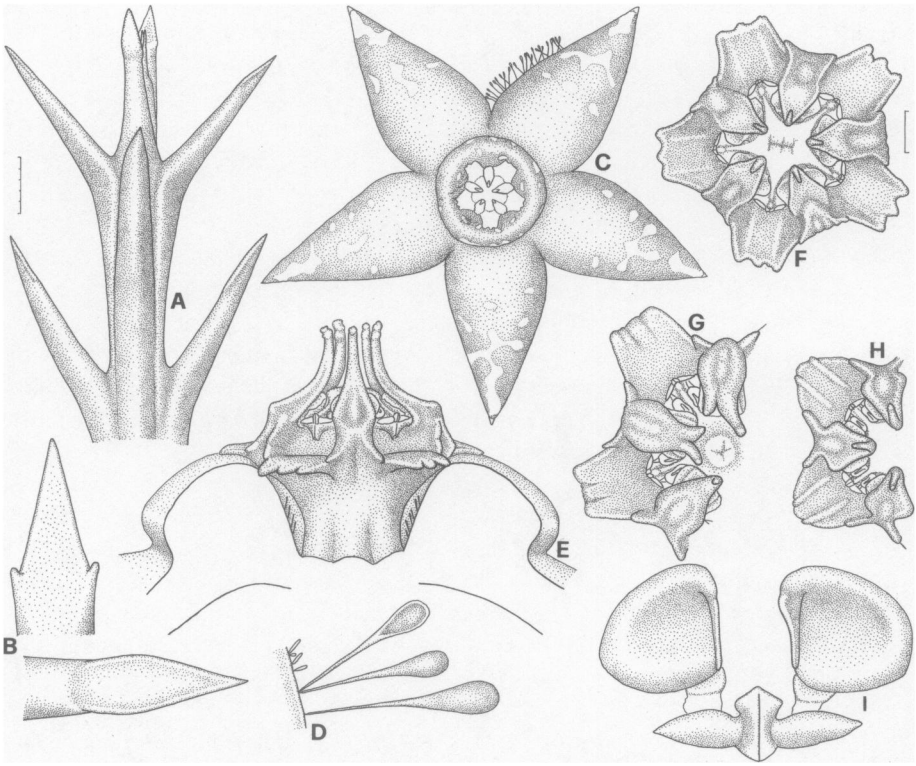

FIG. 68. *Orbea halipedicola.* A. Portion of stem. B. Leaf rudiments. C. Face view of flower. D. Cilia borne along margins of lobes, with tiny ones sometimes present near base of lobes. E. Side view of center of dissected flower. F–H. Face views of gynostegium. I. Pollinarium. Scale bars: A, C, 3 mm (at A); B, 1 mm (at A); D, 0.5 mm (at A); E–H, 1 mm (at F); I, 0.25 mm (at A). [Based on: A, B-the lower one, H, *Bruyns 7401*; B-the upper one, C–G, I, *Bruyns 7402*.]

of subacute fleshy teeth laterally fused to outer lobes, bright yellow spotted with red or purple. Fig. 68.

Distribution (Fig. 69). Mozambique; 20–200 m.

Orbea halipedicola is known only from the coastal region of Mozambique, where it has been found in a few places from near the mouth of the Save River northwards to the Gorongoza Park.

Orbea halipedicola was recorded as growing in *Colophospermum mopane* woodland in the Gorongoza Park (Leach 1978). It is very common in certain spots in the low-lying flats from southwest of Beira southwards towards the Save River. Here it grows among small, scattered grasses, trees of *Strychnos* or *Hyphaene natalensis* Kunze with *Adenium obesum* (Forssk.) Roem. & Schult. and *Portulaca* in firm, white, somewhat calcareous sand of almost neutral pH.

ADDITIONAL SPECIMENS EXAMINED. **Mozambique.** [1934] Near Lake Gambue ± 24 km S of Muda [-CB], *Leach 5822* (SRGH), *Bruyns 7401* (BOL, MO). [2034] 40 km N of Save R. [-CA], *Bruyns 7402* (NBG).

Plants of *O. halipedicola* spread very extensively underground with rhizomes, forming diffuse clumps up to 2 m in diameter and often with only single, erect stems

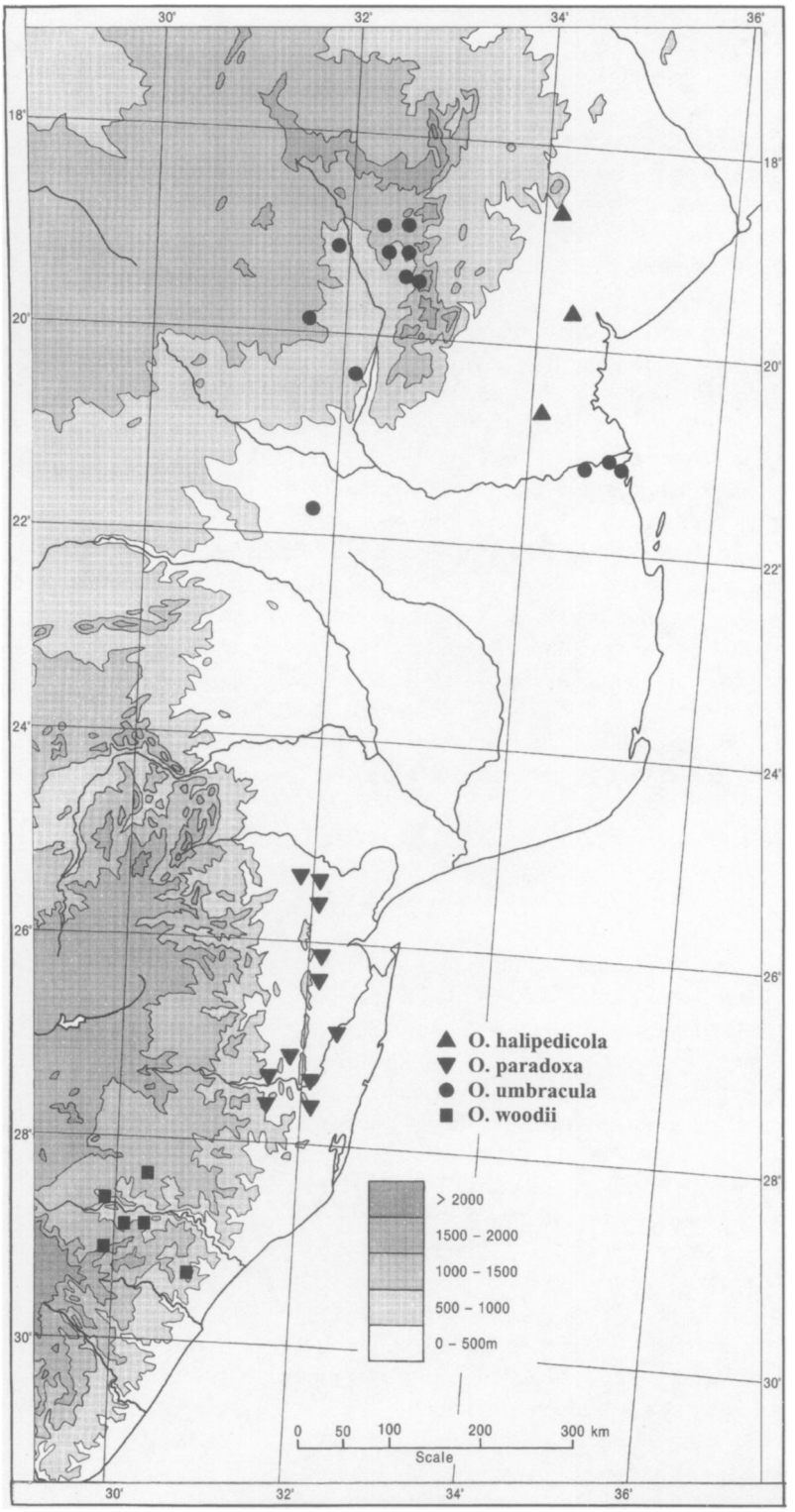

FIG. 69. Distribution of *Orbea halipedicola*, *O. paradoxa*, *O. umbracula*, and *O. woodii*.

projecting from the soil over much of this area. As with several of the tropical species of *Orbea*, they have long, slender, ascending tubercles that break up their outline and make them harder to see among tufts of grass.

Orbea halipedicola is similar to *O. umbracula* and *O. woodii* in many respects. All of them have slender tubercles on the stems. In *O. umbracula* the flowers are held on an erect pedicel, whereas in the other two the pedicel spreads, and the flowers are often pressed to the ground. In all of them the annulus gives rise to the corolla tube; it is broadest and flattest in *O. halipedicola*, where the corolla lobes are also the least reflexed and not at all transversely rugulose. The same short, broad outer corona lobes, often with a channel down the middle, are found in all three species, and the respective coronas only differ somewhat in the nature of the tips of the inner lobes. These are not extended beyond the anthers in *O. woodii*, but they extend beyond the anthers and rise up in the other two, to the greatest extent in *O. umbracula*, where they are noticeably swollen and tuberculate at the tips. There is also a relationship with *O. semota* from further north in Kenya and Tanzania, but that species has a more rugulose corolla with an even flatter annulus than in *O. halipedicola*, and its stems more closely resemble those of *O. variegata*.

Leach recognized two subspecies in *O. halipedicola*, with subsp. *septentrionalis* recorded from the Gorongoza Park and from near Beira, and the nominate subspecies from between the Buzi and Gorongoza Rivers a little to the south of Beira. Subspecies *septentrionalis* was distinguished by erect, thicker stems with shorter teeth, a less distinctly raised annulus and almost flat outer corona lobes; however, plants indistinguishable from subsp. *halipedicola* have been found near Beira (*Bruyns 7401*), among other specimens characteristic of subsp. *septentrionalis*. It seems, therefore, that the characteristics of subsp. *septentrionalis* fall within the range of variation among populations of *O. halipedicola*, and therefore subspecific taxa are not recognized here.

41. Orbea semota (N. E. Brown) L. C. Leach, Kirkia 10: 290. 1975. *Stapelia semota* N. E. Brown, J. Cact. Succ. Soc. Amer. 4: 393. 1933.—TYPE: TANZANIA. Kondoa Irangi [0435 DD], *Burtt 1450* (holotype: K!).

Small succulent forming clumps 6 cm to 1 m in diameter, not rhizomatous. Stems 3–10 cm long, 0.6–0.8 cm in diameter (excluding teeth), slender, erect to shortly decumbent, green to grey-green flecked with purple-brown; tubercles 6–12 mm long, arranged into 4 obtuse rows along stem with a slight groove between rows, tapering to a slender spreading conical tooth, only occasionally with a pair of small obtuse stipular denticles ± 3–5 mm from tip. Inflorescence 1 per stem in proximal half, of 1–3 flowers developing in gradual succession, peduncle absent, with a few concave ovate bracts ± 2 mm long and 1.5 mm wide with lateral teeth; pedicel 15–40 mm long, 2.0–2.5 mm in diameter, slightly ascending and holding flower facing upwards. Sepals 5–7 mm long, 2–3 mm wide at base, lanceolate, acuminate. Corolla 2–5.5 cm in diameter, rotate, deeply lobed; outside glabrous, cream to green, with 5 darker lines along lobes; inside transversely rugulose on lobes and annulus, bright yellow to yellow spotted with dark maroon (coalescing towards center) to nearly wholly dark maroon with slight mottling of yellow near apices of lobes; tube ± 2 mm deep, shallow, bounded by a broad somewhat flattened spreading concentrically rugulose annulus 7–13 mm in diameter and abruptly raised ± 2 mm above corolla just below bases of lobes, with a ring of small ascending bristles on the proximal 1 mm of sides; lobes 7–25 mm long, 6–10 mm wide at base, spreading and slightly reflexed, ovate-lanceolate, acuminate, convex above, the margins recurved and with a dense row of fine

spindle-shaped to clavate white (in plain yellow flowers) to maroon vibratile marginal cilia 1.5–3.5 mm long. Corona ± 3 mm tall, 6–10 mm in diameter, raised above base of tube on an obscurely pentagonal cream stipe ± 1.5 mm long; outer lobes ± 2 mm long, 2 mm wide, subquadrate, spreading and touching top of annulus, truncate to obtuse, ± flat above, dark maroon to pale maroon, becoming yellow near base; inner lobes 0.7–1.5 mm long, adpressed to backs of anthers and usually shorter than these, ovate, truncate to dentate to acute, slightly gibbous on rear, maroon with yellow markings to yellow. Figs. 70, 71.

Distribution (Fig. 50). Kenya, Rwanda, Tanzania; 1000–1800 m.

Orbea semota is recorded over a wide area in East Africa from around Lake Victoria in Tanzania and Rwanda to the Taita Hills close to the coast in Kenya. It shares many features with *O. halipedicola*, *O. umbracula*, and *O. woodii*, which occur considerably further to the south. It seems to be particularly similar to *O. woodii* from Natal, South Africa, and differs from it only in the rather more flattened and broader annulus, which is concentrically rugulose, and in the considerably broader corona with a shorter stipe.

Two subspecies are recognized. Although the stems of subsp. *orientalis* are slightly less boldly toothed than those of subsp. *semota*, the main differences between the two lie in the much smaller flowers of subsp. *orientalis*. In subsp. *semota* the corolla is at least 3.5 cm in diameter, whereas in subsp. *orientalis* it is at most 2.5 cm in diameter. The corolla lobes are only 7–8 mm long (at least 12 mm in subsp. *semota*), and the annulus is at most 8 mm in diameter. As the illustrations (Figs. 70, 71) show, the gynostegium is slightly smaller, too, but is not quite in proportion to the size of the corolla. The pollinia of the new subspecies (Fig. 71C) are also considerably smaller.

KEY TO THE SUBSPECIES OF ORBEA SEMOTA

Corolla >34 mm in diameter.	41a. *O. semota* subsp. *semota*.
Corolla <25 mm in diameter.	41b. *O. semota* subsp. *orientalis*.

41a. Orbea semota subsp. **semota.**

Stapelia molonyae A. C. White & B. Sloane, Stapelieae, ed. 2, 2: 435. 1937.—TYPE: KENYA. Nairobi, *Molony s.n.* (holotype: not located).

Stapelia discoidea Obermeyer in A. C. White & B. Sloane, Stapelieae, ed. 2, 3: 1167. 1937.—TYPE: of unknown origin, *Transvaal Museum 35740* (holotype: not located).

Stapelia kagerensis Lebrun & Taton, Explor. Parc Nat. Kagera, Miss. J. Lebrun 1937–38, 1: 108. 1948.—TYPE: RWANDA. *Lebrun 5923* (holotype: BR!).

Corolla 3.5–5.5 cm in diameter; inside wholly bright yellow to yellow spotted with dark maroon (coalescing towards center) to nearly wholly dark maroon with slight mottling of yellow near apex of lobes; tube bounded by a circular to pentagonal annulus 10–13 mm in diameter, usually with a ring of hairs near base inside; lobes 12–25 mm long, 8–10 mm wide at base, often with a dense row of white (in plain yellow flowers) to maroon vibratile marginal cilia 2.5–3.5 mm long. Corona ± 3 mm tall, 10 mm in diameter; outer lobes maroon; inner lobes maroon with yellow markings to yellow. Fig. 70.

Distribution (Fig. 50). Kenya, Rwanda, Tanzania; 1000–1800 m.

Orbea semota subsp. *semota* is widely distributed in the higher parts of Kenya and

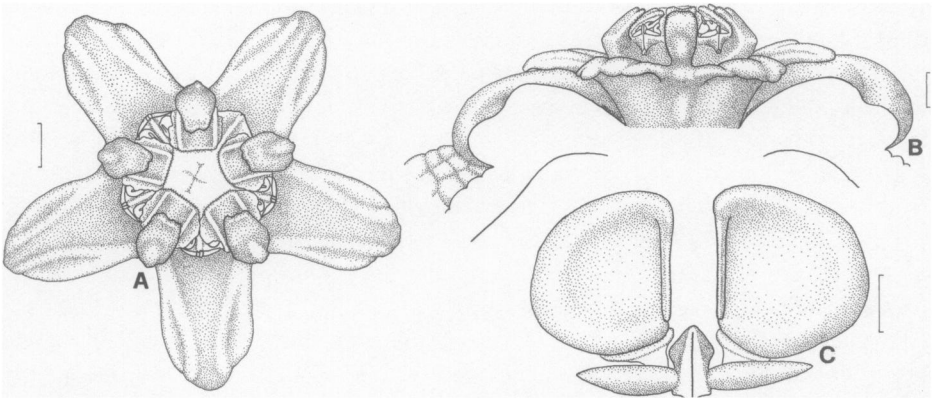

FIG. 70. *Orbea semota* subsp. *semota.* A. Face view of gynostegium. B. Side view of center of dissected flower. C. Pollinarium. Scale bars: A, 1 mm; B, 1 mm; C, 0.25 mm. [Based on a living plant with plain yellow flowers, ex hort. E. Aslander; no voucher).

Tanzania from near Rumuruti as far south as Kondoa and westwards to near the shores of Lake Victoria.

In Tanzania plants have been seen among granite boulders on pale yellow soil. They grew among stunted trees of *Brachystegia* and *Acacia*, with scattered *Aloe*, a small spiny *Euphorbia*, and small tufts of grass.

ADDITIONAL SPECIMENS EXAMINED. **Kenya.** [N 0036] Near Rumuruti [-BC], *Napier 1874* (K). [0135] Olololo escarpment [-AA], 01°14′S, 35°00′E, Masai Mara, *Dodds s.n.* (BOL). [0136] Nairobi [-BD], *Napier 6206* (K, EA). [0137] Ol Doinyo Sapuk [-AB], *Napier 1875* (K, EA). Kirichwa, Kubwa Valley, *McLoughlin 673* (PRE). **Rwanda.** [0130] Kakitumba (AB), *Christiaensen 786* (K); Lugadzi [-CB], S of Gabiro, *Lebrun 9523* (BR). East of Hinweya, *Becqaert 562* (BR). **Tanzania.** [0231] Biharamulo [-CB], *Reynolds 8885A* (PRE, SRGH). [0437] Kisiwani [-BB], *Greenway 4592* (K, EA).

41b. Orbea semota subsp. **orientalis** Bruyns, subsp. nov.—TYPE: KENYA. Taita distr., near Bura [0338 AD], 1200 m, 2 Dec 1998, *Luke 5511* (holotype: BOL!).

A O. semota subspecie semota floribus parvioribus et in partibus omnibus parvioribus differt.

Corolla 2.0–2.5 cm in diameter; inside faintly transversely rugulose, dull brown; tube bounded by circular annulus 7–8 mm in diameter, without a ring of hairs inside; lobes 7–8 mm long, 6 mm wide at base, with a few brown spathulate vibratile marginal cilia ± 1.5 mm long. Corona ± 3 mm tall, 6 mm in diameter; outer lobes dark brown; inner lobes brown with yellow margins. Fig. 71.

Orbea semota subsp. *orientalis* is known from a single locality in the Taita hills in southeastern Kenya (Fig. 50), where it was found on steep slopes among rocks and grass.

The flowers of subsp. *semota* are very variable in color, from plain yellow to brown and variously speckled with yellow or more or less plain brown. In this respect subsp. *orientalis*, with its uniformly dull brown flowers, is not unusual. The outer corona lobes are rather darker than is usual and lack any of the customary yellowish markings. The inner lobes are somewhat paler and have slightly yellow margins.

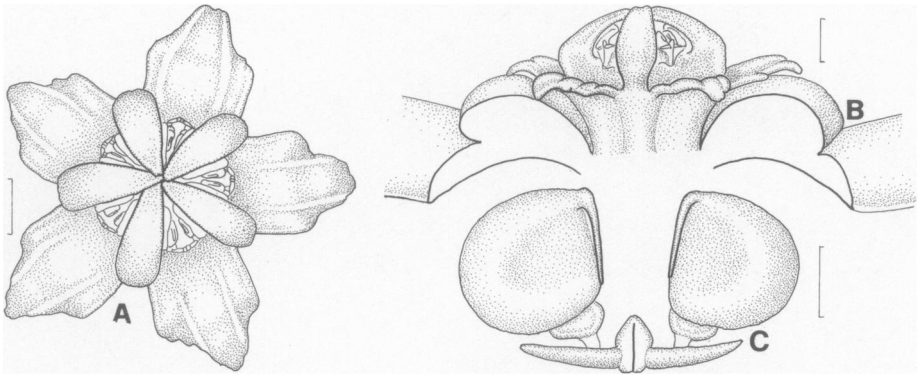

FIG. 71. *Orbea semota* subsp. *orientalis*. A. Face view of gynostegium. B. Side view of center of dissected flower. C. Pollinarium. Scale bars: A, 1 mm; B, 1 mm; C, 0.25 mm. [Based on *Luke 5511*.]

42. Orbea woodii (N. E. Brown) L. C. Leach in Kirkia 10: 290. 1975. *Stapelia woodii* N. E. Brown, Gard. Chron., ser. 3, 11: 554. 1892.—TYPE: SOUTH AFRICA. Natal: Noodsberg [2930 BD], *Medley-Wood 4119* (holotype: K!).

Orbea woodii var. *westii* R. A. Dyer, Flow. Pl. S. Africa 21: t. 811. 1941.—TYPE: SOUTH AFRICA. Natal: Estcourt, *West 1531 sub PRE 26437* (holotype: PRE).

Dwarf succulent forming diffuse clumps up to 10 cm in diameter, not rhizomatous. Stems 4–6 cm long, 0.6–0.8 cm in diameter (excluding teeth), branching from base, erect to shortly decumbent, green mottled with purple-brown; tubercles 6–15 mm long, arranged loosely into 4 obtuse rows along stem ± with a groove between rows, tapering to a prominent slender conical-acute ascending-spreading tooth, usually with a pair of small denticles shortly below apex. Inflorescence 1 per stem near base, of 1–3 flowers developing successively, occasionally with a stout peduncle; pedicel 20–55 mm long, 1.5–2.5 mm in diameter, spreading horizontally with upturned apex. Sepals 5.5–7.0 mm long, 1.5–2.0 mm wide at base, narrowly ovate-acuminate. Corolla 3–4.5 cm in diameter, rotate to slightly reflexed; inside light reddish to blackish brown or maroon; tube ± 1.5 mm deep, conical, formed entirely by a thick cushion-like to ± dome-shaped smooth to slightly rugulose annulus often slightly darker than lobes; lobes 12–18 mm long, 10 mm wide at base, spreading to somewhat reflexed, ovate and shortly acuminate to ± narrowly ovate-acuminate, convex, the margins sometimes quite strongly recurved, lightly to heavily transversely rugulose, very finely papillate, with clavate vibratile marginal cilia up to 2 mm long. Corona ± 4.5 mm tall, 6–7 mm in diameter, darker than annulus to almost black, raised on a short stout obtusely pentagonal stipe ± 1 mm long; outer lobes 1.5–2.0 mm long, 1.0–1.5 mm wide, more or less truncate and obtusely dentate or crenulate at apex, with two raised fleshy ridges forming a trough running down the center, resting on annulus; inner lobes 1.2–1.5 mm long, adpressed to backs of anthers, sometimes exceeding them and then shortly connivent-erect in center, dorsiventrally flattened and broadly ovate below, acuminate, margins sometimes slightly raised (then lobes channelled above) and occasionally with 1–2 small obtuse teeth, sometimes with a small dorsal tubercle. Fig. 72.

Distribution (Fig. 69). South Africa; 800–1200 m.

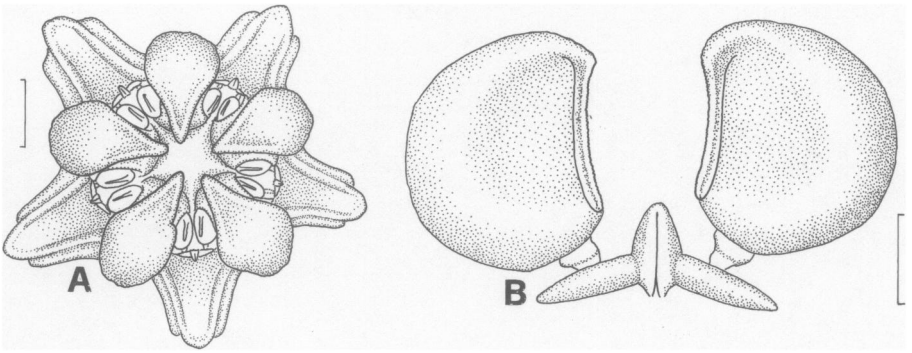

FIG. 72. *Orbea woodii.* A. Face view of gynostegium. B. Pollinarium. Scale bars: A, 1 mm; B, 0.25 mm. [Based on *Frandsen sub Leach 14876.*]

Orbea woodii is only known from central Natal along the middle reaches of the Tugela River Valley.

Plants are usually found on stony slopes among grasses, *Aloe*, and other smaller succulents, and seem generally to be rare and scattered in their occurrence.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** NATAL: [2829] Colenso [-DB], *Frandsen sub Leach 14876* (BOL, MO); Platrand, near Ladysmith [-DB], *Wood sub NH 12393* (NH). [2830] 8–9 miles SE of Helpmekaar [-AD], *Frandsen sub Leach 14913* (K, PRE, SRGH); Weenen [-CC], *Repton s.n.* (PRE); *Thomanet s.n.* (PRE); Muden [-CD], *Cronwright 74* (PRE). [2929] 7 miles SE of Estcourt [-BB], *Plowes 2604* (NBG, NH); Brakfontein, 13 km E of Estcourt [-BB], *Plowes 3909* (PRE); Estcourt [-BB], *Acocks 11449* (NH); Estcourt Research Station [-BB], *West 707* (PRE).

The stems of *O. woodii* have relatively long tubercles that taper to a slender tooth and, as such, resemble somewhat those of *O. longidens*; however, they generally are darker green. The two species are markedly different florally.

Orbea woodii shares many features with *O. halipedicola*, *O. semota*, and *O. umbracula*, and, of these, it is most similar to *O. halipedicola* from Mozambique and *O. semota* from East Africa. In *O. halipedicola* the stems are somewhat different and the flower is not at all rugulose, whereas the inner corona lobes are markedly longer. In *O. semota* the stems are very similar to those of *O. woodii*, and the inside of the corolla is similarly rugulose, but the gynostegium is broader and raised on a far shorter stipe.

43. Orbea macloughlinii (Verdoorn) L. C. Leach, Kirkia 10: 291. 1975. *Stapelia macloughlinii* Verdoorn, Fl. Pl. South Africa 21: t. 812. 1941.—TYPE: SOUTH AFRICA. Cape Province: Transkei, Umtata Falls, *McLoughlin sub PRE 26384* (holotype: PRE!).

Orbea speciosa L. C. Leach, Excelsa Taxon. Ser. 1: 33. 1978.—TYPE: SOUTH AFRICA. Natal: Izingolweni, *Lubbers sub Leach 14742* (holotype: PRE!).

Dwarf succulent forming small clumps, sometimes extensively rhizomatous. Stems 3–10 cm long, 0.6–0.8 mm in diameter (excluding teeth), sometimes forming rhizomes up to 15 cm long, slender, erect to shortly decumbent, pale green flecked with purple-brown; tubercles 4–10 mm long, arranged into 4 obtuse rows along stem with a slight groove between rows, tapering to a slender spreading conical tooth, with a pair of much reduced

to obsolescent stipular denticles shortly below apex. Inflorescence 1 per stem near base, of 1–3 flowers developing in gradual succession, peduncle <5 mm long, with a few concave narrowly ovate acute bracts 2–3 (–6) mm long and 1.5 mm wide at base; pedicel (15–) 20–25 mm long, 2 mm in diameter, heavily streaked with purple-brown on green, ± horizontally spreading often with upturned apex, holding flowers facing horizontally or upward. Sepals 5–12 mm long, 2–3 mm wide at base, narrowly ovate, acute or acuminate. Corolla 3.5–5.5 cm in diameter, rotate to somewhat reflexed right from center, usually with the lobes slightly reflexed; outside glabrous, pale green suffused with dark purple, with 3–5 longitudinal purplish veins along each lobe; inside smooth and somewhat shiny, dark maroon to brown-red with few to many irregular transverse yellow markings towards tips of lobes or with maroon spots on yellow background; tube 2.0–2.5 mm long, ± 5 mm in diameter, cupular, bounded by an annulus abruptly to gradually raised 1.5–2.0 mm above the surface of the corolla and abruptly to gradually merging with rest of the surface, pentagonal; lobes 12.5–20 mm long, 9–13.5 mm wide at base, spreading and often reflexed, ovate-deltate, shortly acuminate, rarely slightly rugulose towards tips, margins not folded back, with clavate vibratile maroon marginal cilia up to 3 mm long except at tips. Corona ± 4 mm tall, 6.5–7 mm in diameter, raised well above base of tube on a dark maroon obtusely pentagonal stipe ± 1.5 mm long and 2.5 mm in diameter; outer lobes ± 1.5–2.0 mm long, 1.5–2.0 mm wide, subquadrate, spreading and touching upper rim of annulus, truncate to obtusely 3–4-dentate, emarginate, dark maroon; inner lobes 1.0–2.0 mm long, adpressed to backs of anthers and shorter to slightly exceeding them, ± ovate, acute to truncate, slightly gibbous on rear, irregularly and sparingly dentate on margins, yellow minutely speckled with red. Figs. 73, 74.

