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Revision of the three Boraginaceae genera *Echiochilon*, *Ogastemma* and *Sericostoma*

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The Afro-Asiatic genus *Echiochilon* Desf. (Boraginaceae) is revised and 14 species are recognized. The two monotypic genera *Ogastemma* Brummitt and *Sericostoma* Stocks ex Wight (Boraginaceae), earlier suggested to be close relatives of *Echiochilon*, are also revised to evaluate their distinction from the genus *Echiochilon*. There is no support for including any of the two monotypic genera in *Echiochilon*. Morphological aspects of the three genera are discussed. Three new species are described: ***E. baricum*** Lönn **sp. nov.** and ***E. cyananthum*** Lönn **sp. nov.** from northern Somalia, and ***E. callianthum*** Lönn **sp. nov.** from Arabia.. A key, descriptions, pictures and distribution maps are provided for all species of *Echiochilon*, and descriptions and distribution maps are provided also for *Ogastemma* and *Sericostoma*. Several lectotypes are selected and several names are placed in synonymy.

ADDITIONAL KEY WORDS:—desert plants – dispersal – patterns of distribution – pollen morphology – seed germination.

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INTRODUCTION

Echiochilon is a genus of small shrubs and herbs with a distribution from Mauritania across northern Africa to the Horn of Africa, thence across Arabia to Iran and Pakistan. In a revision of the genus, Johnston (1957) treated *Echiochilon* together with the two monotypic genera *Ogastemma* and *Sericostoma*, and the three genera have since then been supposed to be closely related.

The systematic position of the three genera has been debated (de Candolle, 1846; Bentham & Hooker, 1873; Baillon, 1888; Gürke, 1897; Johnston, 1924; Sauvage & Vindt, 1954; Riedl, 1967). Even groups of *Echiochilon* species (as it is circumscribed today), with actinomorphic and zygomorphic flowers respectively, have been placed in different tribes within Boraginoideae. Until 1957, only the *Echiochilon* species with zygomorphic flowers were included in the genus *Echiochilon* and many of the species with actinomorphic flowers were included in *Sericostoma*. In Johnston's (1957) revision, all but one species of *Sericostoma* was included in *Echiochilon*, leaving *Sericostoma* as a monotypic genus.

Recent molecular data show that some of the tribes (as traditionally circumscribed) of the subfamily Boraginoideae do not form monophyletic groups (Uta-Regina Böhle & Hartmut H. Hilger, pers. comm.).

The present study aims at a revision of all known species of *Echiochilon* and an improved understanding of its relations to *Ogastemma* and *Sericostoma*. Articles on the phylogeny and biogeography of *Echiochilon* and the positions of the three genera within Boraginaceae are in preparation.

MATERIAL AND METHODS

The present study is based mainly on material obtained on loan from or studied in the following herbaria: B, BM, BR, E, FT, G, HBG, K, LIV, M, MA, P, S, UPS, W, WAG and WU (abbreviations according to Holmgren, Holmgren & Barnett, 1990).

Field work was undertaken in Yemen, 1992, in the Hadramaut region, where a number of populations of *E. arabicum* (O. Schwartz) I.M. Johnst., *E. callianthum*, *E. kotschyi* (Boiss. & Hohen.) I.M. Johnst. and *E. persicum* (Burm.f.) I.M. Johnst. were

studied. An *Echiochilon kotschyi* plant raised from seed of a collection made in Yemen was cultivated in the greenhouses of the Botanical Garden at Uppsala University, and a plant of *Ogastemma pusillum* (Coss. & Durieu ex Bonnet & Barratte) Brummitt has been grown from a seed obtained from a herbarium collection. The living material was used for comparison with the herbarium material.

Plant parts were measured with a ruler or, for finer details, under a dissecting microscope. Flowers were softened in hot water before dissection. Pollen grains were studied under a light microscope or by scanning electron microscopy (SEM). For the SEM studies pollen grains were put on double-sided adhesive tape on stubs and coated with gold-palladium. Pollen grains were studied in SEM after acetolysis (Erdtman, 1952).

As the study is based mainly on herbarium material, a morphological species concept (cf. Stuessy, 1990) has been applied. Since there are some species with a very complex variation, no taxonomic rank under the species level has been adopted.

All the names, both accepted and synonyms, have been typified as far as possible, and the abbreviations of authors follow Brummitt & Powell (1992).

The spelling of the names in the list of material studied follows (as far as possible) Polhill (1988) for Kenya, and NIMA/USBGN (National Imagery and Mapping Agency and the United States Board on Geographic Names), Geographic Names Data Base (NIMA/USBGN, 1997) presented on WWW for the other countries. The localities are arranged in an order from north to south and west to east. Altitudes, distances and measures, where originally given in inches, feet or miles, have been converted to metric. All collections cited have been seen by the author unless otherwise stated.

Principal Component Analysis (PCA) was performed with GENSTAT (Lawes Agricultural Trust, 1995). The variables used for different combinations of taxa vary because the availability of the characters in the herbarium material vary. A character absent in an individual used in the analyses would exclude that individual from the analyses.

HISTORICAL OUTLINE

The first species of *Echiochilon* was described by Burman (1768) in his *Flora Indica* as *Heliotropium persicum* Burm.f. (= *Echiochilon persicum*). The description was based on material from Persia collected by Garcin. The species was later included in *Sericostoma* (Burtt, 1950), as were many of the regular-flowered *Echiochilon*, and as late as 1957 (Johnston, 1957) it was included in *Echiochilon*.

The name *Echiochilon* was introduced by Desfontaine (1800) who described the type species *E. fruticosum* Desf. in his *Flora Atlantica* based on material from Tunisia. Rafinesque (1821) proposed a new name, *Chilochium*, for *Echiochilon*, which according to him was a bad name ("*Echiochilon* Desf. mauvais nom"; Rafinesque, 1821: 269), and some years later in *Flora Telluriana* (Rafinesque, 1836) he used yet another name, *Exioxylon*, for the genus. In de Candolle's (1846) *Prodromus* only one species of *Echiochilon* was included, i.e. *E. fruticosum*.

In 1848 the first (and now only) species of *Sericostoma* was described, *S. pauciflorum* Stocks ex Wight, in Wight's *Icones Plantarum* (Stocks, 1848). The generic name *Megastoma* was first published (but not validly) on an exsiccate label. After several problems with validation, thoroughly explained by Brummitt (1982), the genus now has the name *Ogastemma* with the single species *O. pusillum*.

In 1879, the new species, *Echiochilon longiflorum* Benth. was described by Bentham (1879) in Hooker's *Icones Plantarum*, based on a collection from Aden, Yemen.

Moore (1901) described the genus *Leurocline* with the new species *L. lithospermoides* S. Moore (=*E. lithospermoides* (S. Moore) I.M. Johnst.) He also transferred the species *Lobostemon somalensis* Franch. (=*E. longiflorum*) to his new genus. He wrote: "This genus has all the characters of *Echiochilon*, except that the stamens are inserted in the throat of the corolla, and, its principal *raison d'être*, that the nutlets are fixed by a flat base to a flat (not conical) gynobase" (Moore, 1901: 257). Johnston (1924) who was studying *Echiochilon*, among other genera, realized that Moore must have made a mistake when studying the nutlet-attachment of the type species of *Leurocline*. The nutlets of the type species of *Leurocline* are affixed exactly as those of *Echiochilon*, and furthermore, the stamens are inserted in the throat of all species of *Echiochilon*. Johnston (1924) made *Leurocline* a synonym of *Echiochilon*.

Caballero (1935) described the genus *Echichilopsis* with the single species *E. caerulea* Caball. The type belongs to the species *Echiochilon chazaliei* (H. Boissieu) I.M. Johnst. and the genus was synonymized with *Echiochilon* by Johnston (1957) in his revision of the genus. Between 1825 and 1939, 13 species now belonging to *Echiochilon* were described in the genera *Heliotropium*, *Lithospermum*, *Lobostemon* and *Sericostoma*.