Distribution (Fig. 75). South Africa; 500–700 m.

Orbea macloughlinii is known from the former Transkei in the eastern Cape and from a single locality in southern Natal at the Oribi Gorge near Izingolweni. In the former

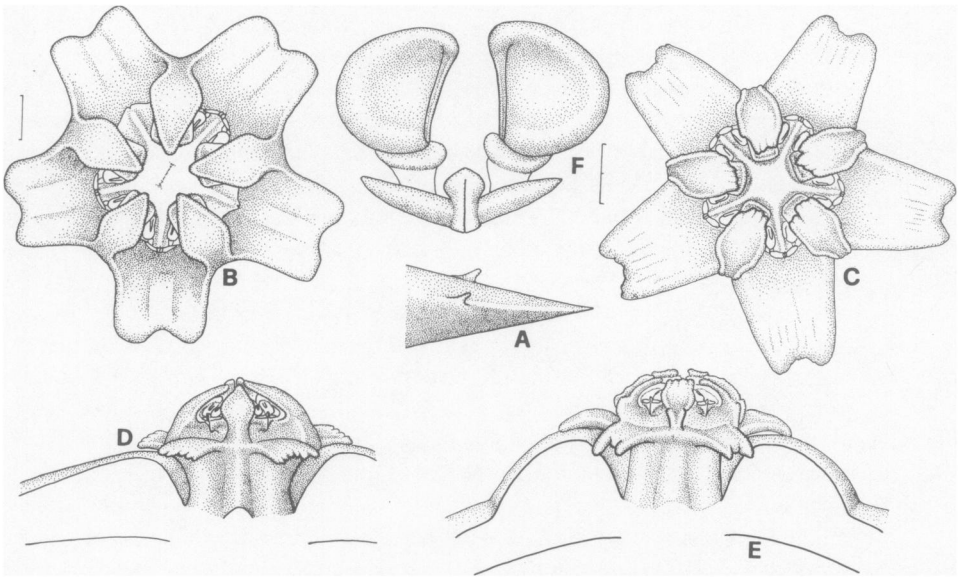

FIG. 73. *Orbea macloughlinii* A. Leaf rudiment. B, C. Face views of gynostegium. D, E. Side views of dissected flower. F. Pollinarium. Scale bars: A, 0.5 mm (at F); B, C, 1 mm (at B); D, E, 2 mm (at F); F, 0.25 mm. [Based on: A, B, D, F, specimen from Tsitsa, South Africa, collector unknown; C, E, *Bruyns 8920*.]

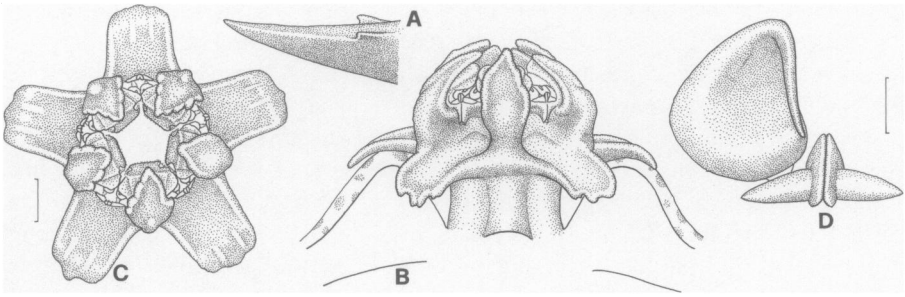

FIG. 74. *Orbea macloughlinii*. A. Leaf rudiment with stipular ridges. B. Side view of center of dissected flower. C. Face view of gynostegium. D. Part of pollinarium. Scale bars: A, 1 mm (at D); B, C, 1 mm (at C); D, 0.25 mm (at B). [Based on *Lubbers sub Leach 14742*, *sub KG 281/73*; the type of *Orbea speciosa*.]

Transkei it has been collected along the Umtata River at the Umtata Falls, which are just east of Umtata, and near the Tsitsa Falls some 60 km to the north.

Plants of *O. macloughlinii* grow in dry, rocky places in shallow soils along the precipitous edges of river banks or in areas where the dolerite bedrock is close to the surface, forming a hot and locally quite arid habitat.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** CAPE PROVINCE: [3128] Tsitsa Falls [-BD], cult. *Kennedy s.n.* (BOL); near Umtata [-DB], *Bruyns 8920* (MO).

The stems of *O. macloughlinii* form loose clumps and have a very similar appearance to those of *O. verrucosa*, except for their occasionally rhizomatous habit. Their appearance is rather different from stems of *O. longidens*, because the tubercles are not as long and are more abruptly acute.

In *O. macloughlinii* the inside of the corolla is variable in color, from dark maroon with only a few, irregularly shaped yellow spots on the lobes to boldly mottled with maroon on yellow. The annulus towards the center is also very variable in prominence. In some plants the corolla gradually becomes thicker towards the center, where there is then a low and barely distinguishable annulus, whereas in others the annulus is abruptly raised out of the surface near the center. This annulus produces a small tube around the gynostegial stipe, and the corolla is either flat beyond the annulus or slightly reflexed. It is this feature that provides the most obvious floral difference from *O. longidens*, in which there is always a small corolla tube beyond the annulus.

The gynostegium is supported on a stipe, which is hidden within the tubelet formed by the annulus. It has comparatively large, nearly square outer corona lobes, which are somewhat rectangular and spread out on the summit of the annulus. These lobes are dark maroon and match the color of the corolla quite closely. The inner lobes are adpressed to the backs of the anthers and slightly exceed them. They are yellow with maroon spots and a maroon margin.

The differences between *O. speciosa* and *O. macloughlinii* (Leach 1978) were thought to lie in the bright mottling of the corolla inside in *O. speciosa* (as opposed to the much darker flower in *O. macloughlinii* with hardly any yellow markings) and the abruptly raised annulus in *O. speciosa*. Plants of the gathering *Bruyns 8920*, collected in the area of the type locality of *O. macloughlinii*, have darker flowers than are believed to be characteristic of *O. speciosa*, but they vary from boldly marked inside with yellow to

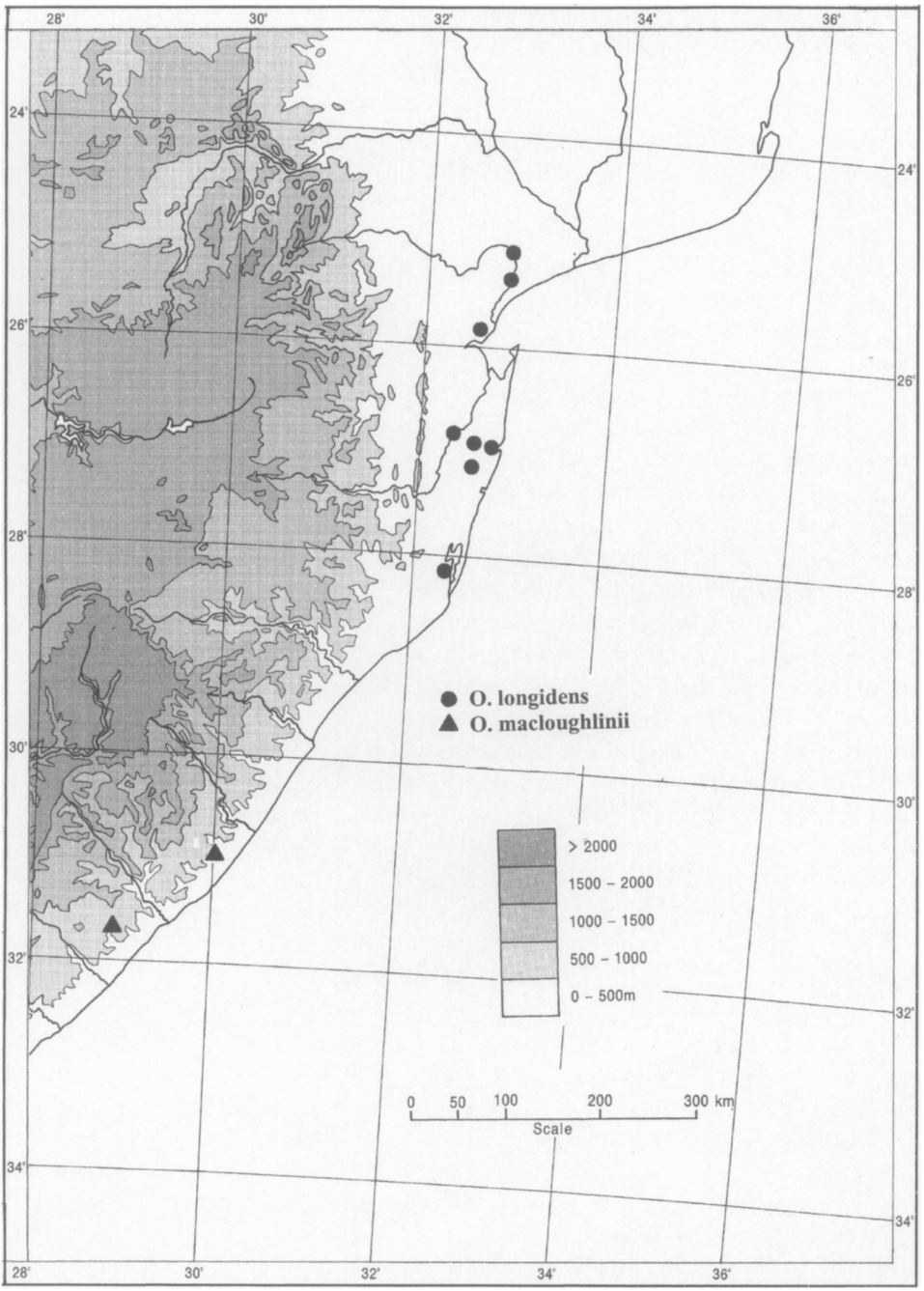

FIG. 75. Distribution of *Orbea longidens* and *O. macloughlinii*.

the typical dark flowers of *O. macloughlinii*. In this collection the annulus varies from abruptly raised above the surface to relatively indistinctly raised. Consequently, *O. speciosa* and *O. macloughlinii* can no longer be maintained as separate taxa, and they are here treated as conspecific.

All the material in cultivation of "*O. speciosa*" seems to belong to a single clone, and it is possible that only one was ever found. This clone is self-fertile, which is rare among the stapeliads.

44. Orbea longidens (N. E. Brown) L. C. Leach, Kirkia 10: 290. 1975. *Stapelia longidens* N. E. Brown, Gard. Chron., ser. 3, 18: 324. 1895.—TYPE: MOZAMBIQUE. Delagoa Bay, *Monteiro s.n.*, *cult. Tillett s.n.* (holotype: K!).

Dwarf succulent forming diffuse clumps up to 10 cm in diameter, sometimes rhizomatous. Stems 5–12 cm long, ± 0.5 cm in diameter (excluding teeth), slender, erect to decumbent, pale green marked with purple-brown; tubercles 5–20 mm long, arranged loosely into 4 obtuse rows along stem with a shallow groove between rows, tapering to a long slender conical usually ascending tooth, mostly with a pair of acute denticles inserted about 2/3 of the distance towards apex. Inflorescence 1 per stem near base, of 1–3 flowers developing in gradual succession, peduncle <5 mm long; pedicel ± 20 mm long, spreading sometimes with ascending apex. Sepals 6–8 mm long, 1.5–3.0 mm wide at base, ovate-acuminate. Corolla 3–5 cm in diameter, rotate, deeply lobed; outside pale green, glabrous; inside glabrous and smooth or minutely pubescent towards tips of lobes, cream-colored or yellowish with numerous small maroon to purple-brown spots within tube, these becoming larger and usually confluent towards apex of lobes; tube ± 5 mm long, 6–10 mm in diameter, broadly campanulate but steep-sided, with an abruptly raised annulus near base 2–3 mm long and 4–6 mm wide (about 1 mm thick) around base of gynostegium, pentagonal; lobes ± 16–20 mm long, 6–12 mm wide at base, spreading to reflexed, ovate to ovate-lanceolate, acute, with spathulate cilia 2–4 mm long along margins, usually at least in proximal half to eciliate, margins often somewhat folded upwards. Corona 3–6 mm tall, 4–5 mm in diameter, seated on a stout pentagonal stipe 2–3 mm long; outer lobes 1.2–1.5 mm long, subquadrate, spreading with the apex closely recurved over rim of annulus, cream with broad purple-brown patch down middle; inner lobes 1.2–1.5 mm long, adpressed to backs of anthers, hiding and exceeding them to meet in center but not produced above them, ± ovate, acute, slightly gibbous on rear, cream finely spotted with pale purple. Figs. 1A, 5A, 76.

Distribution (Fig. 75). Mozambique, South Africa; 10–100 m.

Orbea longidens is known in southern Mozambique from Maputo southwards to near Catuane and in northern Natal from near Ndumu southwards to around Hluhluwe, generally within 50 km of the coast.

Plants of *O. longidens* usually grow in flat areas in soft, white or greyish sand among grasses and under small bushes.

ADDITIONAL SPECIMENS EXAMINED. **Mozambique.** [2532] 20 km N of Manhiça [-BB], *Bruyns 8531* (MO); Manhiça [-BD], *de Sousa 233* (PRE); near Mahotas, ± 5 km from Maputo [-DC], *de Sousa 226, 227, 249* (PRE). [2632] Near Catuane [-CD], *de Sousa 252* (PRE). **South Africa.** NATAL: [2632] North of Lake Sibaya [-DC], *Hardy & Vahrmeijer 1636* (PRE); Maputa [-DD], *PRE 11302* (PRE). [2832] Hluluwe [-AB], *Bruyns 4449* (BOL).

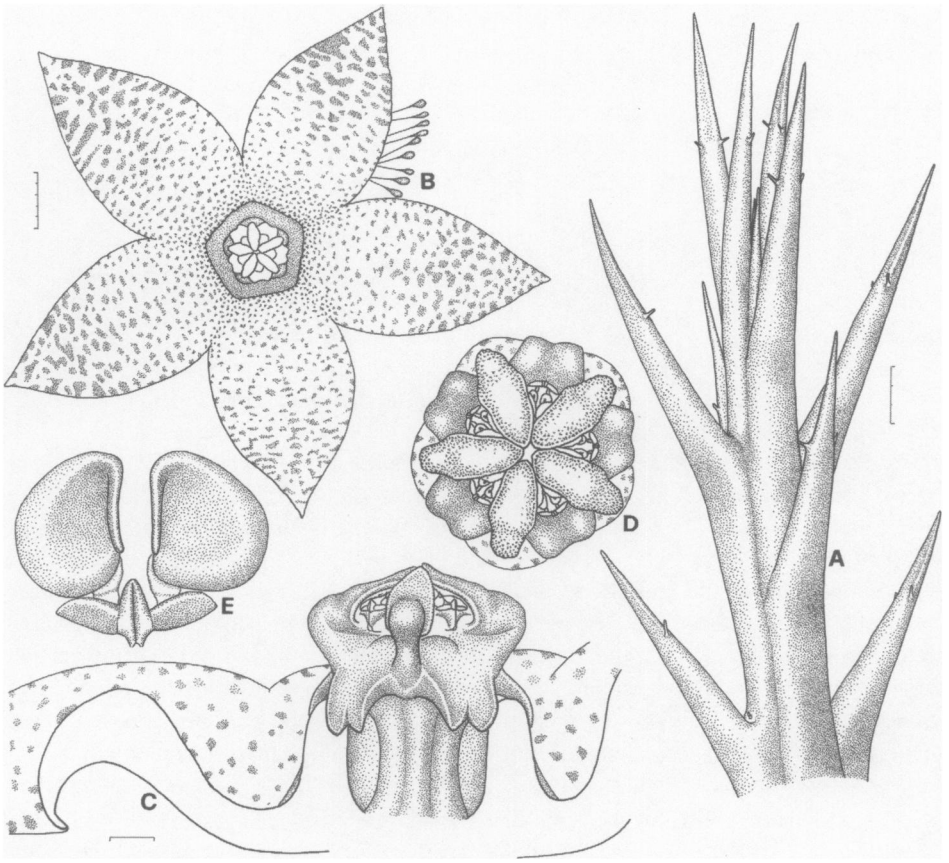

FIG. 76. *Orbea longidens.* A. Portion of stem. B. Face view of flower. C. Side view of center of dissected flower. D. Face view of gynostegium on annulus. E. Pollinarium. Scale bars: A, 3 mm; B, 5 mm; C, D, 1 mm (at C); E, 0.25 mm (at A). [Based on *Bruyns 4449*.]

Orbea longidens is another of the species of *Orbea* with relatively long tubercles on the stems, which give the plants a grass-like appearance and can make them very inconspicuous.

Orbea longidens differs from *O. macloughlinii* by the much steeper annulus surrounding the gynostegium and by the shallow depression in the center of the flower in which this annulus is situated. The stems, with their slender tubercles, are also rather different from those in *O. macloughlinii*.

Beyond the shallow tube in the center, the flower may be either flat or it may have the lobes quite strongly reflexed. Right in the center of the corolla there is one of the most peculiar annuli to be found in *Orbea*. It consists of a thin ridge of tissue that rises abruptly from the flattish base of the corolla tube and forms a steep, narrow tube around the relatively long stipe of the gynostegium.

In *O. longidens* the margins of the corolla lobes are often ornamented with some cilia. The illustrations of material from Mozambique all show no cilia present, and this is true also of recently collected material from north of Manhiça, but cilia seem mostly to be

present in material from northern Natal. Nevertheless, even there they can be very few; on one freshly opened flower only a single cilium was observed.

45. Orbea maculata (N. E. Brown) L. C. Leach, Excelsa Taxon. Ser. 1: 49. 1978. *Caralluma maculata* N. E. Brown, Fl. Trop. Afr. 4(1): 487. 1903.—TYPE: BOTSWANA. Near T'Klakane pits, northern Kalahari, Apr 1899, *Lugard 297* (holotype: K!).

Dwarf to small succulent, usually consisting of several small clumps (to 10 cm in diameter) connected by long rhizomes. Stems 2–10 cm long, 0.6–1.5 cm in diameter (excluding teeth), slender to stout, erect above soil, often arising from a horizontal subterranean rhizome up to 50 cm long, grey-green flecked with purple-brown; tubercles 4–20 mm long, arranged into 4 obtuse rows along stems with a groove between rows, prominent to very prominent, laterally flattened, deltoid, acute to acuminate, usually with pair of deltoid stipular denticles shortly below apex. Inflorescence 1 per stem near base, of 1–5 flowers developing in gradual succession from a short fleshy peduncle; pedicel 25–50 mm long, ± 2 mm in diameter, horizontally spreading then descending with abruptly upturned apex. Sepals 4–6 mm long, 1.5–2.0 mm wide at base, ovate, acuminate to attenuate. Corolla 3–7.5 cm in diameter, rotate, very deeply lobed; outside pale green with purplish spots arranged in longitudinal lines; inside pale greenish yellow to white dotted or irregularly transversely banded with red-purple to maroon (dots often sunken), becoming pinkish to maroon towards center and sometimes coalescing to solid red-purple towards apex of lobes, smooth to slightly papillate; tube 0.5–1.0 mm deep, formed by a small thickened annulus around base of gynostegium; lobes 12–32 mm long, 6–15 mm wide at base, spreading, slightly recurved towards apex of lobe, convex (the margins reflexed), oblong, obtuse to subacute, margins in proximal 2/3 with vibratile flattened clavate white to purple cilia 1.5–3.0 mm long. Corona 3.5–4.5 mm tall, 4.5–7 mm in diameter, dome-shaped, pentagonal to circular, raised above annulus on a pentagonal stipe 1–2 mm long, sometimes concave beneath and sometimes narrowing to a stipe, yellow to orange or pink or maroon; outer lobes continuous and disc-like around gynostegium, forming a horizontal spreading platform (0.5–2.0 mm wide) below guide-rails (sometimes considerably reduced), with a much swollen often somewhat rugulose ± rectangular ridge 1.5–2.0 mm long (sometimes with crenulate outer margin) behind anthers rising to meet inner lobes; inner lobes <1.0 mm long, adpressed to and sometimes slightly longer than backs of anthers, deltate, subacute to obtusely truncate. Figs. 77, 79, 80.

Distribution (Fig. 78). Botswana, Namibia, South Africa, Zimbabwe; 300–2400 m.

Orbea maculata is very widely distributed, occurring nearly continuously from the western side of the subcontinent near the mouth of the Kunene River to the eastern edge in Natal. It is also found southwards in Namibia along the edge of the Namib Desert to quite near the border with South Africa. From this known distribution, it is reasonable to surmise that it occurs in southern Angola.

The corona in *O. maculata* is a peculiar structure in which the outer lobes form a ring that is much more developed behind the anthers than between them. Behind the anthers, this ring is thickened to rise up to the inner lobes, and between the inner lobes there is a flat platform beneath the guide-rails. The ontogeny of this structure has not been properly investigated for lack of material. For the time being the whole ringlike structure around the gynostegium, including the thickened parts behind the anthers, is referred to as the "outer corona"; however, the available evidence suggests that these thickened parts result from growth of the inner coronal meristem behind the anthers and by a lateral spreading

of the outer coronal meristem. This would imply that this structure is neither homologous to that in *O. schweinfurthii* or *Ballyanthus prognathus* nor to the ringlike structure found on the gynostegium in flowers of *Duvalia* and some species of *Huernia*, where the ring is derived only from a lateral spreading of the outer coronal meristem.

The relatively large flowers, which are produced in gradual succession and usually pressed to the ground, make this a typical member of the group of species in southern Africa placed by Leach in *Orbea* s.s. The remarkable ringlike coronal structure is unique in the genus, and the usually obtuse corolla lobes are also characteristic.

KEY TO THE SUBSPECIES OF ORBEA MACULATA

1. Corolla somewhat depressed in center, outer corona lobes much shorter below guide-rail than part behind inner lobes. 45b. *O. maculata* subsp. *kaokoensis*.
1. Corolla somewhat convex towards center, outer corona lobes nearly as long below guide-rail as part behind inner lobes.
   2. Corona narrowing beneath into stipe, outer lobes below guide-rail ± equal in length to part behind inner lobes. 45a. *O. maculata* subsp. *maculata*.
   2. Corona not narrowing beneath into stipe, outer lobes below guide-rail slightly but noticeably shorter than part behind inner lobes. 45c. *O. maculata* subsp. *rangeana*.

45a. Orbea maculata subsp. **maculata.**

Caralluma grandidens Verdoorn, Fl. Pl. South Africa 13: t. 518. 1933.—TYPE: SOUTH AFRICA. Transvaal: Soutpan, *Obermeyer, Schweickerdt & Verdoorn 403* (lectotype, designated by Leach, 1978: PRE!).

Small succulent, usually consisting of several small clumps (to 10 cm in diameter) connected by horizontal underground rhizomes up to 50 cm long. Stems 4–10 cm long, 0.6–1.5 cm in diameter (excluding teeth), slender; tubercles 4–15 mm long, narrowly deltoid. Corolla 3–6 cm in diameter, somewhat convex above towards center; inside pale greenish yellow-dotted (sometimes shortly transversely lined) with red-purple, becoming pinkish towards center and dots usually coalescing to solid red-purple towards apex of lobes, smooth; lobes 14–25 mm long, 6–9 mm wide at base, with white marginal cilia. Corona 4.5–6.5 mm in diameter, obtusely pentagonal to circular, narrowing to a stipe ± 1 mm long; outer lobes below guide-rail ± equal in length to part behind inner lobes; inner lobes deltate, subacute to obtusely truncate, sometimes with crenulate margin, rising onto anthers from swollen area where fused to outer lobes. Fig. 77.

Distribution (Fig. 78). Botswana, South Africa, Zimbabwe; 300–1200 m.

Orbea maculata subsp. *maculata* is probably the most widely distributed of the three subspecies. Leach (1978) recorded a single collection (in addition to the type) from Botswana, various gatherings from western, southern, and eastern Zimbabwe, and several more in South Africa from the western, northern, and eastern Transvaal. Subsequently, investigations in Botswana proved subsp. *maculata* to be widely distributed there, too, from around Maun to near Gaborone. It is also now known to grow in Natal near Ulundi.

Plants of subsp. *maculata* are usually rather scattered. They frequently grow in stony ground (often in calcrete) in open, mostly flat bushveld; over most of its range subsp. *maculata* is associated with *Colophospermum mopane*. Nevertheless, several collections have been made in other types of bush, and populations may be found among tufts of grass and scattered *Acacia* bushes or in overgrazed spots with stunted *Acacia tortilis* shrubs.

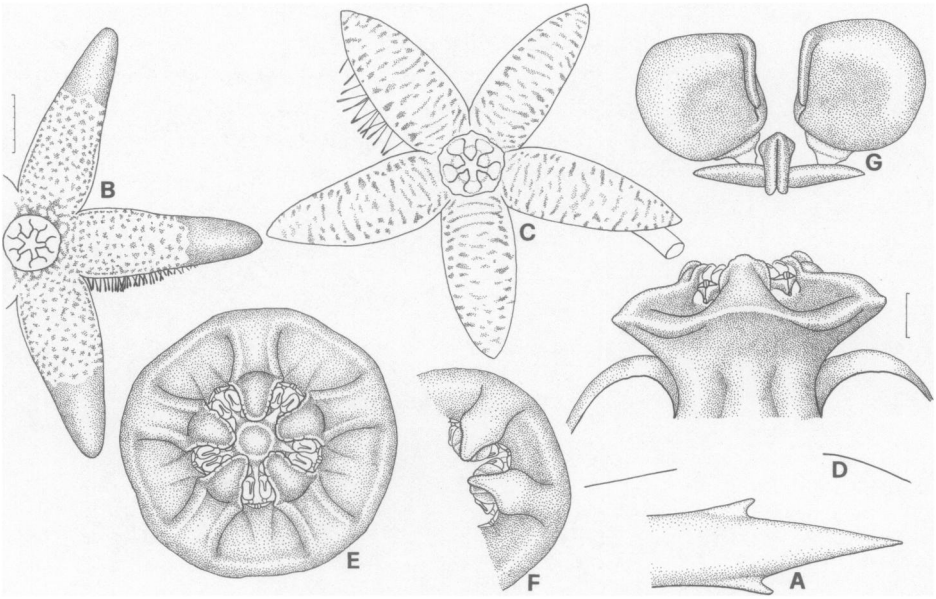

FIG. 77. *Orbea maculata* subsp. *maculata.* A. Leaf rudiment with stipular ridges. B, C. Face views of flower. D. Side view of center of dissected flower. E, F. Face views of gynostegium. G. Pollinarium. Scale bars: A, 1 mm (at B); B, C, 5 mm (at B); D–F, 1 mm (at D); G, 0.25 mm (at B). [Based on: A, *Bruyns 7671*; B, *Bruyns 6986*; C–E, G, *Bruyns 4446*; F, *Bruyns 6435*.]

ADDITIONAL SPECIMENS EXAMINED. **Botswana.** [1923] 10–23 km NW of Makwee [-BC], *Bruyns 6511* (M); 19 km N of Shorobe [-DB], *Bruyns 6512* (MO). [2125] 108 km S of Gweta [-AA], *Bruyns 6986* (MO). [2325] Lephephe [-BD], *Knobel sub KMG 3421* (KMG); Boatlaname, [-DB], *Knobel 3* (PRE). [2326] 18 km S of Shoshong [-AB], *Bruyns 6435* (BOL). **South Africa.** NATAL: [2831] Okhukhu [-BA], *Bruyns 4446* (BOL).—TRANSVAAL: [2229] Delft, Mopane [-DB], *Bruyns 7671* (MO); near Waterpoort [-DC], *Schweickerdt & Verdoorn 660* (PRE). [2231] Pafuri [-AC], *Leach & Mockford 12298* (K, LISC, PRE). [2329] 3 km E of Vivo [-AB], *Bruyns 6569* (NBG). [2426] Near Derdepoort [-CB], *Codd 8900* (PRE). [2531] 40 km E of Malelane [-BD], *Leach 13646* (PRE). **Zimbabwe.** [1932] ± 16 km NW of Birchenough Bridge [-CC], *Leach 5430* (PRE); Nyanyadzi [-CD], *Plowes 2554* (SRGH); ± 7 km W of Birchenough Bridge [-CD], *Leach & Noel 9031* (K, SRGH); ± 8 km SE of Nyanyadzi [-CD], *Percy-Lancaster 50* (SRGH). [2028] Mwewe River, near Kezi [-CD], *Bullock 116* (SRGH). [2131] Chipinda pools, Gona-re-Zhou [-BD], *Mavi 1254* (PRE, SRGH). [2132] Hippo Mine [-AB], *Plowes 2553* (SRGH); Sabi/Lundi Junction [-AD], *Hall 109* (NBG). [2229] 28 km NW of Beit Bridge [-BB], *Leach 14740* (BOL, SRGH).

Orbea maculata subsp. *maculata* is extremely rhizomatous, and a single plant may often spread for up to 2 square meters. Over such an area it will consist of several small clusters of stems (often with only 1–3 stems in a cluster, but occasionally a dense bunch of stems up to 10 cm in diameter may develop) above the ground, which are connected by underground runners that can be up to 0.5 m long.

In subsp. *maculata* the thickened parts of the outer corona behind the anthers do not quite reach the level of the anthers, and the inner corona lobes rise from it onto the anthers. The corona appears to sit on the center of the corolla, but actually it is raised slightly above the surface and out of the tube by a thick stipe beneath it. In subsp. *maculata* the corona gradually narrows into this stipe.

Leach (1978) gave various distinctions between *O. maculata* and *O. rangeana*. The

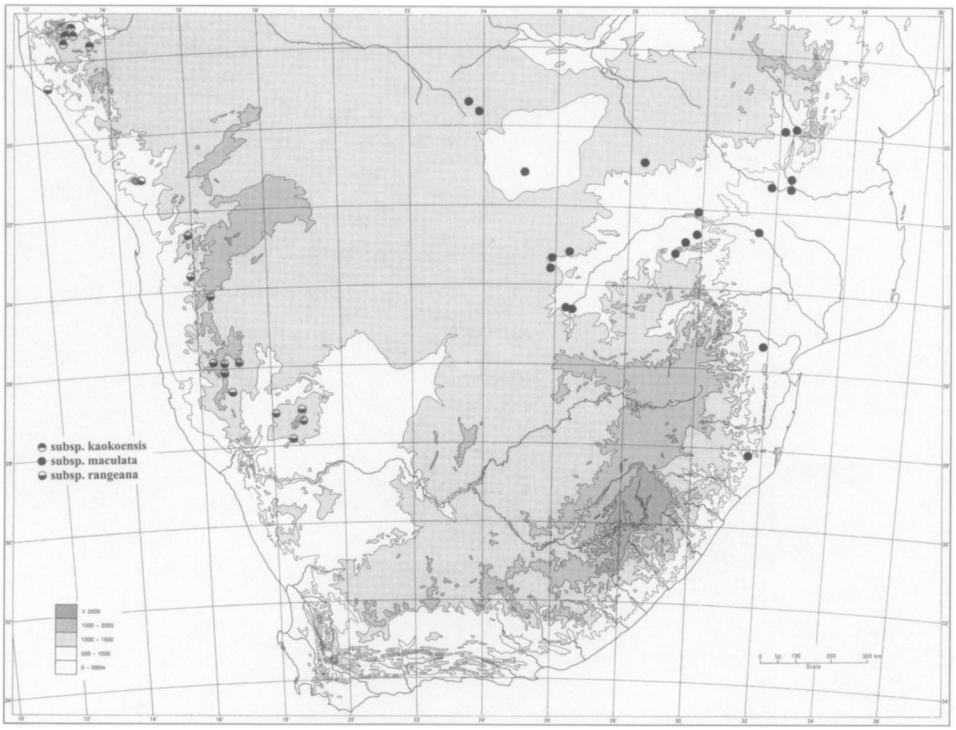

FIG. 78. Distribution of *Orbea maculata* subsp. *maculata*, subsp. *kaokoensis*, and subsp. *rangeana*.

most important of these differences found in *O. rangeana* are the much thicker stems with shortly deltoid teeth, the broader, more strongly folded corolla lobes, and the broader inner corona lobes. The position is much confounded by the recently discovered forms in the Kaokoveld. In these the tubercles on the stems are as long as in *O. maculata* or even longer, but they are much broader than those in either *O. maculata* or *O. rangeana*. The stems are fairly thick, and the inner corona lobes are intermediate in breadth between the two. Consequently, these variants are now all treated as belonging to one species.

45b. Orbea maculata subsp. **kaokoensis** Bruyns, Aloe 37: 75. 2001.—TYPE: NAMIBIA. Kaokoveld, NW of Opuwa, *Bruyns 4083* (holotype: BOL!).

Small succulent, usually consisting of several small clumps (to 10 cm in diameter) connected by horizontal underground rhizomes up to 50 cm long. Stems 4–10 cm long, 0.8–1.5 cm in diameter (excluding teeth), often stout; tubercles 8–20 mm long, often very broadly deltoid. Corolla 5–7.5 cm in diameter, usually with the center shallowly depressed; inside pale cream-yellow becoming pale green in distal half of lobes, with sunken maroon spots, spots becoming abruptly larger and coalescing below base of lobes so that the center is nearly all dark maroon, smooth; lobes 20–32 mm long, 7–15 mm wide at base, with white marginal cilia. Corona 6–7 mm in diameter, pentagonal, raised on a pentagonal stipe ± 1.5–2.0 mm long, convex beneath but not narrowing into stipe, reddish to yellow; outer lobes with part below guide-rail reduced to <0.5 mm long but ± as wide as

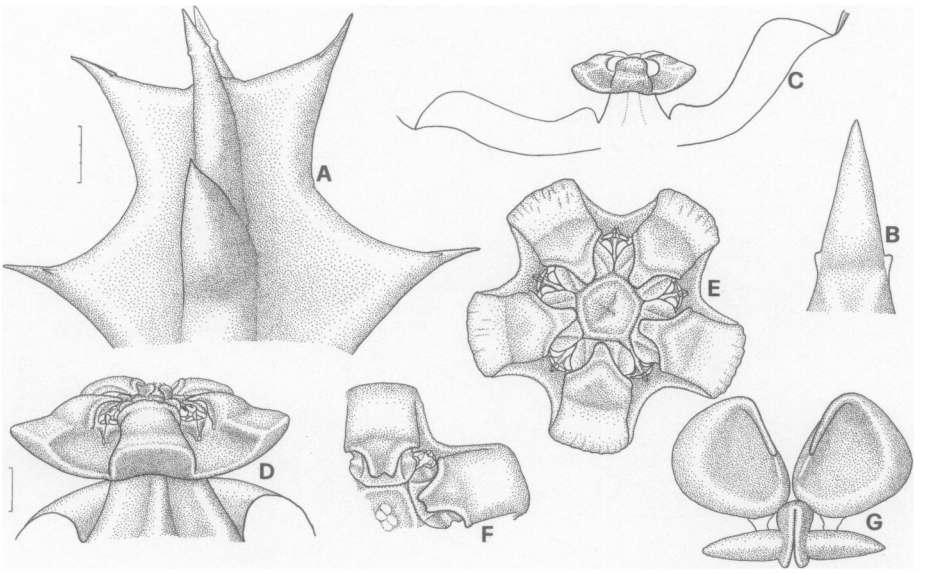

FIG. 79. *Orbea maculata* subsp. *kaokoensis.* A. Portion of stem. B. Leaf rudiment with stipular ridges. C. Side view of center of dissected flower. D. Side view of gynostegium. E, F. Face views of gynostegium. G. Pollinarium. Scale bars: A, C, 3 mm (at A); B, 1 mm (at A); D-F, 1 mm (at D); G, 0.25 mm (at A). [Based on: A–E, G, *Bruyns 4083*; F, *Bruyns 5590*.]

massive, entire and roughly square part behind inner lobes; inner lobes deltate and obtuse to oblong and truncate. Fig. 79.

Distribution (Fig. 78). Namibia; 1200–1800 m.

Orbea maculata subsp. *kaokoensis* is known only in the higher regions of the Kaokoveld of northern Namibia. It has been found from northwest of Opuwa to around the Baynes Mountains, both on the southwestern and northeastern side, and on the western side of the Otjihipa. It is very likely to occur in the adjacent part of southern Angola.

Plants are of rather scattered occurrence, and they generally grow in stony ground among *Colophospermum mopane* and *Acacia* trees. Specimens have mostly been seen on shale hills, often in patches of quartz gravel, from the valleys to some of the higher mountains.

ADDITIONAL SPECIMENS EXAMINED. **Namibia.** [1712] Etengua [-BD], *Bruyns 5586* (BOL); NW of Etengua, *Bruyns 8018* (NBG); W of Etengua, *Bruyns 8036* (S, WIND). [1713] North of Okonguati [-AA], *Bruyns 5590* (K); in pass N of Okonguati, *Bruyns 7996* (K, MO).

In subsp. *kaokoensis* the stems are larger than in either of the other two subspecies. The tubercles may be up to 20 mm long and 15 mm wide at the base, so that they are much broader than in subsp. *maculata* and longer than in subsp. *rangeana*. (They resemble more the very robust forms of *O. carnosa* subsp. *keithii* that one encounters in the Limpopo Valley north of the Soutpansberg.) They have the same rhizomatous habit as the other two, with small clusters of stems developing at distances of up to 0.5 m from the parent plant and connected to it by slender, horizontal, underground runners. Here the underground parts are particularly slender relative to the quite massive aboveground parts.

In all the flowers seen the corolla lobes are spotted and barred with maroon on cream, the spots coalescing to form a dark maroon center below the bases of the lobes. This dark center of the flower is somewhat depressed below the level of the lobes, so that the center is shallowly bowl-shaped; this depression is slightly asymmetric, with the deeper side next to the pedicel.

In subsp. *kaokoensis* the corona closely resembles that of the other two subspecies. The stipe narrows towards the corona, as in subsp. *rangeana*, and not as in subsp. *maculata*. The parts of the outer corona behind the anthers are broad, almost square, and nearly flat on top. They have broad gaps between them (as in subsp. *maculata*), but the part that fills these gaps is greatly reduced and often only slightly visible beneath the guide-rails. As in subsp. *maculata*, the inner corona lobes rise up somewhat onto the anthers.

45c. Orbea maculata subsp. **rangeana** (Dinter & A. Berger) Bruyns, Aloe 37: 76. 2001. *Caralluma rangeana* Dinter & A. Berger, Bot. Jahrb. Syst. 50, Suppl. 591. 1914. *Caralluma maculata* var. *brevidens* H. Huber, Mitteil. Bot. Staatssamml. München 4: 33. 1961. *Orbea rangeana* (Dinter & A. Berger) L. C. Leach, Excelsa Taxon. Ser. 1: 51. 1978.—TYPE: NAMIBIA. Kuibis, *Dinter 1226* (holotype: not located).—NAMIBIA. Kanus, Apr 1913, *Dinter 2597a* (neotype, designated by Bruyns, 2001: SAM!).

Piaranthus streyianus Nel, Desert Pl. Life 21: 99. 1949.—TYPE: NAMIBIA. Büllsport, *Strey s.n.* (holotype: not located).—LECTOTYPE, here designated: upper figure on page 100, Desert Pl. Life, vol. 21, 1949.

Dwarf succulent usually consisting of several small clumps mostly not exceeding 6 cm in diameter connected by horizontal underground rhizomes up to 30 cm long. Stems 2–8 cm long, 0.6–1.5 cm in diameter (excluding teeth), often stout; tubercles 4–7 mm long, often shortly and broadly deltoid. Corolla 3.2–7.0 cm in diameter, somewhat convex above towards center; inside greenish yellow to white, transversely marked and spotted with broken irregular bands of red-purple to maroon, smooth or with a few short stiff clavate papillae on disc and towards sinuses of lobes; lobes 12–26 mm long, 5–10 mm wide at base, with purple marginal cilia. Corona 5–7 mm in diameter, obtusely pentagonal, raised on a stipe 1.5–2.0 mm tall, slightly concave beneath and not narrowing into stipe, yellow, orange-red or maroon; outer lobes with the part below guide-rail considerably narrower than the massive part behind inner lobes; inner lobes ± deltate, apex obtuse to irregularly somewhat bilobed. Fig. 80.

Distribution (Fig. 78). Namibia; 350–2400 m.

Only found in Namibia, subsp. *rangeana* is known now from almost the entire length of the territory. In the south it occurs from around the base of the Great Karas Mountains westwards to near Helmeringhausen. North of this area there are scattered records along the eastern edge of the Namib Desert from around the Naukluft Mountains, from near Usakos, and several collections have been made on the upper parts of the Brandberg slightly further north (Bruyns 1990). Very recently subsp. *rangeana* was also recorded southwest of Orupembe on the edge of the Skeleton Coast Park, some 150 km S of the Kunene River.

Subspecies *rangeana* grows on stony ground on the slopes of hills or at their base, sheltering under small bushes or between rocks. In many of its habitats it is associated with granites.

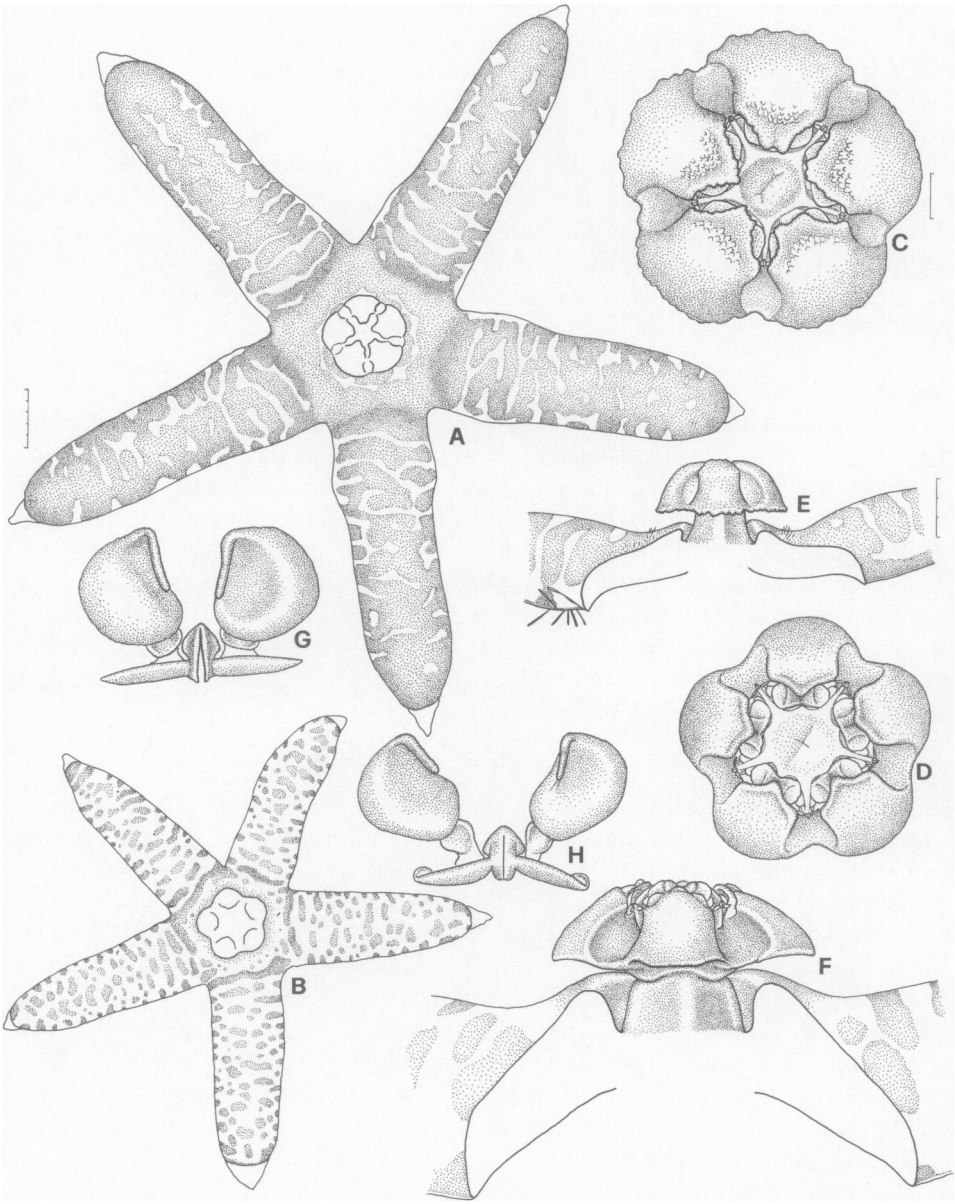

FIG. 80. *Orbea maculata* subsp. *rangeana.* A, B. Face views of flower. C, D. Face views of gynostegium. E, F. Side views of center of dissected flower. G, H. Pollinaria. Scale bars: A, B, 5 mm (at A); C, D, F, 1 mm (at C); E, 3 mm; G, H, 0.25 mm (at E). [Based on: A, C, E, G, *Bruyns 3063*; B, D, F, H, *Bruyns 3547*.]

ADDITIONAL SPECIMENS EXAMINED. **Namibia.** [1812] SW of Orupembe [-CB], *Bruyns 8065* (WIND). [2114] Brandberg [-BA], *Bruyns 2357* (NBG); *Bruyns 3063* (NBG). [2215] Anschluss [-DB], *Bleissner 9* (M). [2315] Donkerhoek [-DB], *Hardy & de Winter 1509* (PRE). [2516] Naus [-CD], *Bruyns 5699* (K); Lovedale [-DC], *Bruyns 5720* (WIND). [2517] Alsuma [-CC], *Bruyns 4181* (WIND). [2616] Gamochas [-BA], *Hall 1960* (NBG); Kuibis [-DB], *Dinter 2597* (SAM). [2718] Steinfeld [-AA], *Bruyns 8135* (WIND); Pieterskloof [-BB], *Bruyns 3547* (WIND); Narudas Nord [-BD], *Bruyns 3532* (WIND); Sandmund [-BD], *Bruyns 3544* (BOL).

Florally subsp. *rangeana* is more similar to subsp. *maculata* than the rather different looking stems would suggest. The flowers are a little larger but are similarly spotted with maroon on pale yellow. Although some of them are indistinguishable in their coloring from those of subsp. *maculata*, many are far more densely spotted. In some plants from the Brandberg the flowers were particularly large and dramatically mottled, with deep maroon on white. In these the center of the flower was also plain maroon, but usually it is the same as the rest, i.e., spotted with maroon on pale yellow. The lobes are often somewhat reflexed, so as to push the center of the flower forwards, and their margins are usually ornamented with purple cilia.

As in subsp. *maculata*, the corona of subsp. *rangeana* is raised out of the small corolla tube (formed by the annulus) on a trunk-like stipe; however, where in subsp. *maculata* the stipe widens into the base of the gynostegium, here the base of the corona is somewhat concave and has small flaps of tissue surrounding the top of the stipe. Once again, the outer corona is ringlike with large, thickened portions behind the inner lobes. In subsp. *rangeana* these thickened areas are much broader than the parts between them, which are very small indeed. They rise from the edge of the corona and reach the level of the anthers, so that the inner corona lobes are not clearly distinguishable from them, as in subsp. *maculata*.

46. Orbea paradoxa (Verdoorn) L. C. Leach, Excelsa Taxon. Ser. 1: 55. 1978. *Stultitia paradoxa* Verdoorn, Fl. Pl. South Africa 17: t. 677. 1937.—TYPE: MOZAMBIQUE. Ressano Garcia, *Blignaut & v. d. Merwe 403* (lectotype, designated by Leach, 1978: PRE!).

Dwarf succulent forming small clumps (up to 15 cm in diameter) connected underground by rhizomes up to 10 cm long. Stems 3–6 cm long, 0.4–0.8 mm in diameter (excluding teeth), slender, aboveground parts erect, grey-green mottled with purple-brown; tubercles 5–15 mm long, arranged into 4 obtuse rows along stems with a groove between rows, tapering to a prominent conical acute tooth, often somewhat flattened above towards apex, with 1–3 pairs of ascending (also sometimes somewhat flattened) denticles shortly below apex. Inflorescence 1 per stem near base, of 1–3 extremely foul-smelling flowers developing successively, peduncle and bracts absent; pedicel 8–10 mm long, spreading with ascending apex, holding flower facing upwards. Sepals 4–6 mm long, 1.5 mm wide at base, ovate, acuminate. Corolla 1.8–3.2 cm in diameter, campanulate, rigidly fleshy; outside smooth, pale green with longitudinal purplish lines; inside smooth and somewhat shiny, with irregular transverse pink to dark red or purple markings on white or cream around and below bases of lobes, with markings fading and becoming finer towards tips where background color faintly greenish, dark to pale maroon on annulus and inside tube, sometimes with a white ring just outside mouth of tube; tube 6–8 mm long, 7 mm in diameter, cupular, slightly constricted at mouth by a prominent inward-pointing fleshy pentagonal to circular annulus 2–3 mm tall, with a ring of stiff erect acute bristles up to 0.75 mm long towards base around gynostegium; lobes 6–10 mm long, 6–10 mm wide at base,

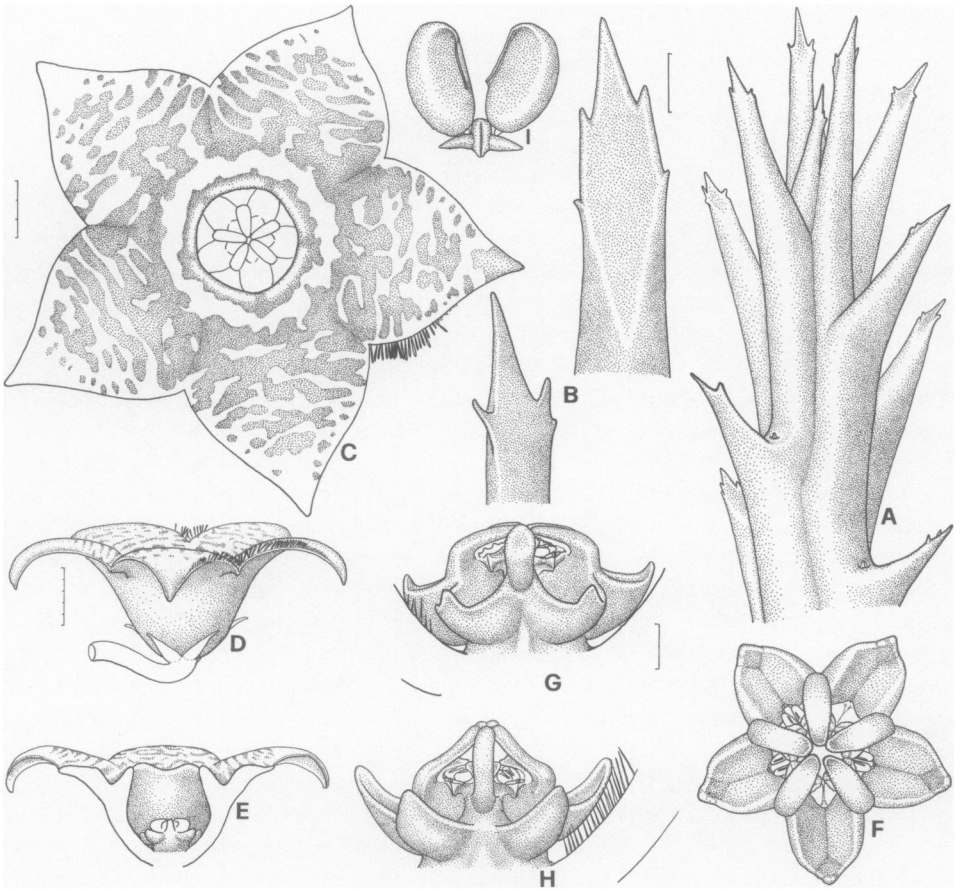

FIG. 81. *Orbea paradoxa.* A. Portion of stem. B. Leaf rudiments with stipular ridges. C. Face view of flower. D. Side view of flower. E. Side view of dissected flower. F. Face view of gynostegium. G, H. Side views of gynostegium. I. Pollinarium. Scale bars: A, C, 3 mm (at C); B, 1 mm; D, E, 5 mm (at D); F–H, 1 mm (at G); I, 0.25 mm (at B). [Based on: A–G, I, *Bruyns 4465*; H, *Peckover s.n.*, Makhatini Flats (no voucher).]

ovate-deltate, slightly convex above, with clavate vibratile cilia <1.5 mm long along margin of proximal half of lobe. Corona 2.5–3.0 mm tall, 5–6 mm in diameter, raised slightly above base of tube on a very short (0.5 mm) pentagonal stipe; outer lobes 1.5–2.0 mm long, 1.8–2.0 mm wide, ± rectangular or ovate with a deltate upturned apex, deeply concave on upper surface especially towards base, yellow suffused with brown to dark red towards base and along margins to wholly maroon distally; inner lobes ± 1 mm long, adpressed to backs of anthers, exceeding them and meeting in center, sometimes rising up in small column there, linear, obtuse, with a slight dorsal swelling towards base. Fig. 81.

Distribution (Fig. 69). Mozambique, South Africa, Swaziland; 20–300 m.

Orbea paradoxa is found for a distance of a little over 200 km in a relatively narrow band along the foot of the Lebombo Mountains in the adjoining parts of Mozambique, Swaziland, and South Africa (Eastern Transvaal and Natal). Plants grow mainly in flat areas and frequently occur in black turf soils or dark brown loam in places that often become seasonally waterlogged.

ADDITIONAL SPECIMENS EXAMINED. **Mozambique.** [2532] Moamba [-CA], *Leach & Bayliss 11739* (PRE). [2632] Goba [-AA], *Keith s.n.* (PRE); Changulane [-AC], *de Sousa 247* (PRE); Catuane [-CD], *Leach & Bayliss 11935* (LISC). **South Africa.** NATAL: [2632] South of Ndumu Gate [-CD], *Bruyns 4465* (BOL). [2731] Pongola [-BC], d*e Wet sub PRE 22712* (PRE); Magut [-DA], *Gerstner s.n.* (PRE). [2732] Makatini Flats [-AC], *Viljoen s.n.* (NH); Mkuzi Game Reserve [-CA], *Symons s.n.* (PRE).—TRANSVAAL: [2531] Komatipoort [-BD], *James* (BOL). **Swaziland.** [2731] Ngwenya Causeway, *Bayliss 2727* (PRE, SRGH); Cecil Mack's Pass [-BB], *Bayliss 2732* (SRGH); Nsoko [-BB], *Bayliss 688* (PRE).

Orbea paradoxa is an extremely rhizomatous species, forming small clumps of erect stems above ground and spreading by horizontal underground rhizomes. The stems are fairly slender but have relatively short tubercles. These tubercles are distinctly flattened towards the apex, and this flattened part constitutes the leaf-rudiment. Towards the base of this flattened area the margins are extended into 1–3 spreading toothlets on each side (i.e., up to 6 toothlets per tubercle). This multitude of small denticles around the apex of the tubercle immediately distinguishes this species from any other in the area.

The flowers of *O. paradoxa* are fairly small but make up for this by having an unusual coloring and a very foul smell of rotten meat. The interior is smooth and quite shiny, except for fine papillae near the tips of the lobes and short hairs in the base of the tube. This whole arrangement, with its coloring and evil smell, somewhat resembles a festering wound on the skin of a mammal.

In *O. paradoxa*, below the base of the lobes, the corolla descends into the tube, which, from the outside of the flower, has a more or less funnel-like shape. On the inside, the tissue is much thickened and also has an annulus that rises out of the tube and projects inwards as a thin wall, thereby considerably constricting the mouth of the tube. The shape of this annulus is such that, on the inside, the tube is more or less urceolate.

This species is somewhat anomalous, and Leach (1978) considered it to be related to *O. longidens*, which he had placed in his *Orbea* s.s., and also to *O. carnosa* subsp. *keithii*, which he assigned to *Pachycymbium*; thus, *O. paradoxa* did not fit very well into his generic arrangement. He thought the flowers of *O. paradoxa* to be rather on the small side for *Orbea*, but he argued that the specimens shared many characteristics in the stems, the corolla, and the corona with other species that he placed in *Orbea* and consequently this species belonged to *Orbea* as well. This study also places *O. paradoxa* with *O. longidens* (Fig. 6).