Schwartz (1939) described a new genus, *Tetraedrocarpus*, with one species, *T. arabicus* O. Schwartz, from Yemen in his *Flora des tropischen Arabien*. It was not recognized that *Tetraedrocarpus* is a synonym to *Echiochilon* until Johnston (1957) made his revision of the genus.

Johnston (1957) was the first author to propose that all species in *Sericostoma*, except for the single one now left in the genus, should belong to *Echiochilon*. After his revision there were 17 species in the genus *Echiochilon*, five of which were described by Johnston (1957). Since Johnston's revision, only one species has been described, *E. simonneaui* Faurel & Dubuis (Faurel & Dubuis, 1959).

The positions of Echiochilon, Ogastemma *and* Sericostoma *within the Boraginaceae*

The family Boraginaceae has traditionally been subdivided into four subfamilies (by some of the earlier authors treated as tribes)—Cordioideae, Ehretioideae, Heliotropioideae and Boraginoideae—based mainly on gynoecium characters (e.g. de Candolle, 1845; Gürke, 1897; Bentham & Hooker, 1873; Dahlgren, 1975). In more recent times, following Pilger (1912), Wellstedioideae is also usually included as a subfamily of Boraginaceae (e.g. Cronquist, 1981; Mabberley, 1987; Al-Shehbaz, 1991; Takhtajan, 1997).

The subfamily Boraginoideae, to which *Echiochilon* belongs, is the largest subfamily in the Boraginaceae, and it has been variously divided into several tribes. The species of *Echiochilon* have been variously partitioned on the three different tribes *Eritrichieae* (Bentham & Hooker, 1873; Sauvage & Vindt, 1954; Riedl, 1967; Verdcourt, 1991), *Echieae* (De Candolle, 1846; Baillon, 1888; Gürke, 1897) and *Lithospermeae* (Bentham & Hooker, 1873; Baillon, 1888; Gürke, 1897; Johnston, 1924, 1957). *Sericostoma*, often with some additional species of *Echiochilon* included, has always been placed in *Lithospermeae* except by Riedl (1967) who placed *Sericostoma s. str.* in his new tribe *Trigonotideae*. *Ogastemma* has been placed in *Eritrichieae*.

MORPHOLOGY OF *ECHIOCHILON, OGASTEMMA* AND *SERICOSTOMA*

The single *Sericostoma* species and most species of *Echiochilon* are shrublets or perennial herbs with more or less obvious adaptations to dry conditions. The single species of *Ogastemma* and a form of *Echiochilon longiflorum* are annuals.

Indumentum

The indumentum in *Echiochilon* consists of eglandular and sometimes also glandular hairs. The eglandular hair type, covering most of the vegetative parts, consists of a unicellular hair arising from a discoid or more rarely cushion-formed multicellular base. These hairs are more or less encrusted and often sharp pointed. This hair type is also present in *Sericostoma* and *Ogastemma*. The eglandular hairs present on the corollas are soft and not incrusted. The glandular hairs are usually short to long-stalked with a ± spheroidal gland, but may also be unstalked. They can be present both on the vegetative parts and on the outside of the corollas.

Phyllotaxy

The most common phyllotaxy in the subfamily Boraginoideae is alternate leaves. *Ogastemma* has alternate leaves but in both *Echiochilon* and *Sericostoma* opposite leaves are found as well. *Echiochilon jugatum* I.M. Johnst has all of its leaves opposite, and several species have the lowermost leaves opposite and the rest alternate.

Calyx

The number of calyx lobes typically found in Boraginaceae is five. There are a few aberrant genera, e.g. *Wellstedia*, *Ehretia*, and *Echiochilon*, which include species with four calyx lobes, and *Cordia* which can have 2–10 calyx lobes. The lobes of *Echiochilon* are almost always divided to the base and, in the species with zygomorphic flowers, there are sometimes only four lobes which are very unequal in size.

Corolla

The symmetry of the corolla in *Echiochilon* is either actinomorphic or zygomorphic. In *Ogastemma* and *Sericostoma*, as in the rest of Boraginaceae (except for *Echium* and a few other genera with zygomorphic corollas), it is actinomorphic. *Echiochilon* has often been grouped together with *Echium* because of the irregular corollas. The *Echiochilon* species with strongly zygomorphic corollas have a distinct upper lip and the stamens are usually inserted at different heights, the species with less strongly zygomorphic corollas do not have an upper lip and the stamens are inserted at slightly different or equal heights and the species with regular corollas have the stamens inserted at equal heights.