47. Orbea cooperi (N. E. Brown) L. C. Leach, Kirkia 10: 291. 1975. *Stapelia cooperi* N. E. Brown, Fl. cap. 4(1): 974. 1909. *Stapeliopsis cooperi* (N. E. Brown) Phillips, Fl. Pl. South Africa 12: t. 445. 1932. *Stultitia cooperi* (N. E. Brown) Phillips, Fl. Pl. South Africa 13: sub t. 520. 1933.—TYPE: SOUTH AFRICA. Cape Province: 2 mi E of Conway Station, *Pillans 181* (lectotype, here designated: BOL!, isolectotype: K!).

Dwarf succulent forming dense clumps 6–12 cm in diameter, not rhizomatous. Stems 2–6 cm long, 0.5–1 cm in diameter (excluding teeth), ascending to erect, green marked with brown to purple patches and lines; tubercles 4–7 mm long, arranged into 4 obtuse rows along stem with a groove between rows, tapering to an ascending to spreading conical laterally slightly flattened acute tooth, with a minute denticle on each side towards apex. Inflorescence 1 per stem near base, of 1–3 (–10) flowers developing in gradual succession, sessile or with a peduncle up to 15 mm long, with several short deltate often laterally toothed bracts 1–2 mm long; pedicel 6–12 mm long, 2.0–2.5 mm in diameter,

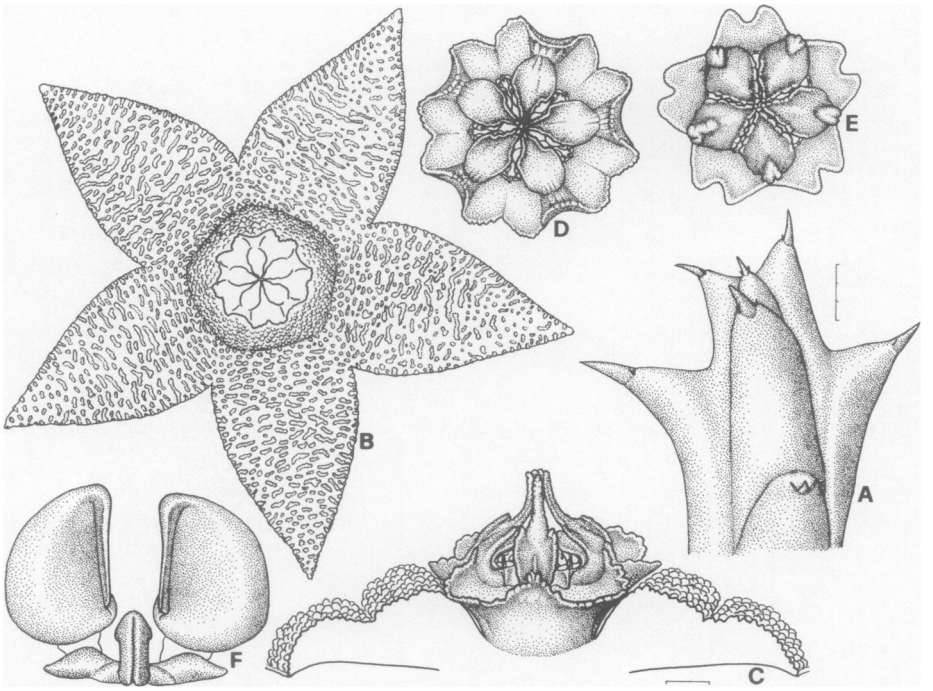

FIG. 82. *Orbea cooperi*. A. Portion of stem. B. Face view of flower. C. Side view of center of dissected flower. D, E. Face views of gynostegium. F. Pollinarium. Scale bars: A, B, 3 mm (at A); C–E, 1 mm (at C); F, 0.25 mm (at A). [Based on: A–D, F, *Bruyns 3043*; E, *Bruyns 7476*.]

ascending and holding flower facing partly upwards or horizontally. Sepals 3–5 mm long, 1.5 mm wide at base, ovate or ovate-lanceolate, acuminate. Corolla 2.2–3.3 cm in diameter, rotate; outside smooth, pale green, with 3–5 purplish veins on lobes; inside irregularly ± transversely rugulose with short ridges and tubercles, rugosities becoming denser towards and on annulus but vanishing inside tube, rugosities pale yellow and areas between them pale purple-brown; tube 1.0–1.5 mm long, 4–5 mm in diameter, cupular, formed by a raised cushion-like convex annulus, containing base of gynostegium only, with dark purple-brown patch in base but without bristles; lobes 10–14 mm long, 8–10 mm wide at base, spreading to recurved, ovate, acute, somewhat convex towards apex, the margins slightly recurving and with vibratile clavate purple cilia up to 2 mm long on proximal half of the lobe. Corona 4 mm tall, 5 mm in diameter, ± without a basal stipe, red to deep maroon (darker on outer lobes) to pale yellow flecked with maroon; outer lobes <1 mm long, spreading and resting upon side of tube near mouth, broadly rectangular to deltate, the apex usually emarginate and with a triangular medial notch dividing it into short obtuse lobules, edges raised up towards base and fused to lower backs of inner lobes; inner lobes 2.0–3.5 mm long, adpressed to backs of anthers then connivent-erect and sometimes recurving, with the apical part terete to slightly clavate, broadly ovate, oblong, or ovate-oblong, entire or with 1–2 teeth on each side, sometimes with small irregular obtuse dorsal projection near base. Fig. 82.

Distribution (Fig. 83). South Africa; 900–1500 m.

Orbea cooperi is widely distributed in the Cape Province of South Africa from the

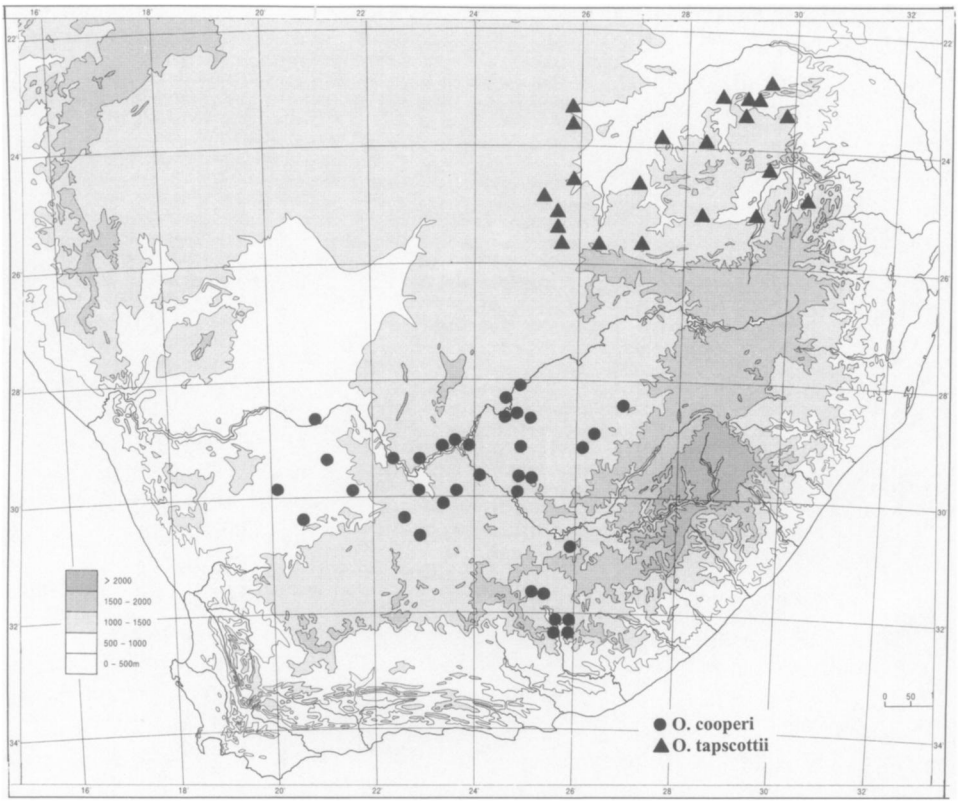

FIG. 83. Distribution of *Orbea cooperi* and *O. tapscottii*.

arid parts of the northern Cape southwest of Kakamas (on the eastern flank of "Bushmanland") via Prieska eastwards to Kimberley and southwards to around Cradock. It also occurs in the Orange Free State from east of Kimberley to near Winburg and southwards to Fauresmith. Specimens of *O. cooperi* are almost always found on stony ground among rocks or under small karroid bushes.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** CAPE PROVINCE: [2820] Keimoes [-DB], *KG 11/48* (PRE). [2824] Warrenton [-BB], *v. d. Westhuizen s.n.* (NBG); Harrisdale [-BC], *Leistner 1413* (PRE); Klippiespan [-DA], *Harris 67* (NBG); Kimberley [-DB], *Acocks s.n.* (PRE). [2920] Nanibees [-CC], *Bruyns 5262* (MO). [2921] Kenhardt [-AC], *Leistner 2306* (PRE); Diemansput Suid [-DC], *Bruyns 3451* (NBG). [2922] Koegasbrug [-AD], *Hall sub Herb. Compt. 44693* (NBG); Kloof [-BD], *Bruyns 2833* (NBG); Groot Rondekop [-DD], *Bruyns 3043* (NBG). [2923] Brakkies [-AB], *Bruyns 4540* (BOL); Maselsfontein [-BA], *Anderson 739* (BOL); Atherton [-BB], *Brueckner 671* (BOL); near Douglas [-BB], *Pillans 612* (BOL); Strydenburg [-DC], *Joubert 48s* (BOL). [2924] Hopetown [-CA], *v. Balen sub PRE 8765* (PRE). [3020] 12 miles E of Brandvlei [-BC], *Plowes 3398* (SRGH). [3022] Leeuput [-BC], *Bruyns 5423* (BOL); Vosburg [-DB], *Plowes 3397* (NBG). [3025] Venterstad [-DD], *Schweickerdt s.n.* (PRE). [3125] Witkransnek [-CA], *Acocks 24569* (PRE). [3225] Baroda [-BA], *Dyer 1050* (GRA); Cradock [-BA], *Lombard s.n.* (NBG); Halesowen [-BA], *Holland s. n.* (GRA); Mortimer [-BC], *Bolus 222* (BOL); 14 km E of Mortimer [-BD], *Bruyns 1784* (NBG).—ORANGE FREE STATE: [2825] Boshoff [-CA], *Zietsman 172* (NMB). [2826] Theunissen [-BD], *du Preez 2738* (NMB); Glen College, Bloemfontein [-CD], *du Preez 2400* (NMB). [2924] Jacobsdal [-BB], *Schweickerdt 1285* (PRE); Lückhoff [-DB], *v. Zyl 3686* (PRE); Koepaal [-DD], *Bruyns 5116* (PRE). [2926] Bloemfontein [-AA], *du Preez 2735* (NMB).

The stems of *O. cooperi* are very similar to those of *O. variegata* or *O. verrucosa*; however, florally these species are rather different. In *O. cooperi* the flower is usually not more than 3 cm across and is flat to somewhat reflexed, with a (sometimes only slightly) raised, thickened, cushion-like annulus in the center, which forms the sides of a small corolla tube. This tube is short and only contains the base of the gynostegium; the outer corona lobes rise and spread to rest on its mouth.

Orbea cooperi shares many features with *O. tapscottii* (no. 48) and the differences between these two are discussed under that species.

The dense ring of hairs found in the base of the corolla tube in some species, such as *O. variegata*, is missing entirely in *O. cooperi*, though traces of these hairs remain in this area in the form of a dark patch with somewhat raised epidermal cells.

48. Orbea tapscottii (Verdoorn) L. C. Leach, Kirkia 10: 291. 1975. *Stapelia tapscottii* Verdoorn, Bull. Misc. Inform. 1927: 357. 1927.—TYPE: BOTSWANA. Lobatsi, *Tapscott s.n.* (holotype: K!; isotype: KMG).

Succulent forming dense clumps 2–50 cm wide, not rhizomatous. Stems 5–12 cm long, 0.5–1 cm in diameter (excluding teeth), erect, green marked with brown to purple patches and lines; tubercles 10–25 mm long, arranged into 4 obtuse rows along stem with a groove between rows, tapering to an ascending to spreading conical laterally slightly flattened slender tooth, with a minute denticle on each side towards apex. Inflorescence 1 per stem near base, of 1–3 (–10) flowers developing in gradual succession, sessile or with a peduncle up to 15 mm long, with several short deltate often laterally toothed bracts 1–2 mm long; pedicel 6–12 mm long, 2.0–2.5 mm in diameter, ascending and holding flower facing partly upwards or horizontally. Sepals 3–5 mm long, 1.5 mm wide at base, ovate or ovate-lanceolate, acuminate. Corolla 2.2–6 cm in diameter, rotate; outside smooth, pale green, with 3–5 purplish veins on lobes; inside pale brown or purple-brown to red between cream ridges; tube 1.0–1.5 mm long, 4–5 mm in diameter, cupular, formed by a raised cushion-like convex annulus, containing base of gynostegium only, with dark purple-brown patch in base but without bristles; lobes 10–20 mm long, 8–13 mm wide at base, spreading to recurved, with vibratile marginal cilia up to 3 mm long on proximal half of lobe. Corona 4 mm tall, 5 mm in diameter, ± without basal stipe, red to deep maroon (darker on outer lobes) to pale yellow flecked with maroon; outer lobes <1 mm long, spreading and resting upon side of tube near mouth, deltate with a small apical notch, maroon with pale yellow margins, edges raised up towards base and fused to lower backs of inner lobes; inner lobes 4–5 mm long, adpressed to backs of anthers, then connivent-erect and diverging towards clavate-tuberculate tips, entire or with 1–2 lateral teeth and often with an erect and somewhat laterally flattened dorsal horn (<1 mm long) below middle, pale yellow with maroon margins and maroon apices, sometimes with small irregular obtuse dorsal projection near base. Fig. 84.

Distribution (Fig. 83). Botswana, South Africa; 1000–1500 m.

Orbea tapscottii is fairly common in southeastern Botswana from Lephephe to Lobatsi and is more widely distributed in the western Transvaal from Rustenburg to the area south of the Soutpansberg. A few records exist from further east: near Pretoria and near Groblersdal.

Orbea tapscottii will sometimes be found among short grasses under an open canopy

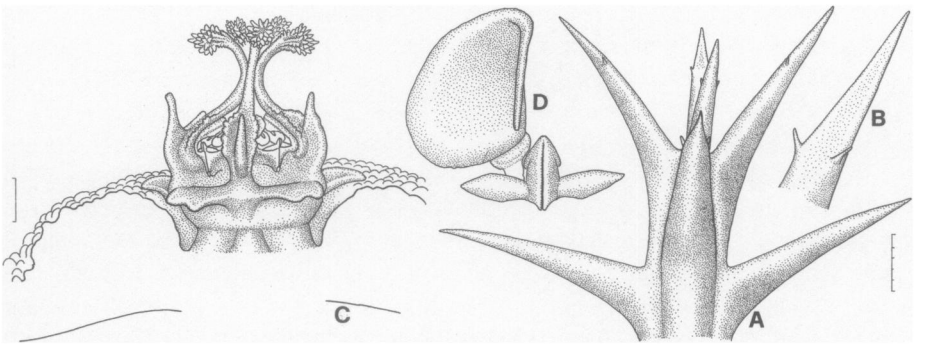

FIG. 84. *Orbea tapscottii.* A. Portion of stem. B. Leaf rudiment with stipular denticles. C. Side view of center of dissected flower. D. Part of pollinarium. Scale bars: A, 5 mm; B, 1 mm (at A); C, 1 mm; D, 0.25 mm (at A). [Based on: A–C, *Bruyns 6557*; D, *Bruyns 6412*.]

of trees but usually seems to prefer growing under short bushes (often of *Acacia tortilis*) in overgrazed, more exposed patches, where it can become quite common. Plants grow in flat areas in sandy to gravelly ground, sometimes on calcrete.

ADDITIONAL SPECIMENS EXAMINED. **Botswana.** [2325] Boatlename [-DB], *Bruyns 6412* (BOL). [2425] ± 10 miles S of Mashupa [-CD], *Leach et al. 12467* (BOL, GRA, K); 11 miles N of Gaberone [-DB], *Leach & Noel 231* (PRE, SRGH); Gaberone [-DB], *Codd 8908* (PRE). [2525] 3 miles SE of Lobatsi [-BA], *Leach et al. 12475* (BM, M); 8 miles N of Lobatsi [-BA], *Leach 9977* (SRGH); Knockduff, 3 miles N of Lobatsi [-BA], *Leach 9981*, *9970* (SRGH); 10 miles S of Lobatsi [-BC], *Leach & Bayliss 12452* (PRE); 11 miles N of Ramathlabama [-DA], *Leach & Bayliss 12448* (SRGH). **South Africa.** TRANSVAAL: [2229] 14 km N of Waterpoort [-DC], *Bruyns 7778* (BOL). [2327] Goedgedacht [-DC], *Bruyns 6543* (BOL). [2328] Ga-Mankodi [-BA], *Bruyns 6557* (NBG); Kwarriehoek [-CD], *Steyn 64* (PRE). [2329] Indermark [-AA], *Bruyns 6565* (BOL); Mara [-AB], *Hardy 397* (PRE); Bochum [-AC], *Schweickerdt s.n.* (PRE); Bandolier Kop [-BD], *Leach 9943* (SRGH). [2427] 29 km W of Thabazimbi [-CA], *Bruyns 6535* (BOL). [2429] M'pathele's Location [-BC], *v. Son sub Tvl. Mus. 28276* (PRE); Molsgat [-BC], *Obermeyer et al. sub NH 27640* (NH). [2430] Buffelsvlei [-CD], *Reynolds 1320* (BOL, PRE). [2526] Marico [-CB], *v. d. Merwe s.n.* (PRE). [2527] Rustenburg, unknown collector [-CA], (BOL). [2528] Rust der Winter, near dam [-AB], *v. d. Merwe s.n.* (PRE). [2529] Groblersdal [-AB], *Morris s.n.* (NBG).

In specimens of *O. tapscottii* the stems have long, slender tubercles up to 25 mm long. The length of these tubercles and the consequently grass-like appearance of the stems create a very different impression from that formed by *O. cooperi* (no. 47).

In their flowers *O. tapscottii* and *O. cooperi* differ only slightly. The flowers of *O. tapscottii* are a little larger and are generally paler, with the ridges more spaced out, and the color between them a paler brown to red. *Orbea tapscottii* has a generally larger and more clearly defined annulus, which forms a raised, pentagonal cushion with well-defined edges, whereas in *O. cooperi* the annulus tends to merge into the surface of the corolla.

Each inner corona lobe has the same broad base, as in *O. cooperi*, sometimes covering the anthers completely, but here the lobes are up to 5 mm long. In *O. tapscottii* the extra length goes into the much longer, slender upper part, which considerably exceeds the broader, lower part. These inner lobes all rise up in a column above the center of the flower, sometimes diverging above, and each terminates in a thickened, distinctly papillate knob.

49. Orbea umbracula (M. D. Henderson) L. C. Leach, Kirkia 10: 291. 1975. *Stultitia umbracula* M. D. Henderson, Fl. Pl. Africa 35: t. 1374. 1962.—TYPE: ZIMBABWE. Bikita distr., Moodies Pass, *Leach & Pienaar 5584* (holotype: PRE!).

Dwarf succulent forming small clumps to 15 cm in diameter, rarely rhizomatous. Stems 4–10 cm long, 0.6–1 cm in diameter (excluding teeth), slender, erect to shortly decumbent, grey-green flecked with purple; tubercles (6–) 10–20 mm long, arranged loosely into 4 obtuse rows along stem ± without a groove between rows, tapering to a long slender conical attenuate ascending-spreading tooth, usually with a pair of ± erect slender denticles up to 1 mm long placed 5–8 mm below apex. Inflorescence 1 per stem below middle, of 1–8 flowers developing successively from an erect peduncle up to 10 mm long and 5 mm in diameter, flowers often opening at or shortly above level of stem apex; pedicel 15–40 mm long, 1.5–2.0 mm in diameter, erect to spreading, holding flower facing upwards or outwards. Sepals ± 6 mm long, 2 mm wide at base, ovate, acuminate. Corolla 3–4.5 cm in diameter when fully spread out, with the lobes very strongly reflexed and the tips sometimes nearly clasping the pedicel; outside glabrous, grey- to yellow-green; inside minutely papillate, dull maroon to brown becoming shiny with yellowish markings on lobes; tube ± 2 mm long, 3 mm in diameter, formed by a smooth and very abruptly raised fleshy convex annulus in center (sides ± 2 mm in diameter); lobes ± 16–20 mm long, 7–9 mm wide at base, ovate, acute, transversely lightly rugulose especially towards the apex, convex above, the margins folded back and with fine rigidly fixed usually whitish cilia <1 mm long (except towards the apex). Corona 7 mm tall, 4.5–7.5 mm in diameter, raised slightly above annulus by a stout stipe 2–3 mm long; outer lobes ± 1.5–2.0 mm, spreading to slightly recurved over rim of annulus, ± subquadrate, with two raised radial ridges forming a central trough that terminates in an acute to rectangular central tooth slightly exceeding the truncate apex, dull maroon to brown and darker on raised ridges; inner lobes 4–5 mm long, adpressed to backs of anthers and there dorsiventrally flattened ± 1 mm wide and oblong-ovate, above this nearly terete and connivent then recurved with clavate-tuberculate apex, dorsally near base with two divergent ridges fused to lateral margins of outer lobes, yellow spotted with red or brown (brown dorsally near base). Figs. 4E, 85.

Distribution (Fig. 69). Mozambique, Zimbabwe; 20–1000 m.

Orbea umbracula is now quite well known from the relatively low-lying region between Moodies Pass, Mutare, and Gona-re-Zhou in the southeastern corner of Zimbabwe. These localities are all to some extent associated with the drainage system of the Save or Sabi River. It is also known from several collections in Mozambique in the area around the mouth of the Save River within 3 km of the coast and some 200 km further to the east of the Zimbabwe localities. It remains unknown whether *O. umbracula* occurs in the intervening territory.

This species seems generally to occur on pale, sandy soils under trees, often in *Brachystegia* woodland in Zimbabwe. In Mozambique plants were found in one spot in a *Baikaea* (teak) forest with lots of leaf litter, and in two other areas they were growing among leaf litter, dead twigs, and clumps of small grasses on the edge of "forest islands," mainly consisting of *Androstachys johnstonii*, the Lebombo ironwood.

ADDITIONAL SPECIMENS EXAMINED. **Mozambique.** [2134] South of Save River [-BA], *Bruyns 7405* (BOL); S of Mambone [-BB], *Bruyns 7683* (BOL). [2135] South of Mambone [-AA], *Bruyns 7680* (K). **Zimbabwe.** [1832] Sabi Riv., Odzi [-CD], *Pienaar sub SRGH 35788* (SRGH); near Umtali [-DC], *Visser s.n.* (PRE).

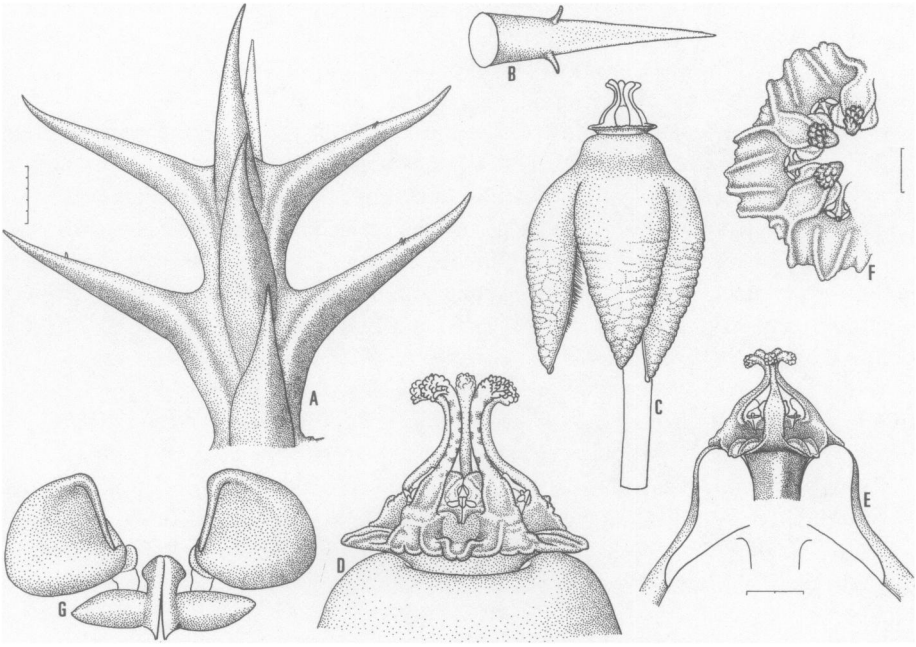

FIG. 85. *Orbea umbracula.* A. Portion of stem. B. Leaf rudiment with stipular denticles. C. Side view of flower. D. Side view of gynostegium. E. Side view of center of dissected flower. F. Face view of gynostegium. G. Pollinarium. Scale bars: A, C, 5 mm (at A); B, E, 2 mm (at E); D, F, 1 mm (at F); G, 0.25 mm (at E). [Based on: A, C, D, F, G, *Bruyns 7418*; B, E, *Bruyns 7405*.]

[1931] Dorowa [-BB], *Mennell sub Bulawayo Mus. 106* (SRGH); Moodies Pass [-DC], *Hall & Carp sub Compton 44690* (NBG). [1932] ± 24 km SW of Umtali, *Plowes 2083* (BOL, SRGH); Maranke Tribal trust-land, ± 30 km S of Odzi [-AB], *Plowes 3824* (K, NBG, PRE); 20 km S of Mutare [-BA], *Bruyns 7418* (MO); Chitore Farm, Banti Forest Res. [-BC], *Mavi 562* (NBG, SRGH); Chitore Farm, Himalayas road [-BC], *Blake 68* (K); Mpudzi River ± 46 km S of Umtali [-BC], *Kimberley 13* (MO); Nyamakari River, Burma Valley [-BD], *Chase 7646* (SRGH). [2032] Turgwe River, Humani Ranch [-AC], *Whittall s.n.* (PRE). [2131] Guluene Riv., Gona-re-Zhou (-D), *Liversedge sub Plowes 2656* (SRGH).

The manner in which the flower is held in *O. umbracula* is particularly unusual. Inflorescences mostly arise below the middle of the stem, though often well above the base, and, with time, a thick peduncle develops. The pedicels, which are extremely variable in length even on one inflorescence, are often erect and hold the flower up among the tips of the stems or even above them.

In this species the flowers are about 4 cm across when fully spread out, but usually have the lobes strongly reflexed. This habit pushes the annulus and corona more to the fore and makes the flower appear much smaller than it really is. From the middle outwards the lobes are transversely rugulose and shiny, and they have a fringe of small, fixed cilia along most of their margins. Towards the center and on the annulus the inside of the flower is smooth and dull. The annulus rises steeply in the center to form a small column and in so doing produces the small tube that surrounds the base of the gynostegium.

Orbea umbracula shares many features with the South African *O. woodii*, the Mozambican *O. halipedicola*, and *O. semota* from East Africa. From *O. woodii* and

O. semota it is separated by the manner in which the flowers are produced above the stems and by the much longer and swollen-tipped inner corona lobes. *Orbea umbracula* is easily separated from *O. halipedicola*, even when not in flower, by the different color of the stems and the long, tapering tubercles with small, erect, cylindrical stipular denticles. In *O. halipedicola* the tubercles are tipped with a shorter, more flattened tooth, and the denticles merge into and run along the side of this tooth for a short distance. Furthermore, in *O. halipedicola* the corolla lobes are less reflexed, the annulus is much broader, flatter, and narrows to the base, and the margins of the lobes are fringed with vibratile cilia. Leach (1978) mentioned that the flowers are humifuse in *O. halipedicola* with longer pedicels, but in fact the flowers of this species are not usually pressed to the ground and may have pedicels as short as 15 mm, whereas they may be up to 40 mm long in *O. umbracula*.

50. Orbea rogersii (L. Bolus) Bruyns, Aloe 37: 76. 2001. *Stapelia rogersii* L. Bolus, Ann. Bolus Herb. 1: 194. 1915. *Caralluma rogersii* (L. Bolus) E. A. Bruce & R. A. Dyer, Bull. Misc. Inform. 1934: 303. 1934. *Pachycymbium rogersii* (L. Bolus) M. G. Gilbert, Bradleya 8: 28. 1990. *Angolluma rogersii* (L. Bolus) Plowes, Excelsa 16: 120. 1994.—TYPE: BOTSWANA. Mahalapye, *Rogers 6298* (holotype: BOL!).

Usually a small succulent forming clumps 6–50 cm in diameter, not rhizomatous. Stems 3–10 cm long, 0.8–10 cm in diameter (excluding teeth), slender, erect, pale green to grey-green flecked with red-brown; tubercles 10–20 mm long, arranged loosely into 4 obtuse rows along stem with a slight groove between rows, tapering to a slender conical ascending to spreading acuminate tooth with a pair of small denticles near apex. Inflorescences 1–8 per stem mainly in distal half, each of 1–3 (–8) flowers developing in gradual (to rapid) succession from a swollen peduncular patch (<5 mm long); pedicel 8–15 mm long, 1.5 mm in diameter, ascending, with a few deltate bracts 1–2 mm long at base. Sepals 3–4 mm long, 1.0–1.5 mm wide at base, lanceolate, acuminate. Corolla 2.5–3.5 cm in diameter, rarely expanding fully, very deeply and narrowly lobed; outside smooth pale green with a few radial darker veins; inside finely papillate on lobes but with cylindrical papillae (up to 0.5 mm long) on swollen "annulus," pale greenish yellow to white on united portion; tube ± 0.5–1.0 mm deep, very short, formed by an abruptly thickened "annulus" immediately below sinuses of lobes and around base of gynostegium; lobes 18–22 mm long, 3–5 mm wide at base, ascending-incurved, rarely spreading, linear-acute, the margins incurved for the basal 2–4 mm, then replicate and the inner surface strongly convex except near base, with transparent clavate-globose non-vibratile cilia 1.0–2.5 mm long along proximal margins (incurved portions and ± 1 mm beyond them). Corona ± 8–10 mm tall, 5 mm in diameter, raised above tube on a stout ± cylindrical stipe 1 mm long, cream; outer lobes 1.5–3.0 mm long, ± 0.75 mm wide at base, spreading in proximal half then slightly ascending, narrowly rectangular to lanceolate, 1–3-toothed at apex, margin somewhat raised in lower third and thus the lobe channelled there; inner lobes 8–10 mm long, dorsiventrally flattened and adpressed to backs of anthers for lower half of anthers, then bifid (occasionally trifid) into slender terete filiform lobules 7–9 mm long, these twisted together and entangled towards the apices, with a similarly filiform and long dorsal appendage arising near base and initially laterally flattened then terete (often with 1–3 further small dorsal horns). Figs. 3H, 86.

Distribution (Fig. 13). Botswana, South Africa, Zimbabwe; 500–1200 m.

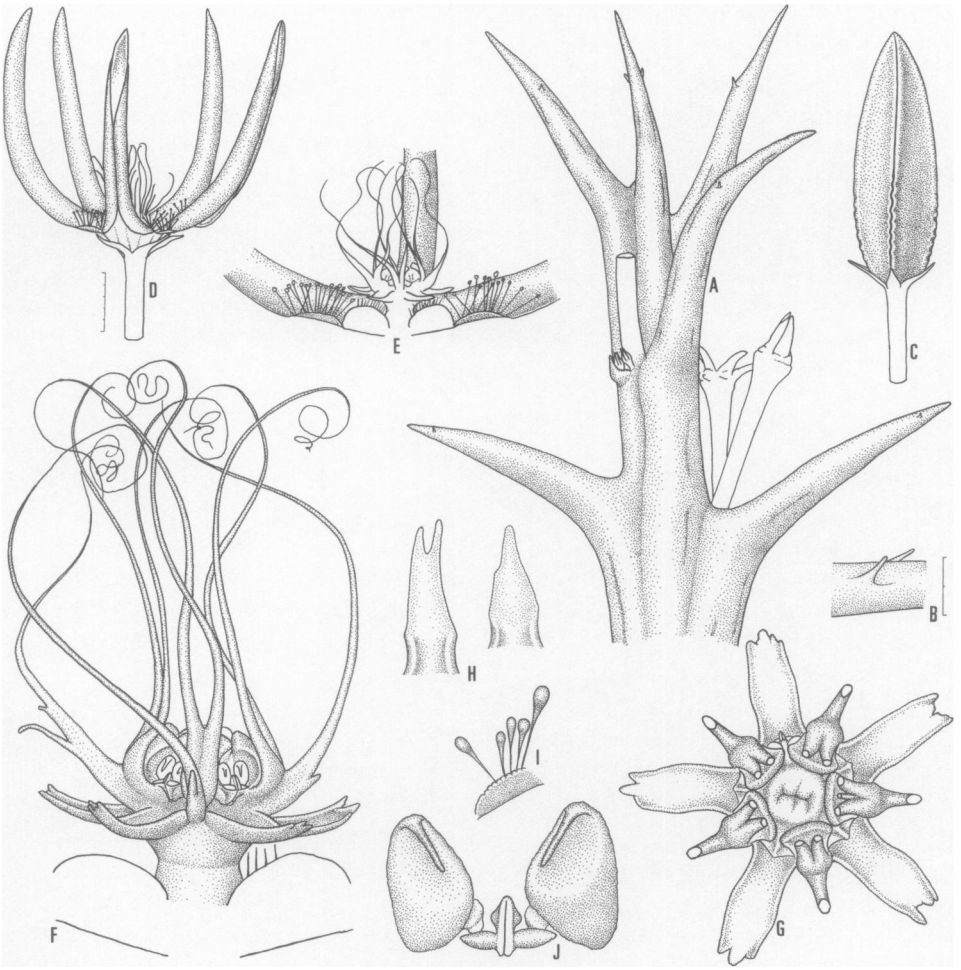

FIG. 86. *Orbea rogersii.* A. Portion of stem. B. Leaf rudiment with stipular denticles. C. Bud. D. Side view of flower. E. Side view of center of dissected flower. F. Side view of gynostegium. G. Face view of gynostegium with long inner lobules excised. H. Variation in outer corona lobes. I. Cilia borne along base of corolla lobe. J. Pollinarium. Scale bars: A, C, D, 5 mm (at D); B, 2 mm; E, 3 mm (at B); F, G, H, I, 1 mm (at B); J, 0.25 mm (at B). [Based on: A, C, D, *Bruyns 4473*; B, E, F, G, H-at right, I, J, *Bruyns 6507*; H-at left, *Bruyns 6504*.]

Orbea rogersii is widely distributed but has been very scantily recorded. In Botswana, it is found north of Maun on the southern edge of the Okavango Delta and then in the east from around Nata southwards to near Lobatse (Hargreaves 1997). In Zimbabwe it is recorded only from the low-lying, hot, and relatively dry country in the south near Beit Bridge and in the lower Sabi Valley. In South Africa in the Transvaal it occurs in the region north of the Soutpansberg, and in the "lowveld" bordering on and inside the Kruger National Park. It is also known in Natal from the vicinity of Ulundi.

Plants are generally scattered and are rarely locally common. They usually grow in flat, sandy areas around the foot of a tree (often *Acacia* or *Colophospermum mopane*) or inside a small shrub.

ADDITIONAL SPECIMENS EXAMINED. **Botswana.** [1923] Okavango [-AA], Jan 1974, *Smith 762* (SRGH); 20 km N of Makwee [-BC], *Bruyns 6507* (BOL); 33 km N of Maun [-DC], *Bruyns 6504* (BOL). [2026] Nata R. [-AA], *Smithers sub NBG 54/57* (NBG); 17 km E of Matshalo [-AB], *Bruyns 6981* (MO). [2325] Boatlaname [-DB], 18/4/34, *Knobel 2* (PRE). [2326] 18 km S of Shoshong [-AB], *Bruyns 6434* (MO); Mahalapye [-BB], *Bayliss 1846* (SRGH). [2525] Lobatsi [-BA], Mar 1914, *Rogers s.n.* (PRE). **South Africa.** NATAL: [2831] West of Ulundi [-AD], *de Kock 350* (NBG); Ulundi, Nodwendu battlefield [-BC], 15 Jan 1940, *Gerstner* (PRE).—TRANSVAAL: [2229] Dongola, Soutpansberg [-BC], 30 Mar 1942, *Pole-Evans s.n.* (PRE); Loretto [-CA], *Bruyns 4473* (BOL); Waterpoort [-DC], 15 Mar 1945, *Holloway 404/2/45* (PRE). [2230] West of Klein Tshipize [-DA], Nov 1980, *Hardy 5555* (PRE). [2330] Mokeetsi [-CA], Dec 1932, *Messing s.n.* (PRE); Hans Merensky Res. [-DA], 8 May 1970, *Oates 306* (PRE). [2331] Letaba [-DC], 16 Feb 1954, *v. d. Schyff 3550* (PRE); Letaba Shooting Range [-DC], *v. Jaarsveld 1996* (NBG). [2430] Olifants R. near Mica [-BB], 8 Mar 1944, *Ashley-Mabberley* (PRE). [2431] 14 km S of Phalaborwa [-AA], 12 Feb 1984, *Retief 158* (PRE); Tshokwane, Kruger National Park [-DD], Sep 1980, *Hardy 5433* (PRE). [2531] 3 miles W of Malelane [-AD], 24 Feb 1949, *Codd 5237* (PRE); Crocodile Bridge, Kruger National Park [-BD], 4 Mar 1954, *v. d. Schyff s.n.* (PRE); near Malelane [-CB], Apr 1981, *Jacobsen* (PRE). **Zimbabwe.** [2132] Palm Forest, Lower Sabi, 9 Jan 1934, *Eyles 7630* (K), *Vereker s.n.* (SRGH). [2230] 7 miles towards Chituripasi [-AA], 10 Jan 1961, *Leach 10680* (SRGH, PRE).

Orbea rogersii is distinguished from all species in *Orbea* by the narrow corolla lobes with conspicuous cilia near the base, but most particularly by the relatively long and very slender, filiform parts of the inner corona lobes.

Specimens of *O. rogersii* often become large (up to 50 cm in diameter), with the stems very densely and tightly packed into a clump, but they do not have any tendency to spread underground. The stems are slender and have long, slender, ascending teeth along them, which break up their outline.

Flowers are borne in many small inflorescences along the stems mainly towards the apex. Each inflorescence gives rise to a small, persistent, slightly projecting "peduncular patch," and the presence of many of these on each stem is one of the ways of recognizing this species, even when it is without flowers. The flowers have unusually long, narrow, pentagonal buds, whose edges are somewhat undulating around the middle, though all traces of these undulations disappear once the flower opens. Near the base, the margins of the lobes fold upwards, and here they are adorned with a row of remarkable cilia: these are altogether transparent, with an almost spherical, shiny apex that tapers suddenly into a very slender stalk. The cilia are fairly rigidly fixed (not at all vibratile), and most of them are held facing upwards so as to form a dense cluster at the sinuses of the lobes. The flowers emit a weak smell of decaying fruit.

The simple outer corona lobes, which have an unusually thin texture, are channelled above towards the base and joined to the inner only at the base. The inner lobes are dorsiventrally flattened and incumbent on the anthers lower down, but then they divide into two (or three) very long and slender, filiform lobules, which rise up and become intertwined in the center. The dorsal projection is laterally flattened towards its base, where there are sometimes a few small dorsal horns. Above this the dorsal projection also becomes long and filiform, like the lobe itself, to join the general confusion of fine, intertwined, filiform lobules in the center.

Since many of the species of *Orbea* have a dense ring of bristles on the corolla around the corona (Fig. 1E, F) and cilia along the margins of the lobes, none of the corolline bristles in *O. rogersii* are surprising. Nevertheless, the shape of the inner corona is without precedent, although the respective dorsiventral and lateral flattening towards the base of the lobes shows that these are much modified from the usual structures. The present study shows that *O. rogersii* is basal to a clade containing most of the species formerly included by Leach in *Orbea* (Fig. 6).

51. Orbea pulchella (Masson) L. C. Leach, Kirkia 10: 290. 1975. *Stapelia pulchella* Masson, Stapel. nov. 22, t. 36. 1797. *Podanthes pulchella* (Masson) Haworth, Syn. pl. succ. 33. 1812.—TYPE: SOUTH AFRICA. *Masson s.n.* (holotype: not located).—LECTOTYPE, designated by Leach, 1978: t. 36 in Masson, Stapelieae novae, 1797.

Dwarf succulent forming clumps 5–30 cm in diameter, not rhizomatous. Stems 2.5–10 cm long, 0.5–1 cm in diameter (excluding teeth), (shortly) decumbent, green mottled with purple-brown; tubercles 4–9 mm long, arranged loosely into 4 obtuse rows along stem with a groove between rows, tapering to a spreading to ascending conical acute tooth (usually lacking denticles). Inflorescence 1 per stem, of 1–3 flowers developing successively from a short peduncle, with few small bracts (<1.5 mm long); pedicel 10–30 mm long, 2 mm in diameter, horizontal to ascending usually with ascending apex. Sepals 4–10 mm long, 2 mm wide at base, ovate-lanceolate, acuminate. Corolla 3–5.5 cm in diameter, rotate to shallowly bowl-shaped; outside smooth, pale green towards base, flecked and veined with purple-brown on lobes; inside pale yellow with purple-brown to red, spots becoming smaller and denser on annulus, uniformly purple-brown or red around and beneath gynostegium, transversely papillate-rugulose except towards base of tube; tube shallowly bowl-shaped, containing and often formed by a thickened pentagonal (with corners below sinuses of lobes) sometimes very obscure annulus 1.5–2.0 mm thick and ± 10–12 mm in diameter, with a ring of cylindrical bristles in base immediately around gynostegium; lobes 13–20 mm long, 12–16 mm in diameter at base, spreading to recurved, deltate to deltate-ovate, very acute or acuminate, margins eciliate. Corona ± 5 mm tall, 6–7 mm in diameter, raised above base of tube on stout cylindrical stipe ± 1 mm tall; outer lobes 2–3 mm long, ascending, deeply channelled on upper surface, ± rectangular, truncate to shallowly apically notched, laterally fused towards base to lower rear of inner lobes, dark purple-red; inner lobes ± 3 mm long, adpressed to backs of anthers and exceeding them to rise in small column in center, then slightly diverging, dorsiventrally flattened below, becoming terete near apex, usually with deltate to truncate often transversally flattened dorsal projection near base. Fig. 87.

Distribution (Fig. 89). South Africa; 20–400 m.

Orbea pulchella is best-known from around Port Elizabeth, with a single record from the Baviaanskloof and another from Carlisle Bridge to the northeast (Leach 1978). It occurs more or less in an area where the ranges of *O. variegata* and *O. verrucosa* overlap.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** CAPE PROVINCE: [3324] Baviaan's Kloof [-CA], *Bayliss 5015* (PRE). [3325] Sandflats [-BD], *Brocklebank sub Pillans 136* (BOL); Despatch [-CD], *Bayliss 4880* (NBG); Mackay Bridge [-DA], *Leach 8542* (PRE); Humewood [-DC], *Paterson 64* (BOL), *Bruyns 6262* (BOL); Port Elizabeth [-DC], *Drège s.n.* (GRA); *Pringle s.n.* (BOL); Redhouse [-DC], *Bayliss 4859* (MO, SRGH); between Two Creeks and New Brighton Rd [-DC], *Crampton 153* (GRA); sand dunes along coast S of Port Elizabeth [-DC], *Pillans 84* (BOL). [3326] Carlisle Bridge [-AA], *Hutton s.n.* (GRA).

Both the stems and the corolla of *O. pulchella* are more or less indistinguishable from those of *O. verrucosa*. In particular, in *O. pulchella* the corolla is finely spotted on a creamy-yellow background, and it has a small annulus rising out of the side of the tube, just as in *O. verrucosa*. From *O. verrucosa* it differs mainly in characters of the corona. The outer lobes are considerably longer, narrowing slightly to a truncate end. The inner lobes are longer as well and rise up in a small column in the center. They have a noticeable dorsal ridge near their base.

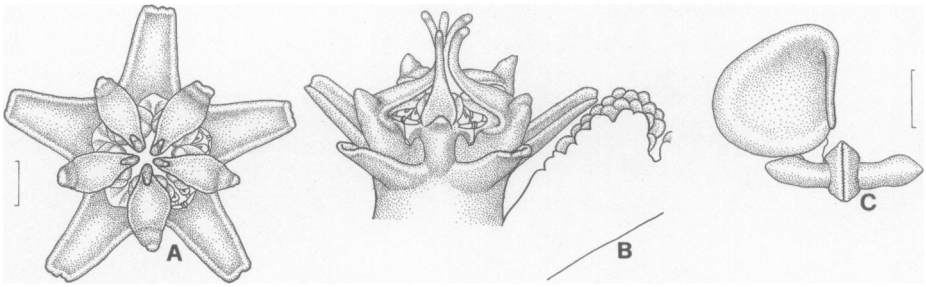

FIG. 87. *Orbea pulchella.* A. Face view of gynostegium. B. Side view of gynostegium. C. Part of pollinarium. Scale bars: A, B, 1 mm (at A); C, 0.25 mm. [Based on *Bruyns 4262*.]

The peculiar distribution of this species, in the area where *O. variegata* and *O. verrucosa* overlap, suggests that it might be a hybrid. Pollination experiments have shown that progeny of direct crosses of *O. variegata* and *O. verrucosa* all had much larger annuli and were far more coarsely mottled than in *O. pulchella*; additional crossing studies are necessary to investigate the possibility of hybrid origin. The structure of the corona of *O. pulchella* is intermediate between *O. variegata* and *O. verrucosa*; however, around Port Elizabeth one generally only finds *O. pulchella*, which suggests that, if it were of hybrid origin, it has become as a viable, breeding species independent of the parent taxa.

Masson's illustration of *O. pulchella* is not particularly clear, and this name has come to be associated with material collected around Port Elizabeth largely because of the interpretation placed on it by N. E. Brown (1907–9). In this case no type has been found (Leach 1978).

52. Orbea verrucosa (Masson) L. C. Leach, Kirkia 10: 290. 1975. *Stapelia verrucosa* Masson, Stapel. nov. 11, t. 8, 1796. *Podanthes verrucosa* (Masson) Haworth, Syn. pl. succ. 33. 1812.—TYPE: SOUTH AFRICA. Cape Province: in dry places, *Masson s.n.* (holotype: BM!).

Stapelia irrorata Masson, Stapel. nov. 12, t. 9. 1796. *Podanthes irrorata* (Masson) Haworth, Syn. pl. succ. 33. 1812. *Orbea irrorata* (Masson) L. C. Leach, Excelsa Taxon. Ser. 1: 27. 1978.—TYPE: SOUTH AFRICA. Cape Province: *Masson s.n.* (holotype: not located).—LECTOTYPE, designated by Leach, 1978: t. 9 in Masson, Stapelieae novae, 1796).

Stapelia roriflua Jacquin, Stapel. hort. vindob. cult. t. 19. 1806–1819. *Podanthes roriflua* (Jacquin) Sweet, Hort. Brit. 278. 1826. *Piaranthus rorifluus* (Jacquin) Decaisne in DC., Prodr. 8: 664. 1844. *Stapelia verrucosa* var. *roriflua* (Jacquin) N. E. Brown, Fl. cap. 4(1): 988. 1909.—LECTOTYPE, designated by Leach, 1978: t. 19 in Jacquin, Stapeliarum in hortis vindobonensibus cultarum, 1806–1819.

Stapelia rugosa J. C. Wendland, Coll. pl. 41. 1809, non *Stapelia rugosa* J. Donn ex Jacquin, 1806–1819. *Stapelia wendlandiana* Schultes in Roemer & Schultes, Syst. veg. 6: 39. 1820.—LECTOTYPE, here designated: t. 52 in J. C. Wendland, Collectio plantarum, vol. 2, 1809.

Podanthes pulchra Haworth, Syn. pl. succ. 32. 1812. *Stapelia pulchra* (Haworth) Schultes in Roemer & Schultes, Syst. veg. 6: 28. 1820. *Stapelia verrucosa* var. *pulchra* (Haworth) N. E. Brown, Fl. cap. 4(1): 987. 1909.—TYPE: based on living material in cultivation.

Podanthes pulchra var. *major* Sweet, Hort. Brit. 278. 1826. *Podanthes pulchra* var. *verrucosa* G. Don, Gen. hist. 4: 118. 1837–1838, nom. superfl.—TYPE: based on Botanical Magazine 20: t. 786. 1804.

Stapelia fucosa N. E. Brown, Fl. cap. 4(1): 977. 1909. *Orbea verrucosa* var. *fucosa* (N. E. Brown) L. C. Leach, Excelsa Taxon. Ser. 1: 25. 1978.—TYPE: SOUTH AFRICA. Cape Province: Just SE of Mt Ayliff, *Pillans 173* (holotype: BOL!).

Stapelia verrucosa var. *conspicua* N. E. Brown, Fl. cap. 4(1): 988. 1909.—TYPE: SOUTH AFRICA. Cape Province: Glen Avon Estate, *Pillans 192* (holotype: BOL!).

Stapelia verrucosa var. *pallescens* N. E. Brown, Fl. cap. 4(1): 988. 1909.—TYPE: SOUTH AFRICA. Cape Province: Glen Avon Estate, *Pillans 56* (holotype: BOL!).

Stapelia verrucosa var. *punctifera* N. E. Brown, Fl. cap. 4(1): 988. 1909.—TYPE: SOUTH AFRICA. Cape Province: Bellevue, Alexandria distr., *Brocklebank sub Pillans 655* (lectotype, designated by Leach, 1978: BOL!).

Stapelia verrucosa var. *robusta* N. E. Brown, Fl. cap. 4(1): 988. 1909.—TYPE: SOUTH AFRICA. Cape Province: Glen Avon Estate, *Pillans 604* (holotype: BOL!).

Dwarf succulent forming clumps 5–30 cm in diameter, not rhizomatous. Stems 2.5–10 cm long, 0.5–1 cm in diameter (excluding teeth), (shortly) decumbent, green mottled with purple-brown; tubercles 4–9 mm long, arranged loosely into 4 obtuse rows along stem with a groove between rows, tapering to a spreading to ascending conical acute tooth, usually lacking denticles. Inflorescence 1 per stem, of 1–3 flowers developing successively from a short peduncle, with a few small bracts (<1.5 mm long); pedicel 10–30 mm long, 2 mm in diameter, horizontal to ascending usually with ascending apex. Sepals 4–10 mm long, 2 mm wide at base, ovate-lanceolate, acuminate. Corolla 4.5–6 cm in diameter, rotate to shallowly bowl-shaped often with a flat base; outside smooth, pale green towards base, flecked and veined with purple-brown on lobes; inside pale yellow with purple-brown to red spots, these becoming smaller and denser on annulus, uniformly purple-brown or red around and beneath gynostegium, transversely papillate-rugulose except towards base of tube; tube shallowly bowl-shaped, containing and often formed by a thickened pentagonal (with corners below sinuses of lobes) sometimes very obscure annulus 1.5–2.0 mm thick and ± 10–12 mm in diameter, with a ring of cylindrical bristles in base immediately around gynostegium; lobes 13–20 mm long, 12–16 mm wide at base, spreading to recurved, deltate to deltate-ovate, very acute or acuminate, margins eciliate. Corona ± 4 mm tall, 6–7 mm in diameter, raised above base of tube on a stout cylindrical stipe ± 1 mm tall; outer lobes 1–2 mm long, horizontally spreading to slightly deflexed, deeply channelled on upper surface, with a shallow to deep triangular notch in apex dividing the lobe into two deltate slightly ascending lobules, laterally fused towards base to lower rear of inner lobes, dark purple-red; inner lobes 1.0–1.5 mm long, adpressed to backs of anthers and equalling to exceeding them, sometimes meeting in center and with the apex upturned, dorsiventrally flattened and narrowly deltate, slightly gibbous on rear towards base, rear and margins purple-red, upper surface bright yellow. Fig. 88.

Distribution (Fig. 89). South Africa; 20–1700 m.

Orbea verrucosa is widely distributed and quite common in the southeastern parts of South Africa. It is commonest in the eastern Cape from Port Elizabeth eastwards to the Kei River but occurs also as far west as Oudtshoorn, onto the Great Karoo around Graaff Reinet, Somerset East, and northeastwards as far as near Aliwal North, Mt Frere, and Mt Ayliff.

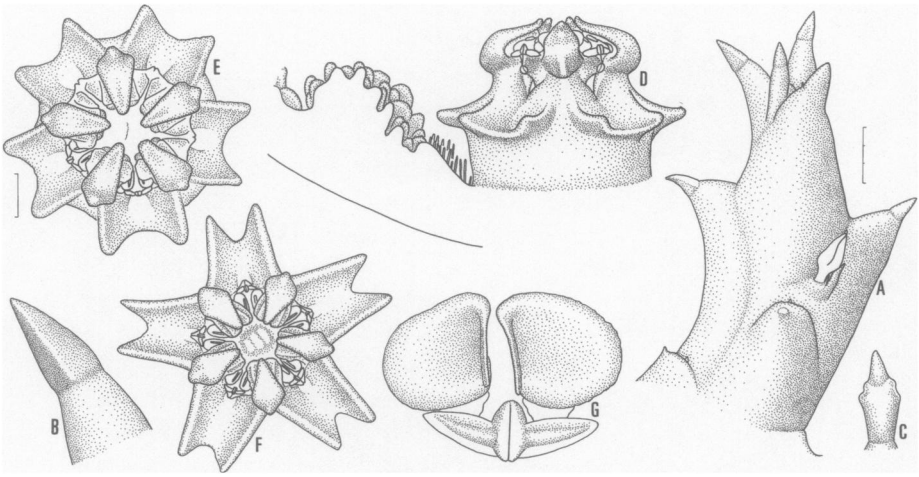

FIG. 88. *Orbea verrucosa.* A. Portion of stem. B. Leaf rudiment. C. Bract from inflorescence. D. Side view of center of dissected flower. E, F. Face views of gynostegium. G. Pollinarium. Scale bars: A, 3 mm; B, C, 1 mm (at A); D–F, 1 mm (at E); G, 0.25 mm (at A). [Based on: A–E, G, *Bruyns 3066;* F, *Bruyns 6242*.]

Plants usually grow on shale banks or among rocks and small bushes on dry slopes or flats.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** CAPE PROVINCE: [3026] Burgersdorp [-CD], *Reynolds 465* (BOL). [3029] ± 8 miles E of Mt Frere [-CC], *Plowes 3269* (SRGH); Tonti Mtn. near Mount Ayliff [-CD], *Pillans 173* (BOL). [3124] Naudesberg Pass [-DC], *Bruyns 4372* (BOL). [3126] Kees se Berg [-AA], *Bruyns 5051* (NBG); Umbumbula Mtn. near Queenstown [-DD], *Galpin 6942* (BOL, GRA, PRE). [3128] Tsolo [-BC], *Becker* (GRA); ± 1 mile S of Tsolo [-BC], *Plowes 3270* (SRGH); Corana River, Umtata [-DB], *Nevill sub PRE 43936* (PRE); Signal Hill, Umtata [-DB], *Reynolds 2186* (PRE); Umtata [-DB], *Abernethy s.n.* (NBG). [3224] Kamdebooberg [-AC], *Bruyns 3066* (NBG); Graaff Reinet [-BC], *Bolus 716* (BOL). [3225] Glen Avon [-DA], *Pillans 56, 60, 152, 189, 192* (BOL); Mountain Drive, Somerset East [-DA], *Reynolds 192* (BOL); Somerset East [-DA], *MacOwan 2177* (BOL, SAM). [3226] Huntly Glen [-AC], *Plowes 2915* (SRGH); Lovedale [-DD], *Bennie 708* (GRA). [3227] Tarsus [-AC], *Bruyns 5024* (PRE); Thomas River, ± 16 miles N of Stutterheim [-AD], *Leach 9512* (BM, SRGH); Tsomo [-BB], *Barker s.n.* (BOL); Inversomo [-BD], *Bruyns 5388* (BOL); Keiskamma Hoek [-CA], *Crampton 156* (GRA); Kingwilliamstown [-CD], *Sim 271* (GRA); Kei Road [-DA], *Leach 8847* (PRE); Komgha [-DB], *Stayner s.n.* (MO, SRGH). [3228] Haga Haga [-CD], *Thomas s.n.* (NBG). [3321] 13 km W of Swartberg Pass [-BD], *Bruyns 6242* (BOL). [3323] Bo-Kouga [-CB], *Bayliss 6963* (PRE, SRGH); Koega Mtns. [-CB], *Wisura 2164* (NBG); Braamrivier [-DB], *Bruyns 7094* (BOL). [3324] Moordenaars [-CC], *Stayner s.n.* (PRE); Groot Rivier Poort [-DA], *Bruyns 2183* (NBG); 6 miles E of Hankey [-DD], *Bayer s.n.* (NBG). [3326] Brak Kloof [-AB], *Schonland 1160* (GRA); Howieson's Poort [-AD], *Bayliss 374* (PRE); Salem [-AD], *Bayliss 3282* (PRE); Belmont Valley [-BC], *Bayliss s.n.* (SRGH); Brooklands, Southwell [-BC], *Bayliss 3340* (SRGH); Grahamstown [-BC], *Northover s.n.* (PRE); Vaalvlei [-BC], *Bayliss 6741* (K); Barwell Park [-BD], *Bayliss 2772* (PRE); Blaaukranz [-BD], *Northover s.n.* (PRE); Coombes [-BD], *Bayliss sub Leach 15536* (K); Kowie West Road [-BD], *Dyer 1616* (GRA); Kowie, road to Mentone [-BD], *Britten 2121* (GRA); Martindale Village [-BD], *Leach & Bayliss 12633* (BOL); Trappes Valley [-BD], *Bayliss 2356* (MO, SRGH); Alexandria [-CB], *Plowes 3052* (SRGH); Alexandria, 7 miles from Kariega mouth [-DA], *Northover s.n.* (PRE); Port Alfred [-DB], *Hutton 5* (GRA); *Wisura 2705* (NBG). [3327] Peddie [-AA], *Dyer 1616* (GRA).