Faucal appendages are often found in Boraginoideae and Heliotropioideae, but not in *Echiochilon* and *Sericostoma*. *Ogastemma* has five weak, circular invaginations of the throat that may be homologous to the faucal appendages of other Boraginaceae plants. An annulus is another feature sometimes found inside and at the base of the corolla in Boraginoideae. In *Echiochilon* an annulus is in some species sometimes present as a ring of hairs at the base of the corolla. In *Sericostoma* it is absent and in *Ogastemma* the annulus is present as weak invaginations at the base of the corolla. Hairs inside the throat are always present in *Echiochilon* and *Sericostoma*, but in *Ogastemma* they are always absent.

TABLE 1. Measurements of acetolysed pollen grains from *Echiochilon*, *Ogastemma* and *Sericostoma*, mounted in glycerine jelly. Measurements in μm, the measurements of *E. kotschyi* are from Pollen Flora of Qatar (El-Ghazaly, 1991)

Species	Equatorial diameter	Polar diameter
E. baricum	(11–) 12–14	12–13
E. kotschyi	(14–) 15 (–18)	(16–) 17 (–20)
E. lithospermoides	14–15	12–14
O. pusillum	12–15	12–13
S. pauciflorum	(18–) 21–22 (–24)	17–21

Gynoecium

The gynoecium is superior, deeply 4-lobed and 4-locular with one ovule in each locule in the three genera. The gynobase is pyramidal in *Echiochilon* and *Ogastemma*, and flat in *Sericostoma*. The style is terminal in all three genera with terminal stigmas in *Ogastemma* and *Sericostoma* and subterminal stigmas in *Echiochilon*. *Echiochilon* has a bifid or only notched sterile tip protruding beyond the stigmas, *Sericostoma* has a sterile portion of the style deeply sunken between the stigmas (only visible from above), and the stigmas of *Ogastemma* are totally fused at the top.

Nutlets

Ogastemma has tuberculate nutlets somewhat angulate or ridged on the ventral side and with a poorly developed longitudinal ridge on the dorsal side. *Sericostoma* has almost smooth, shiny nutlets, angulate or ridged on the ventral side and with a longitudinal ridge on the dorsal side. *Echiochilon* has smooth and shiny to tuberculate nutlets, often angulate or ridged on the ventral side and sometimes with a longitudinal ridge on the dorsal side, occasionally also with a pair of small ridges on each side of the dorsal ridge.

Pollen

The pollen grains of *Echiochilon* are 2- or 3-colporate or colpate, square to rectangular in equatorial view and rectangular-rounded to rounded (when 2-aperturate) (Figs 1, 2) or rounded triangular in polar view (when 3-aperturate). The apertures of the pollen grains of *Echiochilon* are mentioned as colpate in some literature (Erdtman, 1952; Johnston, 1957; Kazempour Osaloo & Khatamsaz, 1994), and my observations and El-Ghazaly's (1991) studies show that *Echiochilon* also has colporate pollen grains. Colporate and colpate pollen grains can be found within the same species, and even within the same individual. The pollen also seem to vary in size between species; some species are listed in Table 1. The 3-colporate pollen grains from *E. kotschyi* are larger than the 2-colpate pollen grains from *E. baricum* and *E. lithospermoides*.

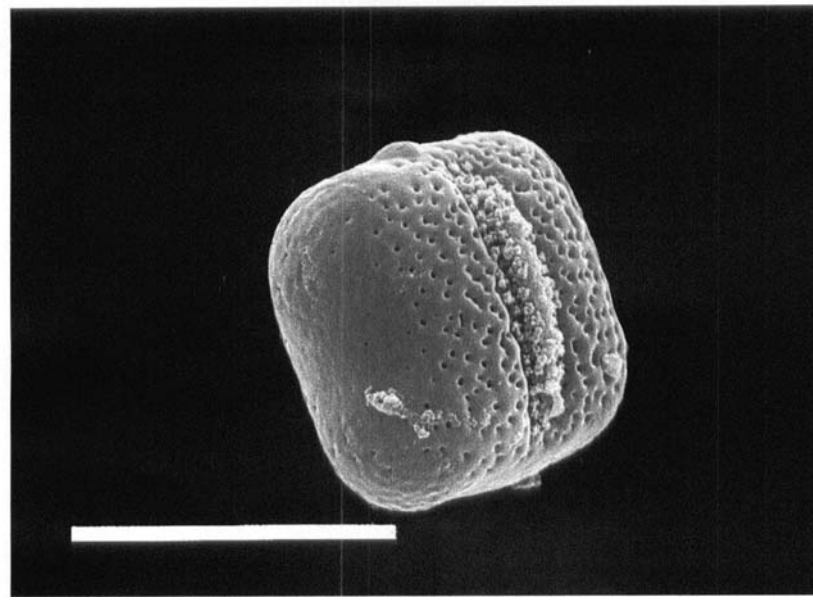

Figure 1. SEM. Pollen from *Echiochilon lithospermoides*, Ethiopia, Friis, Mesfin Tadesse & Vollesen 3049 (UPS). Scale bar = 10 μm.

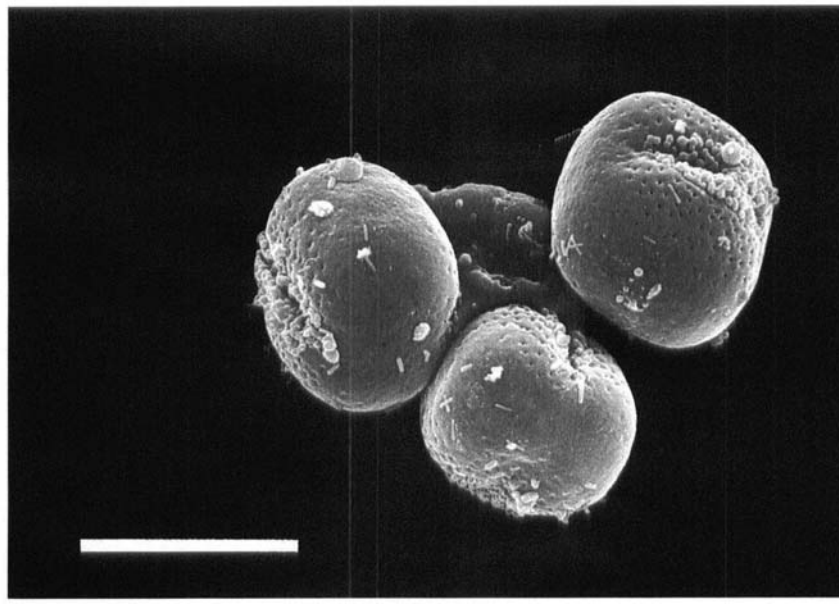

Figure 2. SEM. Pollen from *Echiochilon baricum*, Somalia Thulin & Warfa 5947 (UPS). Scale bar = 10 μm.

Sericostoma has 2-colpate pollen grains (Fig. 3), similar in shape to the 2-aperturate pollen grains of *Echiochilon*. The difference, compared to *Echiochilon*, is that the pollen grains of *Sericostoma* have the major part of the perforations in the pollen wall situated