In *O. verrucosa* the stems are less brightly colored and usually are also smaller with smaller tubercles than those of *O. variegata*, but they are otherwise indistinguishable from them.

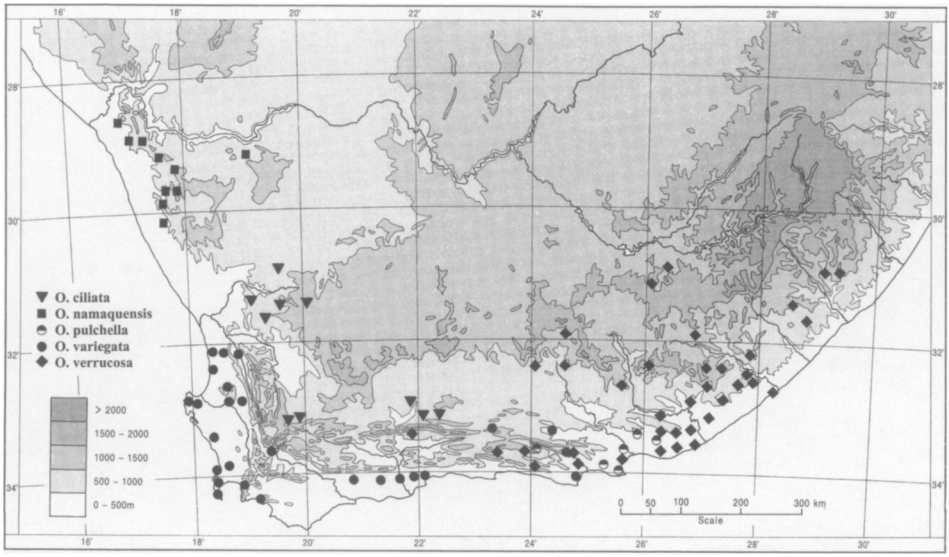

FIG. 89. Distribution of *Orbea ciliata*, *O. namaquensis*, *O. pulchella*, *O. variegata*, and *O. verrucosa*.

Superficially the flowers also appear to be very similar to those of *O. variegata*. The flower is usually shallowly bowl-shaped and less commonly quite flat, and it is covered with transverse, papillate rugosities all over the inside. Near the center there is a small annulus, occasionally barely distinguishable from the surrounding tissue, but usually raised up to 2 mm out of the surface. This annulus forms the beginnings of the slightly steeper lower part of the tube, and, on the inside, it is often distinctly pentagonal: the tissue of the corolla is somewhat swollen behind the outer corona lobes and thinner between them (i.e., below the sinuses of the corolla lobes), so that five grooves arise in the lower part of the tube alternating with the outer corona lobes. Towards the base of the tube the rugosities give way to a dense ring of small, cylindrical hairs.

In this species the outer corona lobes are often very short and channelled deeply on their upper surface. The inner lobes do not rise above the anthers at all and have at most a very small, dorsal swelling near the base.

Orbea verrucosa is in many ways similar to *O. variegata* and very similar indeed to *O. pulchella*. Vegetatively they cannot be separated reliably. Florally *O. verrucosa* and *O. pulchella* are the more similar, and they differ from *O. variegata* by the much smaller annulus, which appears merely as a ridge on the side of the tube and does not form the tube itself around the corona, as in *O. variegata*. Among the three species, the corona has the shortest outer lobes and the shortest inner lobes in *O. verrucosa*.

Not quite as many variants of *O. verrucosa* have been given varietal or specific names as happened in *O. variegata*, but N. E. Brown described several varieties from material collected in 1903 by N. S. Pillans on the Glen Avon Estate near Somerset East. Leach (1978) abandoned all of these but maintained a "var. *fucosa*" for specimens in which the stems have shorter tubercles, and the flowers are slightly smaller, darker, and flatter towards the center than in var. *verrucosa*. There seems to be no basis for maintaining this variety either and it is not recognized here.

53. Orbea namaquensis (N. E. Brown) L. C. Leach, Kirkia 10: 290. 1975. *Stapelia namaquensis* N. E. Brown, Gard. Chron., n. s., 18: 648. 1882.—TYPE: SOUTH AFRICA. Cape Province: Namaqualand, *Barkly 64* (holotype: K!).

Stapelia namaquensis var. *ciliolata* N. E. Brown, Gard. Chron., n. s., 18: 648. 1882. *Stapelia ciliolata* (N. E. Brown) Rüst, Monatsschr. Kakteenk. 6: 43. 1896.—TYPE: SOUTH AFRICA. Cape Province: Namaqualand, *Barkly 38* (holotype: K!).

Stapelia namaquensis var. *minor* N. E. Brown, Gard. Chron., n. s., 18: 648. 1882.—TYPE: SOUTH AFRICA. Cape Province: Namaqualand, *Barkly 64 bis* (holotype: K!).

Stapelia namaquensis var. *tridentata* N. E. Brown, Gard. Chron., n. s., 18: 648. 1882. *Stapelia tridentata* (N. E. Brown) Rüst, Monatsschr. Kakteenk. 6: 43 (1896).—TYPE: SOUTH AFRICA. Cape Province: Namaqualand, *Barkly s.n.* (holotype: K!).

Stapelia namaquensis var. *bidens* N. E. Brown, Fl. cap. 4(1): 991. 1909.—TYPE: SOUTH AFRICA. Cape Province: Namaqualand, without precise locality, *Bolus s.n.* (holotype: BOL!).

Succulent forming clumps 5 cm to 1 m in diameter, not rhizomatous. Stems 3–10 cm long, 2–4 cm in diameter (excluding teeth), stout and often nearly cylindrical, shortly decumbent, green heavily mottled with purple-brown; tubercles 4–10 mm long, arranged loosely into 4 very broadly obtuse rows along stem ± without a groove between rows, tapering to a spreading conical stoutly acute tooth, sometimes with 1 or 2 denticles near apex. Inflorescence 1 per stem in proximal half, of 1–2 (–4) flowers developing in gradual succession from a short peduncle; pedicel 25–40 mm long, 4–5 mm in diameter, heavily striped with purple-red, spreading with upturned apex holding flower facing upward on ground. Sepals 6–8 mm long, 3–5 mm wide at base, ovate, acuminate. Corolla 7–10 cm in diameter, rotate; outside smooth, pale green to deeply suffused with purple-brown, with 3–5 longitudinal darker veins running down each lobe and fading towards base of tube; inside rugose with transverse papillate ridges on lobes and around annulus, obscurely rugulose on annulus, becoming smooth towards center, pale greenish yellow to bright yellow variously spotted and lined with purple-brown, bright yellow under annulus and with dark purple-brown ring around base of gynostegium; tube very shallowly bowl-shaped and slightly pentagonal, formed around gynostegium by a thick (3–4 mm) annulus 8–10 mm tall, recurved so that rim often touches the corolla surface outside tube, with a narrow ring of cylindrical-acute black bristles in base around gynostegium; lobes 25–32 mm long, 20–25 mm wide at base, spreading to recurved, broadly ovate, acuminate, often with dense fringe of short (<1 mm) clavate rigidly fixed marginal cilia, except towards the base and apex. Corona ± 8 mm tall, 16 mm wide, raised above base of tube on a stout cylindrical often dark purple stipe 1–2 mm long; outer lobes 6–8 mm long, 1.5–2.0 mm wide at base, initially horizontal then ascending, linear or linear-lanceolate, acute, yellow dotted with purple-brown with larger purple-brown patches at base; inner lobes 4.5–5.5 mm long, adpressed to backs of anthers then slender ± terete connivent-erect with clavate-tuberculate usually recurved tips, with slight rounded dorsal gibbosity at base, yellow dotted with purple-brown. Figs. 5D, 90.

Distribution (Fig. 89). South Africa; 200–1500 m.

Orbea namaquensis is of relatively restricted distribution in Namaqualand in the extreme west of South Africa and is only known south of the Orange River. It is confined to the arid winter-rainfall area, receiving less than 250 mm annually.

Plants of *O. namaquensis* can become extremely common, sometimes growing under almost every bush, and they often form large mats up to 1 m across. Below the escarp-

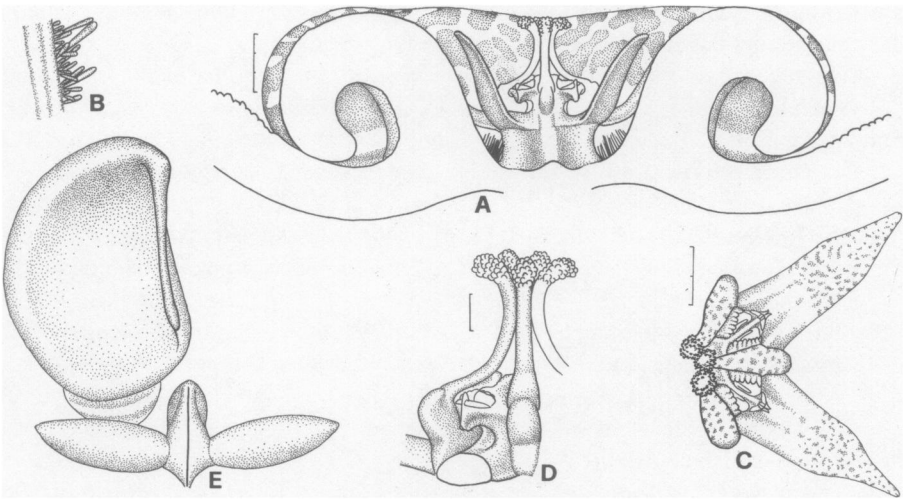

FIG. 90. *Orbea namaquensis.* A. Side view of center of dissected flower. B. Papillae borne along margin of lobe around its middle, inside of corolla at right. C. Face view of part of gynostegium. D. Side view of inner corona lobes. E. Part of pollinarium. Scale bars: A, 3 mm; B, 0.5 mm (at A); C, 2 mm; D, 1 mm; E, 0.25 mm (at A). [Based on: A, D, E, *Bruyns 8253*; B, C, *Bruyns s.n.*, Brakfontein, Komaggas (no voucher).]

ment *O. namaquensis* occurs on gently sloping, usually somewhat gravelly areas. Among the gneiss hills of the Springbok area it often grows in flattish somewhat disturbed areas under bushes of *Galenia africana* L. or on gravelly slopes.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** CAPE PROVINCE: [2816] Doornpoort [-DB], *NBG 700/53* (NBG). [2817] 13 miles N of Lekkersing [-CC], *Plowes 3613* (SRGH); 6 miles N of Lekkersing [-CC], *Plowes 3692a* (SRGH); Modderfontein [-CC], *Compton 20657* (NBG); Kliphoogte [-CD], *comm. Stayner* (NBG). [2917] 4 miles W of Steinkopf [-BA], *Hall 200* (NBG); 4 miles WNW of Steinkopf [-BA], *Leistner 794* (PRE); Anenous Hills [-BA], *Taylor s.n.* (BOL); 4 km NNE of Concordia [-BD], *v. Berkel 263* (NBG); Spektakel [-DA], *Compton 22796* (NBG); Okiep [-DB], *Templeman sub Pillans 7* (BOL); Springbok [-DB], *v. Heerde 29* (BOL); 10 km E of Springbok (DB), *Bruyns 8253* (K); Kourkam [-DC], *Templeman sub Pillans 16* (BOL); near Kourkam [-DC], *Rich sub Pillans 167* (BOL). [2919] Pella [-AA], *Smithers sub SAM 52158, 52356* (SAM).

Specimens of *O. namaquensis* have very stout and short stems, which, when exposed to enough sunlight, are beautifully marked with purple-brown on green. These are impossible to separate from the stems of *O. ciliata*; however, florally these two are quite dissimilar.

The flowers of *O. namaquensis* are very similar to those of *O. variegata* but are mostly larger and more strikingly marked. As in *O. variegata*, the flower is pressed facing upwards to the ground and is practically flat. The lobes are broadly ovate, and there is a similarly thick annulus near the center forming a bowl-shaped tube around the gynostegium. The annulus is recurved, so that its edge points down to the corolla (spreading in *O. variegata*), and it is uniformly thick right to this edge, not becoming thin towards the rim, as in *O. variegata*. The surface of the corolla is rugose on the lobes and around the annulus, but it is not nearly as rough as in *O. variegata*. There are often lots of short, clavate cilia along the margins of the lobes around their middle. In *O. namaquensis* there is, also,

a narrow ring of black, cylindrical (this time sharp-pointed) hairs in the tube formed by the annulus around the base of the gynostegium.

Although somewhat similar to that of *O. variegata*, the corona of *O. namaquensis* shows some obvious differences. The outer lobes taper gradually to a point in their upper half and are not bifid. The inner lobes have similar clavate-tuberculate apices connivent in a cluster above the center of the flower, but they lack any trace of a dorsal horn.

54. Orbea variegata (L.) Haworth, Syn. pl. succ. 40. 1812. *Stapelia variegata* L., Sp. pl. 1: 217. 1753.—TYPE: SOUTH AFRICA. Cape Province: collector unknown (holotype: LINN 311/1).

Stapelia mixta Masson, Stapel. nov. 23, t. 38. 1797. *Orbea mixta* (Masson) Haworth, Syn. pl. succ. 38. 1812. *Stapelia variegata* var. *mixta* (Masson) N. E. Brown, Fl. cap. 4(1): 1000. 1909.—TYPE: SOUTH AFRICA. Cape Province: *Masson s.n.* (holotype: not located).—LECTOTYPE, designated by Leach, 1978: t. 38 in Masson, Stapelieae novae, 1797.

Stapelia orbicularis Andrews, Bot. Repos. 7: t. 439. 1806. *Orbea orbicularis* (Andrews) Haworth, Syn. pl. succ. 40. 1812.—LECTOTYPE, here designated: t. 439 in Andrews, The botanist's repository, vol. 7, 1806.

Stapelia trisulca Jacquin, Stapel. hort. vindob. cult. t. 33. 1806–1819. *Stapelia variegata* var. *trisulca* (Jacquin) N. E. Brown, Fl. cap. 4(1): 997. 1909.—LECTOTYPE, here designated: t. 33 in Jacquin, Stapeliarum in hortis vindobonensibus cultarum, 1806–1819.

Stapelia clypeata J. Donn ex Jacquin, Stapel. hort. vindob. cult. t. 34. 1806–1819. *Orbea clypeata* (J. Donn ex Jacquin) Haworth, Suppl. pl. succ. 13. 1819. *Stapelia variegata* var. *clypeata* (J. Donn ex Jacquin) N. E. Brown, Fl. cap. 4(1): 1000. 1909.—LECTOTYPE, here designated: t. 34 in Jacquin, Stapeliarum in hortis vindobonensibus cultarum, 1806–1819.

Stapelia bufonia Jacquin, Stapel. hort. vindob. cult. t. 35. 1806–1819, non *Stapelia bufonia* (Haworth) Sims, 1814. *Stapelia variegata* var. *bufonia* (Jacquin) N. E. Brown, Hooker's Icon. Pl. 20: sub. t. 1907. 1890.—LECTOTYPE, here designated: t. 35 in Jacquin, Stapeliarum in hortis vindobonensibus cultarum, 1806–1819.

Stapelia anguinea Jacquin, Stapel. hort. vindob. cult. t. 37. 1806–1819.—LECTOTYPE, here designated: t. 37 in Jacquin, Stapeliarum in hortis vindobonensibus cultarum, 1806–1819.

Stapelia marmorata Jacquin, Stapel. hort. vindob. cult. t. 38. 1806–1819. *Orbea marmorata* (Jacquin) G. Don, Gen. hist. 4: 120. 1837–1838. *Stapelia variegata* var. *marmorata* (Jacquin) N. E. Brown, Fl. cap. 4(1): 1004. 1909.—LECTOTYPE, here designated: t. 38 in Jacquin, Stapeliarum in hortis vindobonensibus cultarum, 1806–1819.

Stapelia planiflora Jacquin, Stapel. hort. vindob. cult. t. 40. 1806–1819. *Orbea planiflora* (Jacquin) Haworth, Suppl. pl. succ. 12. 1819. *Stapelia variegata* var. *planiflora* (Jacquin) N. E. Brown, Fl. cap. 4(1): 998. 1909.—LECTOTYPE, here designated: t. 40 in Jacquin, Stapeliarum in hortis vindobonensibus cultarum, 1806–1819.

Stapelia rugosa J. Donn ex Jacquin, Stapel. hort. vindob. cult. t. 41. 1806–1819, non *Stapelia rugosa* J. C. Wendland, 1809. *Orbea rugosa* (J. Donn ex Jacquin) Sweet, Hort. Brit., ed. 1: 277. 1826. *Tridentea rugosa* (J. Donn ex Jacquin) G. Don, Gen. hist. 4: 118. 1837–1838. *Stapelia variegata* var. *rugosa* (J. Donn ex

Jacquin) N. E. Brown, Fl. cap. 4(1): 1001. 1909.—LECTOTYPE, here designated: t. 41 in Jacquin, Stapeliarum in hortis vindobonensibus cultarum, 1806–1819.

Stapelia normalis Jacquin, Stapel. hort. vindob. cult. t. 42. 1806–1819. *Orbea normalis* (Jacquin) G. Don, Gen. hist. 4: 120. 1837–1838. *Stapelia variegata* var. *normalis* (Jacquin) A. Berger, Stapel. u. Klein. 207. 1910.—LECTOTYPE, here designated: t. 42 in Jacquin, Stapeliarum in hortis vindobonensibus cultarum, 1806–1819.

Stapelia lepida Jacquin, Stapel. hort. vindob. cult. t. 43. 1806–1819. *Orbea lepida* (Jacquin) L. C. Leach, Excelsa Taxon. Ser. 1: 18. 1978.—LECTOTYPE, designated by Leach, 1978: t. 43 in Jacquin, Stapeliarum in hortis vindobonensibus cultarum, 1806–1819.

Stapelia picta Sims, Bot. Mag. 29: t. 1169. 1809. *Orbea picta* (Sims) Haworth, Syn. pl. succ. 42. 1812. *Stapelia variegata* var. *picta* (Sims) N. E. Brown, Fl. cap. 4(1): 1004. 1909.—LECTOTYPE: Botanical Magazine 29: t. 1169. 1809.

Stapelia conspurcata Willdenow, Enum. pl. 284. 1809. *Orbea conspurcata* (Willdenow) Sweet, Hort. Brit., ed. 1: 277. 1826. *Stapelia variegata* var. *conspurcata* (Willdenow) N. E. Brown, Fl. cap. 4(1): 1003. 1909.—TYPE: based on plants of South African origin cultivated at the Botanical Garden in Berlin ["Habitat ad Cap. b. spei"] (holotype: B-W 5301).

Stapelia planiflora var. *marginata* Willdenow, Enum. pl. 284. 1809. *Stapelia marginata* (Willdenow) Willdenow, Enum. pl., Suppl. 13. 1814. *Orbea planiflora* var. *marginata* (Willdenow) G. Don, Gen. hist. 4: 120. 1837–1838. *Orbea marginata* (Willdenow) G. Don, Gen. hist. 4: 120. 1837–1838. *Stapelia variegata* var. *marginata* (Willdenow) N. E. Brown, Fl. cap. 4(1): 998. 1909.—TYPE: based on plants of South African origin cultivated at the Botanical Garden in Berlin ["Habitat ad Cap. b. spei"] (holotype: B-W 5303).

Stapelia ophiuncula Haworth, Syn. pl. succ. 27. 1812.—TYPE: unknown.

Podanthes lepida Haworth, Syn. pl. succ. 34. 1812.—TYPE: unknown.

Orbea quinquenervia Haworth, Syn. pl. succ. 38. 1812. *Stapelia quinquenervis* (Haworth) Schultes in Roemer & Schultes, Syst. veg. 6: 37. 1820.—TYPE: unknown.

Orbea bisulca Haworth, Syn. pl. succ. 39. 1812. *Stapelia bisulca* (Haworth) Schultes in Roemer & Schultes, Syst. veg. 6: 37. 1820.—TYPE: unknown.

Orbea bufonia Haworth, Syn. pl. succ. 40. 1812. *Stapelia bufonia* (Haworth) Sims, Bot. Mag. 40: t. 1676. 1814 (as "*Stapelia bufonis*"), non *Stapelia bufonia* Jacquin, 1806–1819.—TYPE: unknown.

Orbea curtisii Haworth, Syn. pl. succ. 40. 1812. *Stapelia curtisii* (Haworth) Schultes in Roemer & Schultes, Syst. veg. 6: 38. 1820. *Stapelia variegata* var. *curtisii* (Haworth) N. E. Brown, Hooker's Icon. Pl. 20: sub t. 1907. 1890.—TYPE: Botanical Magazine 1: t. 26. 1787.

Orbea anguinea Haworth, Syn. pl. succ. 41. 1812.—TYPE: unknown.

Orbea retusa Haworth, Syn. pl. succ. 41. 1812. *Stapelia retusa* (Haworth) Schultes in Roemer & Schultes, Syst. veg. 6: 41. 1820. *Stapelia variegata* var. *retusa* (Haworth) N. E. Brown, Fl. cap. 4(1): 1003. 1909.—TYPE: unknown.

Orbea woodfordiana Haworth, Syn. pl. succ. 42. 1812. *Stapelia woodfordiana* (Haworth) Schultes in Roemer & Schultes, Syst. veg. 6: 41. 1820.—TYPE: unknown.

Stapelia obliqua Willdenow, Enum. pl., Suppl. 13. 1814. *Tromotriche obliqua* (Willdenow) Sweet, Hort. Brit., ed. 1: 278. 1826.—TYPE: based on plants cultivated at the Botanical Garden in Berlin (holotype: B-W 5312).

Orbea inodora Haworth, Suppl. pl. succ. 12. 1819. *Stapelia inodora* (Haworth) Decaisne in DC., Prodr. 8: 661. 1844.—TYPE: unknown.

Stapelia atropurpurea Salm-Dyck, Hort. dyck. 372. 1834. *Stapelia variegata* var. *atropurpurea* (Salm-Dyck) N. E. Brown, Fl. cap. 4(1): 1005. 1909.—TYPE: unknown.

Stapelia atrata Todaro, Hort. bot. panorm. 1: 50. 1877. *Stapelia variegata* var. *atrata* (Todaro) N. E. Brown, Fl. cap. 4(1): 1006. 1909.—LECTOTYPE, here designated: Todaro's illustration accompanying the description.

Stapelia scutellata Todaro, Hort. bot. panorm. 1: 52. 1877.—LECTOTYPE, here designated: Todaro's illustration accompanying the description.

Stapelia horizontalis N. E. Brown, Hooker's Icon. Pl. 20: t. 1907. 1890. *Stapelia variegata* var. *horizontalis* (N. E. Brown) N. E. Brown, Fl. cap. 4(1): 1001. 1909.—TYPE: based on cultivated plants, *Barkly 4* (holotype: K).

Stapelia variegata var. *pallida* N. E. Brown, Hooker's Icon. Pl. 20: sub t. 1907. 1890.—TYPE: based on cultivated plants from Port Elizabeth, South Africa, *sub Barkly 2* (holotype: K).

Stapelia scylla Sprenger in Cat. Dammann & Co: 120. 1894.—TYPE: unknown.

Stapelia hispida Horn ex Rüst, Monatsschr. Kakteenk. 6: 37. 1896.—TYPE: unknown.

Stapelia natalensis Rüst, Monatsschr. Kakteenk. 6: 37. 1896.—TYPE: unknown.

Stapelia variegata var. *prometheus* Rüst, Monatsschr. Kakteenk. 6: 37. 1896.—TYPE: unknown.

Stapelia ciliolulata Todaro ex Rüst, Monatsschr. Kakteenk. 6: 38. 1896.—TYPE: unknown.

Stapelia atrata var. *tigrina* Rüst, Monatsschr. Kakteenk. 6: 38. 1896.—TYPE: unknown.

Stapelia atrata var. *proboscidea* Rüst, Monatsschr. Kakteenk. 6: 39. 1896.—TYPE: unknown.

Stapelia variegata var. *brevicornis* N. E. Brown, Fl. cap. 4(1): 1003. 1909.—TYPE: without locality, *Chalwin sub Pillans 47* (holotype: BOL!).

Stapelia variegata var. *laeta* N. E. Brown, Fl. cap. 4(1): 1004. 1909.—TYPE: SOUTH AFRICA. Cape Province: Robben Island, *Pillans 24* (lectotype, here designated: BOL!).

Stapelia variegata var. *asparagensis* H. Jacobsen, Sukkulenten 206. 1933.—TYPE: unknown.

Small succulent forming clumps 5–20 cm (–1 m) in diameter, not rhizomatous. Stems 2.5–10 cm long, 0.5–1 cm in diameter (excluding teeth), (shortly) decumbent, green mottled with purple-brown; tubercles 3–9 mm long, arranged loosely into 4 obtuse rows along stem with a groove between rows, tapering to a spreading to ascending conical acute tooth, often with a minute denticle on either side near apex. Inflorescence 1 per stem near base, of 1–3 flowers developing successively from a short peduncle (to ± 10 mm long), with a few small subulate bracts (<1.5 mm long); pedicel 20–60 mm long, 2–3 mm in diameter, horizontal usually with ascending apex holding flower facing upwards, pale green to pinkish streaked with red-purple. Sepals 5–8 mm long, 2–3 mm wide at base, ovate to ovate-lanceolate, acute to acuminate. Corolla 5–8 cm in diameter, ± rotate; outside smooth, pale cream-green becoming veined with red-purple towards tips of lobes; inside rugulose on annulus, transversely rugulose on lobes, becoming nearly smooth towards tips

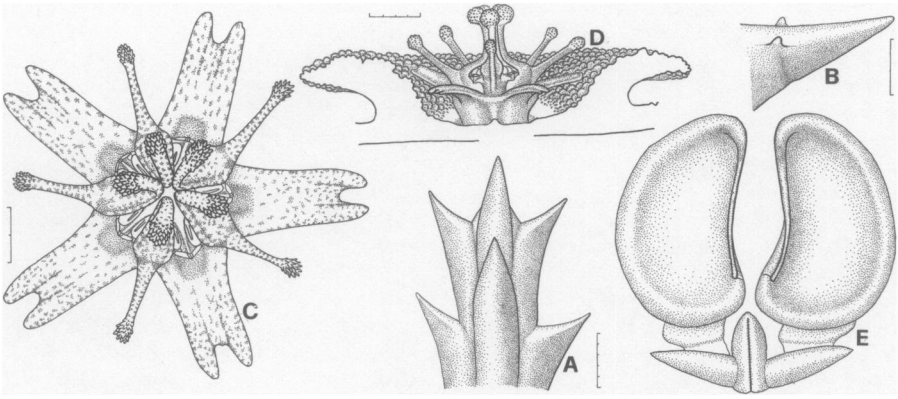

FIG. 91. *Orbea variegata.* A. Portion of stem. B. Leaf rudiment. C. Face view of gynostegium. D. Side view of center of dissected flower. E. Pollinarium. Scale bars: A, 5 mm; B, 1 mm; C, 2 mm; D, 4 mm; E, 0.25 mm (at B). [Based on: A, B, D, *Bruyns 7126*; C, *Bruyns 6261*.]

as well as base of tube and behind rim of annulus, cream to greenish yellow variously spotted with purple-brown, with fewer and finer dots on annulus; tube shallowly bowl-shaped, formed by annulus around gynostegium, annulus pentagonal to circular and 18–23 mm in diameter, shallowly bowl-shaped with spreading to recurved and thinner rim, with dense patch of short erect cylindrical bristles in base around gynostegium; lobes 16–25 mm long, 12–21 mm wide at base, ovate, acute to shortly acuminate, spreading to slightly recurved, margins eciliate. Corona ± 8 mm tall, 12–15 mm in diameter, raised above base of tube on a short cylindrical stipe <1 mm tall; outer lobes 4–6 mm long, 2 mm wide at base, ascending spreading, linear-oblong narrowing slightly towards 2–3-toothed apex, slightly thicker along center than towards sides, cream dotted with purple-brown (larger purple-brown patch at base under guide-rail); inner lobes 3–4 mm long, adpressed to backs of anthers, then rising up connivent-erect in center and recurved towards tips, dorsiventrally flattened and ovate near base, then narrowing to nearly terete and with clavate-tuberculate apex, with an ascending slightly spreading laterally flattened dorsal horn up to 3–4 mm long below level of anthers, also with the apex clavate-tuberculate, cream dotted with purple-brown. Figs. 3A, 91.