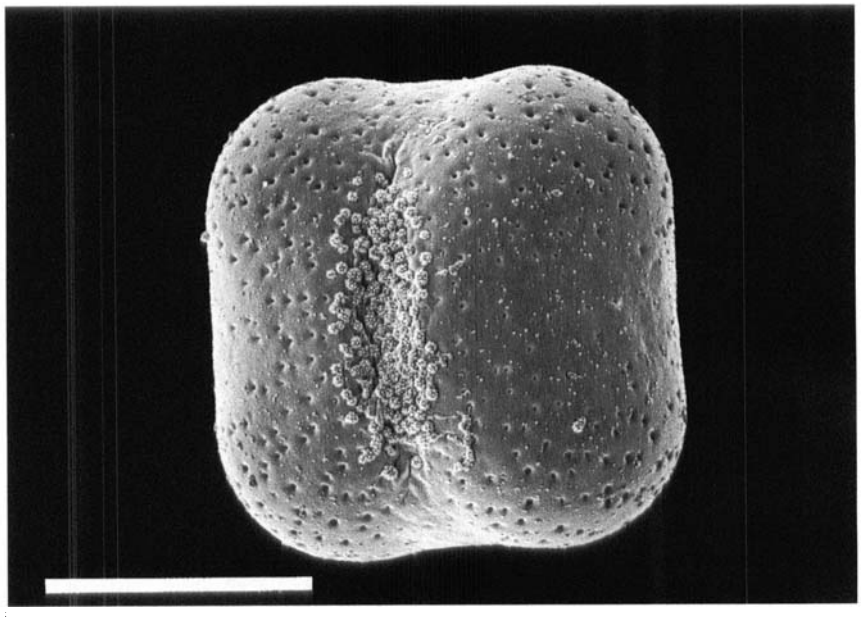

Figure 3. SEM. Pollen from *Sericostoma pauciflorum*, Pakistan, Lamond 735 (E). Scale bar = 10 μm.

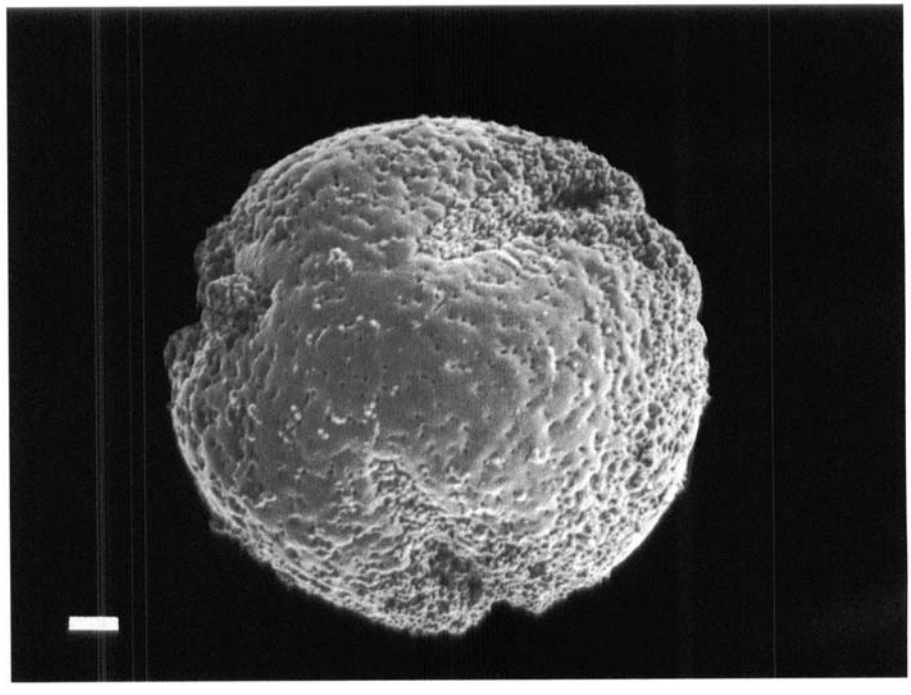

Figure 4. SEM. Pollen from *Ogastemma pusillum*, Oman, Edmondson 3321 (E). Scale bar = 1 μm.

on and around the corners of the pollen grains, facing away from the apertures, instead of concentrated around the apertures as is the case in *Echiochilon*.