Distribution (Fig. 89). South Africa; 5–1000 m.

Orbea variegata is widespread in the southwestern Cape, with its northernmost stations around Lambert's Bay and Clanwilliam, so that it remains somewhat south of Namaqualand, where increasing aridity is obviously a limiting factor. From here it is found southwards to the hills around Cape Town and along the Cape Peninsula to near its southern tip; it is the only stapeliad to occur on the peninsula. Further eastwards it grows on the coastal plain south of the Langeberg to Riversdale, Mosselbay, Humansdorp, and near Hankey. There are also scattered records from the Karoo around Worcester and on the southern parts of the Great Karoo, e.g., Matjiesfontein (White & Sloane 1937: Fig. 673) and specimens from Willowmore and Steytlerville (Leach 1978). Some of these might well represent escapes from local gardens in which it is frequently cultivated, rather than records of naturally occurring populations.

Orbea variegata generally grows on gentle (rarely steep), stony slopes, sometimes under bushes but also more or less fully exposed on rock slabs or ledges.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** CAPE PROVINCE: [3217] Vredenburg [-DD], *Horrocks 180* (NBG). [3218] W of Leipoldtville [-AB], *Bruyns 6352* (BOL); Kliphoutkop [-AD], *Bruyns 6179* (BOL); 14 miles E of Lambert's Bay [-BA], *Bayliss 82* (NBG); Clanwilliam [-BB], *Hardy & Bayliss 1061* (PRE); St Helena Bay [-CC], *Bruyns 4571* (BOL); 9.5 miles S of Redelinghuys [-DA], *Acocks 19699* (PRE); betw Piquetberg Village & Rly. Stn. [-DD], *E Pillans sub N Pillans 199* (BOL). [3318] Slangkop [-AD], *Maynard s.n.* (BOL); Lion's Head [-CD], *Bolus 4773* (BOL); *MacOwan 920* (BOL, G); Robben Island [-CD], *Pillans 82* (BOL); *Walgate 610 & 655* (NBG); Signal Hill [-CD], *Marloth 141* (PRE); Table Mountain [-CD], *Barnard* (SAM); between rocks on shore, Camps Bay [-CD], *C. A. Smith 2622* (PRE); Mamre Hills, Malmesbury [-DC], *v. Niekerk 270* (NBG). [3319] Karoo Botanical Garden [-CB], *Thudichum s.n.* (NBG); Worcester Nature Reserve [-CB], *Olivier 211* (PRE). [3323] Willowmore, outskirts of town [-AD], *Crampton 62* (GRA). [3324] near Steytlerville [-AD], *Reynolds 587* (BOL, PRE); Holrivier [-DC], *Bruyns 7126* (MO). [3418] 0.25 miles S of Fish Hoek Stn. [-AB], *Pillans 141* (BOL); Llandudno [-AB], *Stephens s.n.* (BOL); Slangkop [-AD], *Bond 1494* (NBG); western slopes of Skurf Kop [-BB], *Pillans 1552* (BOL). [3419] Hermanus [-AC], *Bolus 107* (BOL); Hermanus-petrusfontein [-AC], *Gray sub PRE 11604* (PRE). [3420] 3 km SE of Askraal [-BB], *Bruyns 6261* (BOL); Heidelberg [-BB], *Kramer S2* (PRE). [3421] Soetmelks Riv. [-AB], *Anon s.n.* (PRE); Albertinia [-BA], *Hall s.n.* (NBG); Gouritz Riv. Br. [-BA], *Leach 8494* (SRGH); Oude Tuin [-BA], *Muir 1232* (PRE); Herbertsdale [-BB], *Wisura 2189* (NBG). [3422] Brandwag [-AA], *Acocks 21330* (PRE); Mossel Bay [-AA], *E Pillans sub N Pillans 1550* (BOL). [3424] Humansdorp [-BB], *Bolus 273* (BOL).

Orbea variegata has fairly large, flat flowers, which are extremely variable in color; a wide selection of variants was illustrated by White and Sloane (1937). The center of the corolla is more or less flat, but near its base there is an additional ringlike annulus, which rises out of the surface and spreads outwards. While not quite as massive as that in *O. ciliata*, this annulus still manages to form a bowl-shaped tube that contains most of the gynostegium. It is thickest at its base and becomes progressively thinner towards its edge. In the base of this tube around the foot of the gynostegium is a dense ring of small, cylindrical hairs. Most of the inside of the corolla is covered with raised, finely papillate, irregularly transverse ridges, which gradually fade out towards the tips of the lobes.

Orbea variegata is closely related to *O. namaquensis* (no. 53, Fig. 90), which occurs to the north in the much more arid parts of Namaqualand; differences between them are discussed under that species. To the east and partly overlapping with its distribution are the other closely related species *O. pulchella* and *O. verrucosa*. From both of these *O. variegata* differs by the generally larger flowers with their much more developed annulus and the considerably longer outer and inner corona lobes.

Over its long history, there has been more unjustified and pointless "splitting" of *O. variegata* than of any other stapeliad (Leach 1978). Many of the authors of these names have themselves cast doubt on whether they are distinguishable with any certainty from *O. variegata*, but White and Sloane (1937) still managed to construct a key to many of these "varieties." Yet, they also pointed out the extent of the variability of the species, how many of these variants had been found cohabiting within an area of a few square meters, and that the same plant even produces rather different flowers on occasion.

The typification of the names *Stapelia planiflora* var. *marginata* and *Stapelia marginata* is based on annotations in Willdenow's hand of a specimen in the Willdenow Herbarium. The sheet, B-W 5303, bears a label with "*planiflora* β" struck out with a single line below which is written "*Stapelia marginata.*" Willdenow published the varietal name in his *Enumeratio plantarum* (1809). The name *Stapelia marginata* was included in an incomplete manuscript that was intended as a supplement to this work, which was edited and published by Schlechtendal (Willdenow 1814) after Willdenow's untimely death. Because the type for the two names is unequivocal, *Stapelia marginata* is here considered a new combination instead of a new name, although the varietal name is not mentioned in the account of *Stapelia marginata* in the *Supplementum*.

55. Orbea conjuncta (A. C. White & B. Sloane) Bruyns, Aloe 37: 74. 2001. *Stultitia conjuncta* A. C. White & B. Sloane, J. Cact. Succ. Soc. Amer. 10: 69. 1938. *Orbeanthus conjunctus* (A. C. White & B. Sloane) L. C. Leach, Excelsa Taxon. Ser. 1: 73. 1978.—TYPE: based on cultivated material provided by H. Herre of Stellenbosch (holotype: not located).—SOUTH AFRICA. Transvaal: hills above Mara, *Crundall s.n.* (neotype, here designated: PRE!).

Dwarf succulent forming sprawling mats from 10 cm to 2 m in diameter or hanging from ledges on rocky outcrops or cliffs, not rhizomatous. Stems 5–20 cm long, 0.6–1 cm in diameter (excluding teeth), prostrate, branching all along length, grey-green mottled with dark green to purple; tubercles 2–6 mm long, arranged very loosely into 4 rows along stem with a slight groove between rows, tapering to a deltoid acute ± conical spreading tooth, without stipular denticles. Inflorescence 1 (–2) per stem usually towards base, of 1 (–2) flowers developing in gradual succession from a very short peduncle, with few minute lanceolate bracts (<1.5 mm long); pedicels 8–14 mm long, 1.5–3.0 mm in diameter, slightly ascending, holding flower facing partly upwards. Sepals 3–5 mm long, 2 mm wide at base, ovate-lanceolate, acuminate. Corolla 2–3.3 cm long, 2.2–4.2 cm wide, bicampanulate; outside smooth, cream suffused with pink; inside on lower tube annulus and base of upper tube maroon to deep pink, rest of tube and lobes cream (base sometimes also maroon); tube 12–18 mm deep, cupular, slightly narrowing towards mouth, at base with a further (lower) bowl-shaped tube 5–7 mm long and 10–15 mm in diameter formed by an inward-pointing pentagonal annulus 2–3 mm in diameter; lobes 6–17 mm long, 9–15 mm wide at base, ascending to spreading, deltate, acute, somewhat concave above, with sutures running from the base of the lobes a further 5–10 mm down along tube (so that the tube is partly formed from fusion of lobes, the lobes thus really 11–20 mm long), margins eciliate. Corona 5–7 mm tall, 9–10 mm in diameter, raised above base of tube on a very short stipe (<1 mm long) usually just included within lower tube; outer lobes 3–6 mm long, ascending with the apex spreading, deeply bifid (often to near base) into widely diverging lanceolate obtuse dorsiventrally-flattened lobules, lobules from adjacent lobes usually adpressed to one another, deep pink to maroon speckled with white towards base, papillate-pubescent towards the apex, covered with droplets of sweat-like secretion around gynostegium above base of inner lobes; inner lobes ± 1 mm long, adpressed to backs of anthers and sometimes exceeding them (to meet and rise up slightly in center), dorsiventrally slightly flattened with a small obtuse basal dorsal gibbosity connected to outer series, deep pink to maroon spotted with white, finely papillate especially towards the apex. Figs. 2D, 4C, 92.

Distribution (Fig. 93). South Africa; 900–1600 m.

Orbea conjuncta is widely distributed and quite common in the Soutpansberg and in the Blouberg, two ranges of sandstone mountains close to the northern border of the Transvaal in South Africa.

Plants have repeatedly been collected "on ledges on steep rock cliffs" (Leach 1978); but this is mainly the case in Wyllies Poort, the type locality where practically all earlier collections were made. Recent investigations have shown that *O. conjuncta* is mostly found on the southern aspects of the mountains, usually relatively high up on gentle to steep slopes, with the stems creeping among leaf litter under bushes or trees. In many localities in the Soutpansberg (particularly east of Soutpan) it is associated with forests of the euphorbiaceous tree *Androstachys johnstonii* (the Lebombo ironwood).

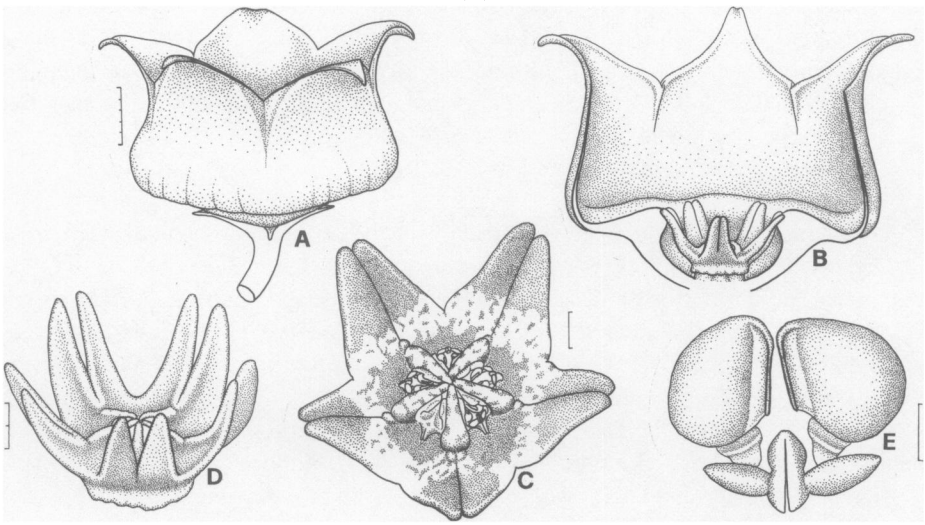

FIG. 92. *Orbea conjuncta.* A. Side view of flower. B. Side view of dissected flower. C. Face view of gynostegium. D. Side view of gynostegium. E. Pollinarium. Scale bars: A, B, 5 mm; C, 1 mm; D, 2 mm; E, 0.25 mm. [Based on: A, C, E, *Bruyns 4477*; B, D, *Bruyns 6570*.]

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** TRANSVAAL: [2229] Robertson [-DC], *Bruyns 7010* (NBG); Wyllie's Poort [-DD], *Bayliss* (NBG). [2230] S of Nzhelele [-CC], *Bruyns 7467* (BOL). [2328] Buffelshoek [-BB], *Bruyns 6990* (BOL, K). [2329] Bergfontein [-AB], *Bruyns 6570* (BOL).

Orbea conjuncta is closely allied to *O. hardyi*, and both of them are distinguished from all other species in the genus by their prostrate stems and the manner in which the corolla lobes remain fused at the base. The two species are easily distinguished by the conspicuously bicampanulate flower in *O. conjuncta* and the much longer inner corona lobes in *O. hardyi*, which rise above the center of the flower and diverge with swollen, bristly tips.

In *O. conjuncta* the base of the corolla consists of a bell-shaped cup, whose mouth is greatly constricted on the inside by a thick, inward-pointing annulus. Beyond this annulus the tube is abruptly much broader but narrows again towards the mouth from which the deltate lobes (which are noticeably concave inside) spread outwards. The corolla is therefore bicampanulate. It is also noteworthy that the upper bell is not part of the true corolla tube, which lies below the annulus, but is formed by partial fusion of the corolla lobes.

In young buds (say, 10 mm long) the lobes occupy 7 mm (i.e., most) of the length of the flower, with clear sutures visible along the exterior where they are fused; however, when the flower ultimately opens the lobes occupy much less than half the length of the corolla. This is not due to changes in the rates of growth of the different parts but by the lobes' remaining fused towards their base, so that this fused part adds to the length of the tube. In the mature flower traces of this fusion are still visible on the inside as a raised ridge and on the outside as a groove, as White and Sloane (1938) pointed out.

The outer corona lobes ascend steeply and press against the inner rim of the annulus. They are deeply bifid, with the lobules that this produces diverging widely, so that those from adjacent lobes are paired behind the anthers, thus giving the appearance of outer lobes opposite the anthers. Both series of corona lobes are covered with fine transparent

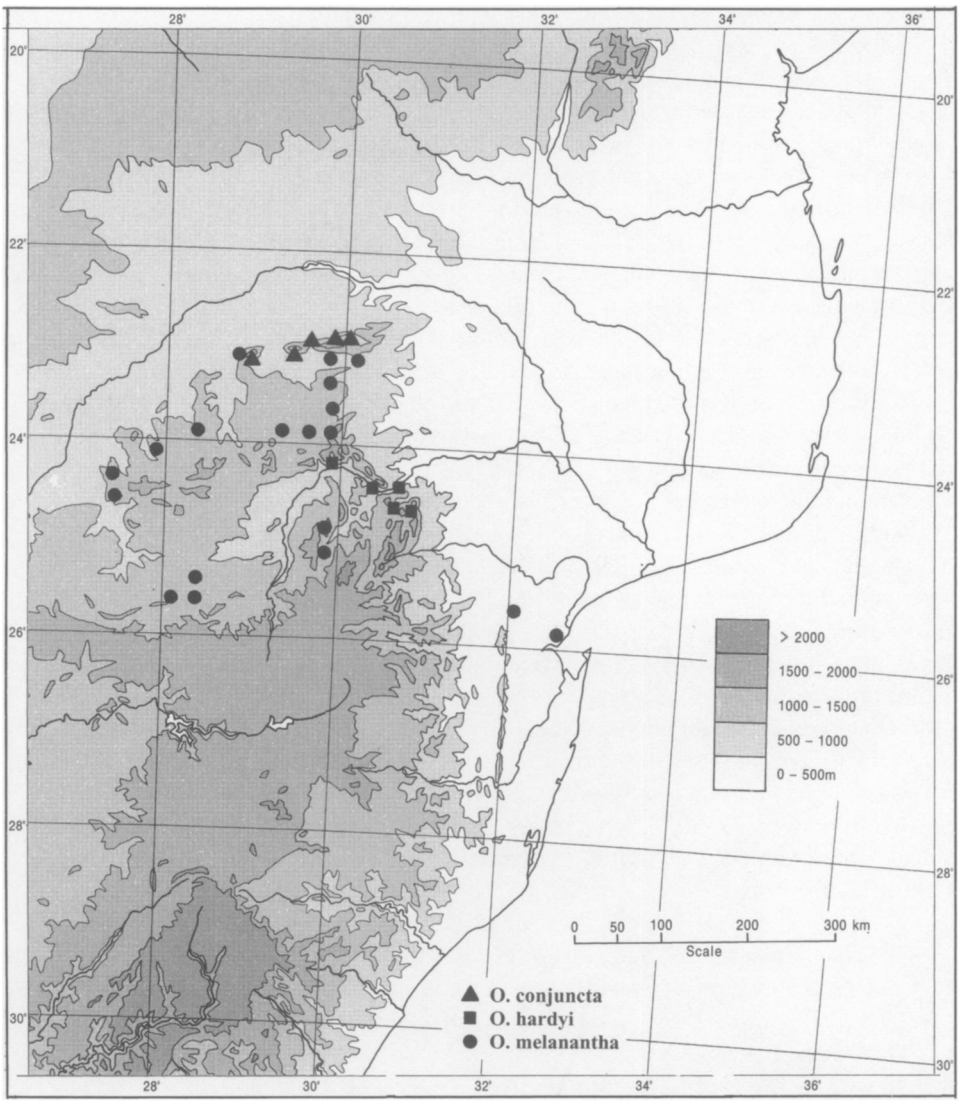

FIG. 93. Distribution of *Orbea conjuncta*, *O. hardyi*, and *O. melanantha*.

papillae, which lend them a furry appearance. There are usually several large drops of nectar secreted on the outer lobes just above where they are fused to the inner lobes.

56. Orbea hardyi (R. A. Dyer) Bruyns, Aloe 37: 74. 2001. *Stultitia hardyi* R. A. Dyer, Fl. Pl. Africa 36: t. 1403. 1963. *Orbeanthus hardyi* (R. A. Dyer) L. C. Leach, Excelsa Taxon. Ser. 1: 74. 1978.—TYPE: SOUTH AFRICA. Transvaal: "Wyllies Poort" [see discussion], *Hardy et al. sub PRE 29028* (holotype: PRE!).

Dwarf succulent forming sprawling mats from 10 cm to 1 m in diameter or more, not rhizomatous. Stems 3–15 (–30) cm long, 0.6–1.2 cm in diameter, slender, prostrate,

branching all along length (branches breaking off extremely easily), green with longitudinal purple-brown stripes and blotches; tubercles 1–3 mm long (nearly obsolete and stems ± square-cylindrical in cross-section when turgid), arranged very roughly into 4 rounded angles without a groove between angles, tapering abruptly into short conical tooth without stipular denticles. Inflorescence 1 (–2) per stem usually towards base, of 1–2 flowers opening in gradual succession from a short peduncle (1–2 mm long), with a few minute lanceolate bracts (<1 mm long); pedicels 5–8 mm long, 1.5–2.0 mm in diameter, ascending, holding flower ± facing upwards. Sepals 2.5–6.0 mm long, 1.5 mm wide at base, ovate-lanceolate, acuminate. Corolla 4–7.5 cm in diameter, rotate to very shallowly bicampanulate with the united portion shallowly plate-like to abruptly bowl-shaped (up to 8 mm deep below lobes); outside smooth, cream suffused with purplish; inside with clavate maroon to white papillae up to 1–2 mm long on proximal half of lobes and 3–5 mm of united area below lobes, otherwise smooth, purple-red to maroon on lobes becoming coarsely mottled with cream towards the base, purple-red to brighter red and more finely spotted with cream on annulus, cream in tube; tube ± 3 mm long, 15–25 mm in diameter, very shallowly cupular to nearly flat, with further tubelet around gynostegium 2–3 mm long and 6–8 mm in diameter formed by a circular annulus ± 2 mm in diameter with inward-pointing edge; lobes 13–25 mm long, 11–20 mm wide at base, spreading to recurved, ovate, acuminate, flat to very slightly concave above, with sutures running from the base a further 2–3 mm down tube, margins eciliate. Corona ± 7 mm tall, 8–9 mm in diameter, raised above base of tube on a short pentagonal stipe ± 1 mm tall; outer lobes 2–3 mm long, ascending then spreading just beyond mouth of tube or adpressed to annulus just outside tube, dorsiventrally flattened, bifid to near base into somewhat divergent obtuse lobules, cream spotted with purple-red, with purple-red margins, papillate-pubescent towards the apex; inner lobes 4–5 mm long, adpressed to backs of anthers, then connivent-erect and diverging towards slightly clavate apices, cream dotted with purple-red, papillate-pubescent especially towards the maroon apex. Fig. 94.

Distribution (Fig. 93). South Africa; 900–1500 m.

Orbea hardyi occurs southeast of Pietersburg in the mountainous area along the Olifants River and southwards to the western edge of the Blyde River Canyon.

Orbea hardyi may grow on the floor of dry forest on south-facing slopes in accumulated leaf litter. Plants also occur on cliffs and rock outcrops where, on exposed slopes, they have even been seen wedged tightly into crevices with *Selaginella* and various other succulents.

ADDITIONAL SPECIMENS EXAMINED. **South Africa.** TRANSVAAL: [2429] Bewaarskloof [-BB], *Bornmann s.n.* (PRE). [2430] Penge [-AD], *Bruyns 2039* (BOL, NBG); Abel Erasmus Pass [-BC], *Percy-Lancaster 131* (SRGH); Branddraai [-DA], *Bruyns 6606* (MO); Kasper's Nek [-DA], *v. d. Merwe sub K 176* (KIEL); Moremala [-DB], *Bruyns 7020* (K).

Flowers of *O. hardyi* are comparatively large (up to 7.5 cm in diameter) and almost flat to shallowly bowl-shaped when fully open. The center of the flower is dominated by a somewhat raised, cushion-like annulus. This annulus lies inside a very shallowly cupular tube, so that the annulus (as in *O. conjuncta*) forms another tube around the gynostegium. Thus, strictly speaking, the corolla in *O. hardyi* is also bicampanulate, but this is not as obvious as in *O. conjuncta* as the outer tube is generally very shallow. If the flower is dissected it is then clear how the edges of the annulus project inwards towards the cen-

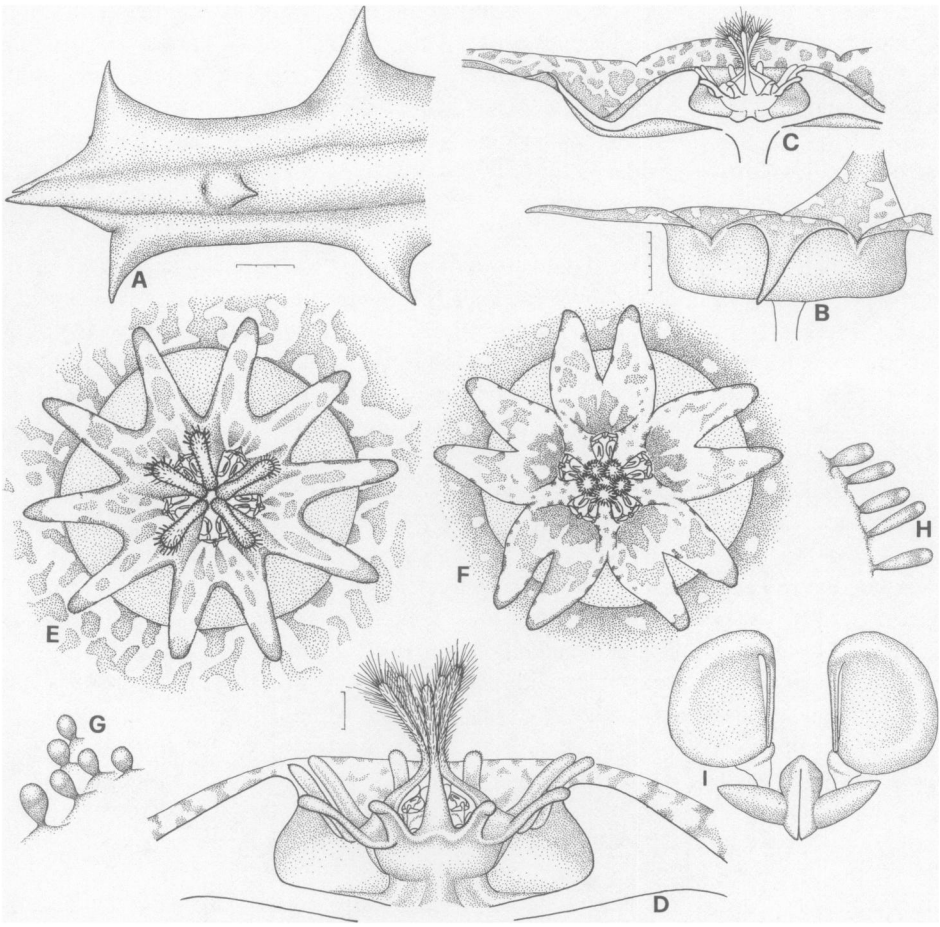

FIG. 94. *Orbea hardyi.* A. Portion of stem. B. Side view of somewhat cupular flower. C. Side view of dissected flower. D. Side view of gynostegium and center of dissected flower. E, F. Face views of gynostegium. G, H. Papillae borne at base of lobes on inside of corolla. I. Pollinarium. Scale bars: A, 3 mm; B, C, 5 mm (at B); D–F, 1 mm (at D); G, H, 0.5 mm (at A); I, 0.25 mm (at A). [Based on: A, F, H, *Bruyns 2039*; B–D, I, *Bruyns 7020*; E, *Bruyns 2030*; G, *Bruyns 6606*.]

ter and cause a distinct narrowing in the mouth of this tube (Fig. 94C, D). The corolla is quite densely covered with little swollen papillae on the proximal half of the lobes and extending onto the often steep, united area below them, but not onto the annulus. These papillae are extremely variable in shape.

As in *O. conjuncta*, part of the tube is formed by the lobes remaining fused near the base at anthesis; however, in *O. hardyi* this zone of fusion is very much shorter than in *O. conjuncta* and is often quite indistinct.

On the corona many of the epidermal cells have their outer walls elongated into slender papillae, lending the surface a pubescent appearance. These papillae are fine and not easily visible on the outer lobes, where they are mainly confined to the margins and tips, but towards the tips of the inner lobes these "hairs" become clearly visible to the naked eye; they are more abundant, longer, and finer.

The type locality was given as "Wyllies Poort." According to annotations by R. A. Dyer on the type specimen, however, this is an error. This species is known only from the eastern Transvaal and has never been recorded again as growing with *O. conjuncta*, as had been noted by Dyer in the protologue of *Stultitia hardyi*.

II. Ballyanthus Bruyns, Aloe 37: 76. 2001.—TYPE: *Ballyanthus prognathus* (P. R. O. Bally) Bruyns.

The cladistic analysis carried out here showed that *B. prognathus* is not related to the other species that Leach placed in *Orbea*, nor is it related to the species now included in *Orbea* (Fig. 6). Bally (1962) thought this species had "its nearest affinity in the South African *Stapelia revoluta* Masson (now *Tromotriche revoluta* (Masson) Haw.)." Leach (1978) considered that it was "a somewhat anomalous species which fits best into *Orbea*," but he mentioned also that the pollinia are rather similar to those found in *Duvalia* and *Huernia*. The present analysis indicated that the species is part of the *Duvalia-Duvaliandra-Huernia* clade. It was therefore necessary to exclude it from *Orbea* as recognized here and to place it in a new genus.

Ballyanthus prognathus shares several characters of the pollinaria with the *Duvalia-Duvaliandra-Huernia* clade, and these characters are common also to *Duvaliandra* (Gilbert 1980). The pollinia are considerably longer than broad, are somewhat ellipsoidal, and have a thick insertion-crest exactly along the outer edge.

Ballyanthus prognathus shares with *Duvalia* the presence of a transverse projection on each inner corona-lobe, which is not to be confused with the transverse structures arising from the outer coronal series. Such transverse projections are not found in any of the species now included in *Orbea*. *Ballyanthus prognathus* also shares the terete stipe beneath the gynostegium with *Duvalia*. In all species of *Duvalia* the annulus rises vertically, forming a cup-like to V-shaped tube in the center of the flower. In *B. prognathus*, on the other hand, the annulus curves over towards the center, leaving a small, flat area at the base of the tube. In this respect the flower is similar to that of *Tromotriche revoluta* but there the similarities end. In addition, although the outer and inner coronas arise separately on the staminal column, as in both *Duvalia* and *Huernia*, in *B. prognathus* they are pressed tightly against one another and are not separated by some distance, as they are in all species of *Duvalia* and *Huernia*. In *B. prognathus* the gynostegium expands considerably around the edge of the style-head (Fig. 4D), so that the guide-rails are suspended over an open area and are not embedded in the tissue of the corona, as in all species of *Duvalia* and *Huernia*.

Duvaliandra differs from *B. prognathus*, *Duvalia*, and *Huernia* by the manner in which the tubercles on the stems are obtuse and do not taper into a leaf rudiment, and also by the nature of the two series of corona lobes, which are not separated on the gynostegium. The outer series in *Duvaliandra* is in fact much reduced below the guide-rails and forms a broad boss behind the each inner lobe. The inner lobes are fused into these bosses and rise from them onto the anthers.

This new genus is named for Peter R. O. Bally (1895–1980), who contributed much to the present knowledge of the succulent flora of the northeastern portion of Africa, and who had a particular interest in stapeliads. Although he does not seem to have discovered this species, he described it in 1962.

1. Ballyanthus prognathus (P. R. O. Bally) Bruyns, Aloe 37: 76. 2001. *Stapelia prognatha* P. R. O. Bally, Candollea 18: 339. 1962. *Orbea prognatha* (P. R. O. Bally) L. C. Leach, Kirkia 10: 290. 1975.—TYPE: SOMALIA. Gaan Libah [N 0944 DB], 09°35′N, 44°48′E, 23 Jul 1945, *Glover sub Bally S147* (holotype: K!; isotype: ZSS!).

Small succulent forming small clumps, not rhizomatous. Stems decumbent, often distinctly clavate, 2–6 cm long, 1–1.5 cm in diameter (excluding teeth), grey-green mottled with purple; tubercles 3–6 mm long, arranged into 4 obtuse angles along stem (stem ± square to rounded), tipped with spreading acuminate to acute tooth subtended by 2 small stipular denticles. Inflorescences 1–5 per stem borne mostly towards the apex (rarely near base), each with 1–6 flowers developing in gradual succession on a peduncle <5 mm long, with a few lanceolate acute bracts 1–2 mm long without lateral teeth; pedicel 8–25 mm long, 1.5 mm in diameter, ascending to hold flower facing upwards. Sepals 3–5 mm long, 1.0–1.5 mm wide at base, narrowly lanceolate, acuminate, spreading to reflexed. Corolla consisting mainly of a convexly reflexed disc 1.5–3.1 cm in diameter; outside purplish green, with 3–5 slightly raised darker veins on lobes and tube; inside dark dull bluish to brownish purple, smooth, near center abruptly thickened into inward-pointing annulus; tube ± 2 mm deep, formed entirely by the annulus, with a very constricted mouth close to gynostegium and below widening with ± flat broader base; lobes 6–10 mm long, 4–12 mm wide at base, deltate, margins reflexed and the lobes thus convex inside, with cilia 1–3 mm long at least in proximal half. Corona 2.0–4.5 mm tall, 3.5–4.5 mm in diameter, raised on a stout cylindrical stipe 0.8–1.5 mm long; outer lobes forming a pentagonal disc (0.5–1.0 mm wide) around gynostegium ± at level of mouth of tube and not attached to inner lobes, with 5 longer ± rectangular often emarginate "lobes" (slightly <1 mm long) beneath each guide-rail, dark purple; inner lobes 2–3 mm long, adpressed to backs of anthers (these ascending, not horizontal), then rising up connivent in a column in center, dorsiventrally flattened towards base (where ± 0.5 mm wide) and somewhat concave on outside, gradually tapering to terete obtuse tips, with narrowly deltate obtuse to emarginate dorsal projections spreading into gaps between outer "lobes," white suffused with pink. Figs. 4D, 95, 96.

Distribution (Fig. 26). Somalia; 1200–1800 m.

Ballyanthus prognathus is confined to northern Somalia, where it has been collected in a few localities along the southern foothills of the mountains north and northeast of

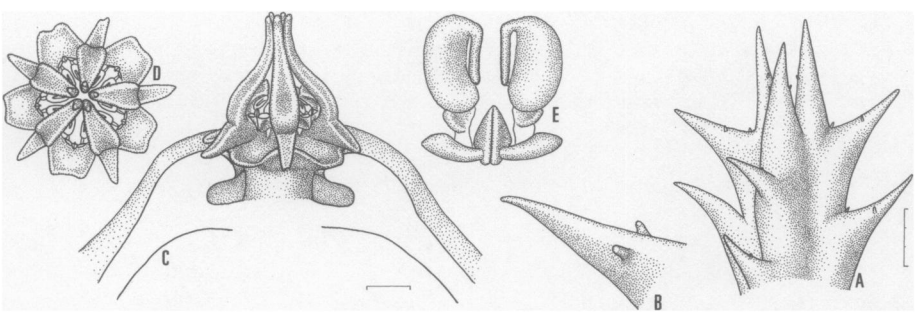

FIG. 95. *Ballyanthus prognathus.* A. Portion of stem. B. Leaf rudiment with stipular denticles. C. Side view of center of dissected flower. D. Face view of gynostegium. E. Pollinarium. Scale bars: A, 3 mm; B, 1 mm (at A); C, D, 1 mm (at C); E, 0.25 mm (at A). [Based on living material, ex hort. D. de Kock.]

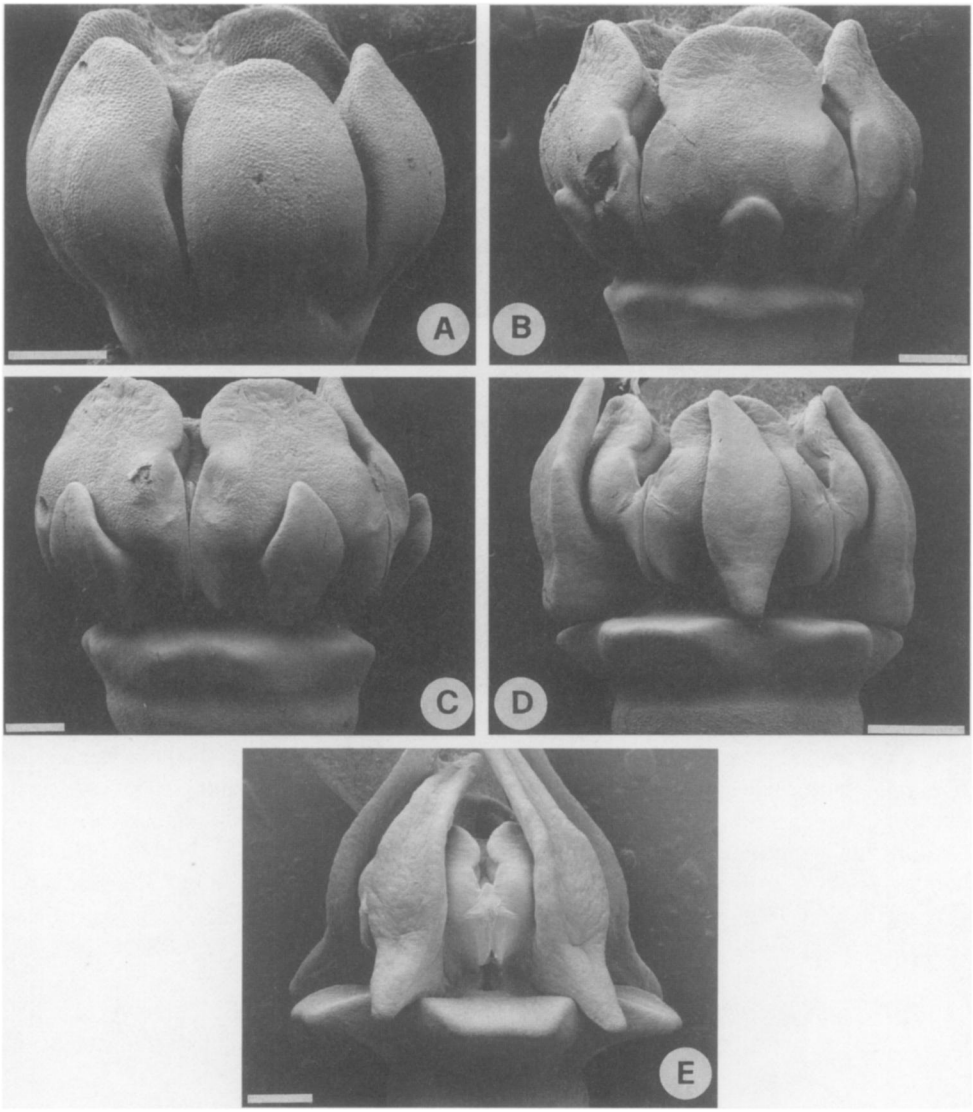

FIG. 96. Ontogeny of the corona in *Ballyanthus prognathus*. A. Outer corona only just visible as a ridge below guide-rails, inner corona not visible yet. B, C. Outer corona becoming ring-like, inner lobes appearing above it and entirely separate from it. D. Further development of corona. E. Mature corona. Scale bars: A–C, 250 μm; D, E, 500 μm. (From living material, ex hort. D. de Kock.]

Burao. Plants have been recorded among stones in *Juniperus* and *Buxus* forest growing in leaf litter.

ADDITIONAL SPECIMEN EXAMINED. **Somalia.** [N 0945] Meriye [-DD], 09°49′N, 45°56′E, NE of Burao, *Hemming s.n.* (PRE).

The nature and relationships of the various corona lobes in *B. prognathus* to one another had not been investigated and thus was not clearly understood by previous workers.

When viewed from above (as in Fig. 95D) the outer corona appears to consist merely of five broad and relatively short lobes between the inner lobes and beneath the guide-rails. Yet, if the structure is dissected carefully, it will be found that the outer corona forms a disc around the gynostegium more or less at the level of the mouth of the tube, and that this disc is attenuated beneath each guide-rail into a short "lobe" (which is the part seen from above). This outer coronal disc is entirely separate from the inner corona lobes, as shown in Fig. 4D. It is also clear from the ontogenetic series showing the development of the corona (Fig. 96). This ontogenetic series shows that, although the outer corona lobes begin as usual as a ridge between each anther, by lateral expansion they rapidly form a ringlike structure around the gynostegium, with the inner lobes above and separate from the ring. Thus, the part of the outer corona, which lies opposite the anthers, develops entirely from lateral spreading of the meristems of the outer corona. The inner corona consists of five lobes adpressed to the backs of the anthers. Since the anthers are ascending, rather than in the more usual horizontal position, the lobes ascend from the base and continue to rise into a column in the center. At their base there is a thick, spreading dorsal projection, which is adpressed to the outer coronal disc but not at all fused to it. The ontogenetic series makes it clear that this dorsal projection is derived from the same meristem as the inner lobe itself.

DOUBTFUL AND EXCLUDED NAMES

Caralluma ango (A. Richard) N. E. Brown, Gard. Chron., ser. 3, 12: 369. 1892. *Stapelia ango* A. Richard, Tent. fl. abyss. 2: 50. 1851.—TYPE: ETHIOPIA. Tigre region, Shire, *Quarton Dillon s.n.* (holotype: not located).—The application of this name is uncertain; see Gilbert (1978: pp. 39–40).

Caralluma longecornuta Croizat ex Gomes e Sousa, Moçambique Doc. Trim. 4: 44. 1935, nomen nudum.

Huernia engleri Terracciano, Annuario Reale Ist. Bot. Roma 5: 105. 1894.—TYPE: ERITREA. Crulli Island in Bay of Anfilah, *Terraciano s.n.* (holotype: not located).—The application of this name is uncertain; see Gilbert (1978: p. 50).

Orbea trisulca Haworth ex N. E. Brown, Fl. cap. 4(1): 997. 1909, pro syn.

Orbea wendlandiana Schultes in Roemer & Schultes, Syst. veg. 6: 834. 1820, pro syn.

Stapelia beffoniana Schultes in Roem. & Schultes, Syst. veg. 6: 49. 1820, nomen nudum.

Stapelia bidentata Salm-Dyck, Hort. dyck. 266. 1834, nomen nudum.

Stapelia bifolia Schultes in Roemer & Schultes, Syst. veg. 6: 49. 1820, nomen nudum.

Stapelia buffoniana G. Don, Gen. hist. 4: 117. 1837–1838, nomen nudum.

Stapelia ciliolata Todaro, Ind. Sem. panorm. 1861: 10. 1862, nomen nudum.

Stapelia deflexa Todaro, Hort. bot. panorm. 1: 50. 1877, nomen nudum.

Stapelia limosa Salm-Dyck, Hort. dyck. 266. 1834, nomen nudum.

Stapelia marmorata Hulle, Rev. Hort. Belge Etrangère: 193. 1889, nomen nudum.

Stapelia monstrosa Steudel, Nomencl. Bot., ed. 2, 2: 631. 1841, nomen nudum.

Stapelia mutabilis Hulle, Rev. Hort. Belge Etrangère: 193. 1889, nomen nudum.

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NUMERICAL LIST OF SPECIES

1. O. schweinfurthii
2. O. ubomboensis
3. O. araysiana
4. O. laticorona
5. O. abayensis
6. O. gilbertii
7. O. sprengeri
8. O. lugardii
9. O. gemugofana
10. O. huernioides
11. O. wissmannii
12. O. luntii
13. O. chrysostephana
14. O. baldratii
15. O. laikipiensis
16. O. decaisneana
17. O. sacculata
18. O. tubiformis
19. O. deflersiana
20. O. circes
21. O. dummeri
22. O. denboefii
23. O. distincta
24. O. carnosa
25. O. subterranea
26. O. wilsonii
27. O. semitubiflora
28. O. taitica
29. O. vibratilis
30. O. miscella
31. O. caudata
32. O. melanantha
33. O. albocastanea
34. O. knobelii
35. O. lutea
36. O. gerstneri
37. O. huillensis
38. O. valida
39. O. ciliata
40. O. halipedicola
41. O. semota
42. O. woodii
43. O. macloughlinii
44. O. longidens
45. O. maculata
46. O. paradoxa

47. O. cooperi
48. O. tapscottii
49. O. umbracula
50. O. rogersii
51. O. pulchella
52. O. verrucosa
53. O. namaquensis
54. O. variegata
55. O. conjuncta
56. O. hardyi
57. B. prognathus

INDEX TO NUMBERED COLLECTIONS

The numbers in parentheses refer to the corresponding species in the text and in the Numerical List of Species above.

(45c), 8253 (53), 8435 (4), 8454 (7c), 8497 (4), 8500 (9), 8509 (9), 8531 (44), 8676 (23), 8679 (22), 8683 (22), 8684 (23), 8695 (25), 8698 (21), 8699a (25), 8705 (21), 8705a (22), 8709 (21), 8709a (22), 8712 (21), 8713 (21), 8724 (1), 8727 (1), 8732 (1), 8735 (1), 8750 (2), 8920 (43).
Bullock 54 (35a), 116 (45a).
Bullock, E. J., & Bullock, W. (31b).
Burtt 1450 (41a).
Cameron 25 (31a).
Carter 85/2028 (15).
Carter & Stannard 630 (21).
Chase 4214 (24b), 7646 (49).
Chevalier 1145 (16), 3489 (16).
Christiaensen 786 (41a).
Codd & Dyer 9110 (32).
Codd & Erens 2064 (24a).
Codd 3722 (32), 3740a (24a), 5237 (50), 5487 (35a), 5946 (24b), 7485 (38a), 7595 (31b), 7720 (24b), 8777 (32), 8900 (45a), 8908 (48), 8921 (34).
Collenette 2222 (7d), 2223 (19), 2618 (7d), 2818 (7d), 2976 (7d), 3292 (7d), 3518 (11c), 3628 (11a), 3739 (7d), 4472 (7d), 5441 (11a), 6764 (7d), 7870 (7d).
Compton 20657 (53), 22796 (53), 28234 (35a), 9647 (39).
Cooke sub KMG 7956 (34).
Crampton 62 (54), 153 (51), 156 (52).
Cronwright 74 (42).
Darvall 4 (4), 5 (4).
da Tôrre, R. 4 (31a).
de Kock 350 (51), 352 (36a).
de Sousa 226 (44), 227 (44), 233 (44), 247 (46), 249 (44), 252 (44).
de Wet sub PRE 22712 (46).
de Wilde & Gilbert 6481 (7c).
de Wilde sub Gilbert 1852 (7c).
de Winter 2586 (34b), 7481 (34).
de Winter & Giess 6880 (35b).
de Witte 1023 (1), 8587 (1).
Deflers 1071 (13).
Dinter 1056 (35b), 1502 (35b), 2105 (33), 2255 (35b), 2597 (45c), 2597a (45c), 2598 (35b), 6783 (8).
Drake-Brockman 129 (17).
Drummond et al. 6919 (1).
du Preez 1299 (35a), 2400 (47), 2735 (47), 2738 (47).
During sub PRE 7200 (24b).
Dyer 1050 (47), 1616 (52), 1923 (35a).
Eggeling 940 sub Bally S 21 (9).
Erens 449 (35a).
Eyles 22 (35a), 7630 (50), 7632 (31b), 8763 (35a).
Fanshawe 5942 (37a), 6234 (1).
Font Quer 354 (16).
Foresti 824 (22).
Foster sub BOL 21311 (24b).
Frandsen sub Leach 14876 (42), 14913 (42).
Galpin 6942 (52).
Gerstner 740 (36a), 794 (24b), 3900 (24b).
Giess 1990 (35b), 8630 (8), 9051 (8), 11371 (38a).
Giess & Hardy 8470 (35b).
Gilbert 1648 (17), 2288 (20), 2298 (7b), 3450 (20), 3891 (5).
Gilbert & de Wilde 2287 (17), 2297 (7b).
Gilbert, M. G. & Gilbert, S. 1731 (9), 1383 (4).
Gilbert et al. 5430 (15).
Gilbert sub K 13207 (7a), 53698 (7b).
Glover sub Bally S147 (57).
Gossweiler 2098 (37a), 12612 (37a).
Gray sub PRE 11604 (54).
Greenway 4260 (23), 4592 (41a), 4600 (21).
Greenway & Kanuri 13479 (27).
Greenway sub K 5295 (29), 6735 (29).
Hall 109 (45a), 200 (53), 1689 (35a), 1960 (45c).
Hall & Carp sub Compton 44690 (49).
Hall sub NBG 253/53 (8), 476/55 (8).
Hanekom 562 (35a).
Hardy 50 (39), 397 (49), 936 (24a), 2150 (35b), 5409 (2), 5433 (50), 5555 (50), 6310 (8).
Hardy & Bayliss 1061 (54).
Hardy & de Winter 1509 (45c).
Hardy & Vahrmeijer 1636 (44).
Hardy et al. sub PRE 29028 (56).
Harries sub Galpin 6308 (35a).
Harris 67 (47).
Hartmann 6620 (21).
Hartmann & Newton 21398 (9).
Heath & Powys 790 (22).
Hiemstra 183a (39).
Holloway 404/2/45 (50).
Horrocks 180 (54).
Hutton 5 (52).
I.I.C.M. 13 (32).
James sub BOL 25435 (30).
Jarrett 441 (1).
Joanna sub Bally S 4 (25), S 20 (25).
Joubert 48s (47).
Joy Bally sub Bally S 30 (25), S 159 (25).
Keith sub PRE 19790 (24b).
Kies & Bruce 32 (32).
Kimberley 13 (49).
Kirsten 2 (32).
Kirsten sub STE 5881 (32).
Knobel 2 (50), 3 (45a).
Knobel sub KMG 3421 (45a).
Knobel sub PRE 8308 (34).
Kohler sub Giess 9207 (38a).
Kramer S2 (54).
Lang sub Tvl. Mus. 30618 (35a), 31804 (35a).
Lavranos 1788 (19), 1933 (12), 7308 (17).
Lavranos & Bavazzano 8524 (10).
Lavranos & Newton 13140 (11c).
Lavranos sub Bally 16017 (14b).
Lavranos, Bavazzano & Bilaidi 8602 (3).
Leach 5430 (45a), 5525 (24b), 5811 (38a), 5818 (35a),

5822 (40), 8494 (54), 8542 (51), 8847 (52), 9512 (52), 9757 (32), 9761 (31b), 9766 (31b), 9770 (35a), 9815 (24b), 9943 (48), 9970 (48), 9977 (48), 9981 (48), 10544 (24b), 10590 (24b), 10680 (50), 12059 (31b), 12066 (24b), 12123 (1), 12152 (24a), 12261 (32), 13646 (45a), 14740 (45a), 15108 (24b), 16892 (39).

Leach & Bayliss 11739 (46), 11935 (46), 12065 (35a), 12083 (32), 12101 (24b), 12443 (35a), 12444 (35a), 12448 (48), 12452 (48), 12515 (35a), 12633 (52), 13029 (35b), 13031 (35b), 13032 (35b), 13034a (35b), 13035 (35b), 13041b (35b), 13054 (35b).

Leach, Bayliss & Lamont 12453 (35a), 12464 (35a), 12472 (35a), 12483 (35a), 12485 (35a).

Leach & Brunton 10078 (32a), 10139 (1).

Leach & Bullock 13145 (31b).

Leach & Cannell 13803a (35a), 14039a (35b).

Leach & Mockford 12298 (45a).

Leach & Noel 101 (35a), 122 (35a), 212 (35a), 231 (48), 9031 (45a).

Leach & Pienaar 5584 (49).

Leach et al. 12467 (48), 12475 (48), 12489 (35a).

Lebrun 5923 (41a), 7669 (1), 9523 (41a).

Leendertz 1279 (32).

Leistner, 794 (51), 1256 (35a), 1412 (35a), 1413 (47), 1415 (35a), 1796 (8), 1837 (8), 2080 (34), 2215 (34), 2226 (34), 2306 (47).

Lejoly 230/83 (16).

Lemos 113 (2).

Liben 639 (1).

Liversedge sub Plowes 2656 (49).

Long sub Parks 81/40 (30).

Lubbers sub Leach 14742 (43).

Lugard 297 (45a), 307 (35a).

Luke 5511 (41b), 5561 (28).

Lunt 209 (12).

M.-Hohenstein & Deil 516 (11a), 1963 (19).

MacArthur sub Bally S 42 (25).

MacOwan 920 (53), 2177 (52).

Maguis sub Hepper & Field 5108 (25).

Malcolm sub Herb. Moss 19622 (35a).

Marloth 141 (54), 3776 (35a), 4377 (35a), 5110 (33).

Mavi 562 (49), 1254 (45a).

McLeish 666 (11b).

McLoughlin 673 (41a).

McLoughlin sub PRE 26384 (43).

Medley-Wood 4119 (42).

Mennell sub Bulawayo Mus. 106 (49).

Miller & King 5336 (11b).

Miller & Long 3217 (11a), 3227 (11a), 3487 (13), 3526 (11a).

Mitchell 3012 (37a).

Mogg 14646 (35a).

Muir 1232 (54).

Napier 1874 (41a), 1875 (41a), 6206 (41a).

Nevill sub PRE 43936 (52).

Newton 3419 (27).

Newton et al. 4148 (25).

Noltee 116 (11c), 397A (11a), 485 (11a).

Oates 306 (50).

Obermeyer et al. 411 (24b).

Obermeyer et al.sub NH 27640 (48).

Obermeyer sub Tvl. Mus. 30617 (32).

Obermeyeret al. 403 (45a), 411 (24b).

Olivier 211 (54).

Ossent sub EAH 12106 (25).

Paterson 64 (51)

Pearson 4350 (35b), 8471 (33), 9499 (35b).

Percy-Lancaster 11 (31b), 50 (45a), 131 (56), 1431 (24b).

Phillips sub PRE 30367 (36b).

Pienaar sub SRGH 35788 (49).

Pillans 56 (52), 60 (52), 82 (54), 84 (51), 141 (54), 152 (52), 173 (52), 181 (47), 189 (52), 192 (52), 612 (47), 1552 (54).

Pillans, E. sub N. Pillans 1550 (54), 199 (54), 657 (30).

Plowes 1529 (35a), 2083 (49), 2161 (24b), 2553 (45a), 2554 (45a), 2572 (24b), 2574 (24b), 2576 (24b), 2601 (24b), 2604 (42), 2608 (24b), 2634 (32), 2915 (52), 3052 (52), 3269 (52), 3270 (52), 3397 (47), 3398 (47), 3613 (53), 3692a (53), 3824 (49), 3909 (42), 7479 (16), 7496 (16), 7550 (4).

Pole Evans 11020 (24a).

Pott sub Tvl. Mus. 19211 (35a).

Rathgens 103 (11c).

Raynal, J. & A. 6438 (16).

Reekmans 3051 (21).

Reinecke 30 (31a).

Renney sub Bally 16601 (18).

Retief 158 (50).

Reynolds 192 (52), 465 (52), 587 (54), 1320 (48), 1713 (35a), 2186 (52), 8885A (41a).

Řičánek & Hanáček 232 (19), 284 (3).

Rich sub Pillans 167 (53).

Richards 24277 (21), 24715 (21), 24856 (29), 24997 (25), 26597 (25).

Richards sub Leach 13296 (31a).

Ritchie sub Bally S 35 (29), S 39 (9), S 52 (23).

Robbie sub Bally S107 (4).

Robertson 17 (32).

Rogers 6298 (50).

Rossouw 61 (24b).

Rusch sub STE 7366 (35b).

Rushworth 479 (24b).

Rutherford 197 (8).

Santos 119a (37a).

Schinz 2041 (35b), 2047 (35b).

Schlieben 8794 (35a).

Schlieben & Strey 8365 (32).

Schonland 1160 (52).

Schweickerdt 1119a (35a), 1285 (47).

Schweickerdt & Verdoorn 660 (45a).
Sim 271 (52).
Smith, C. A. 2622 (54).
Smith, G. G. 2128 (30).
Smith 1858 (8), 3957a (35a), 762 (50).
Smithers sub NBG 54/57 (50).
Smithers sub SAM 52158 (53).
STE 7025 (8).
Stent sub PRE 11373 (35a).
Steyn 50 (32), 64 (48), 80 (32).
Story 5090 (34), 5312 (37a).
Strey 3882 (35b), 4627 (24b).
Strohbach 1453 (38a).
sub Leach 13283 (32).
sub Plowes 1884 (37a).
Taylor sub Bally 14004 (26).
Templeman sub Pillans 7 (53), 16 (53).
Theron 523 (35a).
Thode sub STE 2606 (35a).
Thomalla sub PRE 29286 (30).
Toelken 1079 (35b).
Trochain 3260 (16), 4540 (16), 5144 (16).
Tuck sub MacOwan 2240 (35a).
Tweedie 1114 (21).
v. Balen sub PRE 8765 (47).
v. Berkel 263 (53).
v. Breda 708 (30).
v. d. Merwe sub K 176 (56).
v. d. Schyff 3550 (50)
v. Heerde 29 (53).
v. Jaarsveld 1996 (50), 2977 (35b).
v. Niekerk 270 (54).
v. Son sub Tvl. Mus. 28273 (32), 28276 (48), 28755 (35a), 28756 (35a).
v. Vuuren 1652 (32), 1653 (35a).
v. Vuuren sub PRE 10196 (32).
v. Zyl 3686 (47).
Verdcourt 455 (21).
Vereker 7632 (31b).
Walgate 610 (54), 655 (54).
Ward 10903 (8).
Welwitsch 4266 (37a).
West 707 (42).
White 7420 (38a).
Wild & Drummond 7224 (35a), 7280 (35a).
Wilson, J. G. 13 (26).
Wissmann 1207 (11a).
Wisura 2164 (52), 2189 (54), 2705 (52).
Wood 2587 (11a).
Wood sub NH 12393 (42).
Zietsman 172 (47).

INDEX TO SCIENTIFIC NAMES

Accepted names are in roman type; the main entry for each is in **boldface**. Synonyms are in *italics*.

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