The pollen grains of *Ogastemma*, earlier misinterpreted as 3-porate (Johnston, 1957), are 3-colporate (Fig. 4), somewhat prolate in equatorial view, and rounded

TABLE 2. The characters used in the different PCAs. The mean value, standard deviation (SD) and number of observations (*n*) for each character and species is listed. All measurements are given in mm. The colour of the hairs inside the throat is translated to numbers, bright white = 1, dull white = 2, pale yellow = 3.5, yellow = 4, brownish yellow = 4.5. The pale yellow and brownish yellow are close in colour to yellow and therefore given values close to 4. The last column shows in which analyses the different characters are used (A–E in Fig. 5)

	E. arabicum mean (SD)*n*	*E. callianthum* mean (SD)*n*	*E. baricum* mean (SD)*n*	*E. cyananthum* mean (SD) *n*	*E. persicum* mean (SD) *n*	Used in analysis Fig. no.
leaf length	29.2 (12.4) 6	16.3 (1.9) 7	18.5 (4.9) 2	11.6 (3.2) 6	8.7 (4.3) 50	all
leaf width	4.5 (1.5) 6	2.4 (0.5) 7	1.8 (0.4) 2	2.3 (0.6) 6	1.3 (0.5) 50	all
corolla length (cl)	8.9 (0.2) 6	9.7 (2.0) 7	6.0 (1.4) 2	4.8 (0.7) 6	4.4 (1.0) 44	all
throat width	3.9 (0.7) 6	3.4 (1.0) 7	3.1 (0.6) 2	2.3 (0.8) 6	2.3 (0.6) 39	A, B, C, D
calyx lobe length	4.0 (0.7) 6	5.8 (1.9) 7	3.7 (1.1) 2	2.6 (0.7) 6	2.9 (0.6) 47	all
calyx lobe width	0.8 (0.2) 6	0.7 (0.1) 7	1.0 (0.2) 2	0.6 (0.3) 6	0.9 (0.3) 47	all
nutlet length	2.0 (0.2) 3	2.1 (0.1) 5	1.9 (0.2) 2	1.9 (0.6) 2	1.9 (0.4) 31	E
nutlet width	1.6 (0.2) 3	1.7 (0.1) 5	1.5 (0.1) 2	1.8 (0.1) 2	1.5 (0.2) 30	E
number of nutlet ridges	3.0 (0) 3	1.4 (1.5) 5	2.0 (1.4) 2	1.0 (0) 2	1.0 (1.0) 31	E
throat hairs colour	1.8 (1.2) 6	3.8 (0.3) 7	2.0 (0) 2	1.2 (0.4) 5	4.0 (0.2) 38	all
corolla lobe length (cll)	1.8 (0.5) 6	1.1 (0.1) 7	1.4 (0.5) 2	1.2 (0.5) 5	1.1 (0.3) 38	all
corolla lobe width (clw)	2.3 (0.6) 6	1.4 (0.2) 7	1.8 (0.4) 2	1.3 (0.4) 5	1.3 (0.4) 38	all
corolla waist height/cl	0.2 (0.1) 4	0.3 (0) 7	0.2 (0) 2	0.3 (0) 3	0.3 (0.1) 25	D
cll/cl	0.2 (0.1) 6	0.1 (0) 7	0.2 (0) 2	0.2 (0.1) 5	0.3 (0.1) 38	A

or triangular with the apertures forming the truncate corners in polar view. There are very few pollen grains in each pollen sac of *Ogastemma* but very often full seed set, which might indicate that this plant, growing in very dry conditions (e.g. Sahara desert), has some mechanism for self-fertilization.

Conclusion

Echiochilon and *Sericostoma* are closely related and similar in many respects, but there are important differences between the two genera that support their being separate. *Ogastemma* does not seem to be closely related to *Echiochilon* and *Sericostoma.*

SPECIES DELIMITATION OF *ECHIOCHILON*

In some complex groups of populations of *Echiochilon* it was difficult to see immediately whether they were possible to delimit as separate species, or if they were parts of the variation of a more inclusive species. Principal Component Analysis, PCA was used as a tool to visualize the variation within and between such groups of populations. It was based mainly on quantitative characters and the analyses were performed to suggest patterns in the variation in populations within the complex species group. The actual separations of the species were, however, based mainly on qualitative characters.

Principal Component Analysis

The variation among populations within a group of species (*E. baricum*, *E. cyananthum*, *E. persicum*, *E. arabicum* and *E. callianthum*) related to *E. persicum* was described in a series of PCAs. The characters used in the different analyses are listed in Table 2 with mean values, standard deviations, and number of observations for each species.

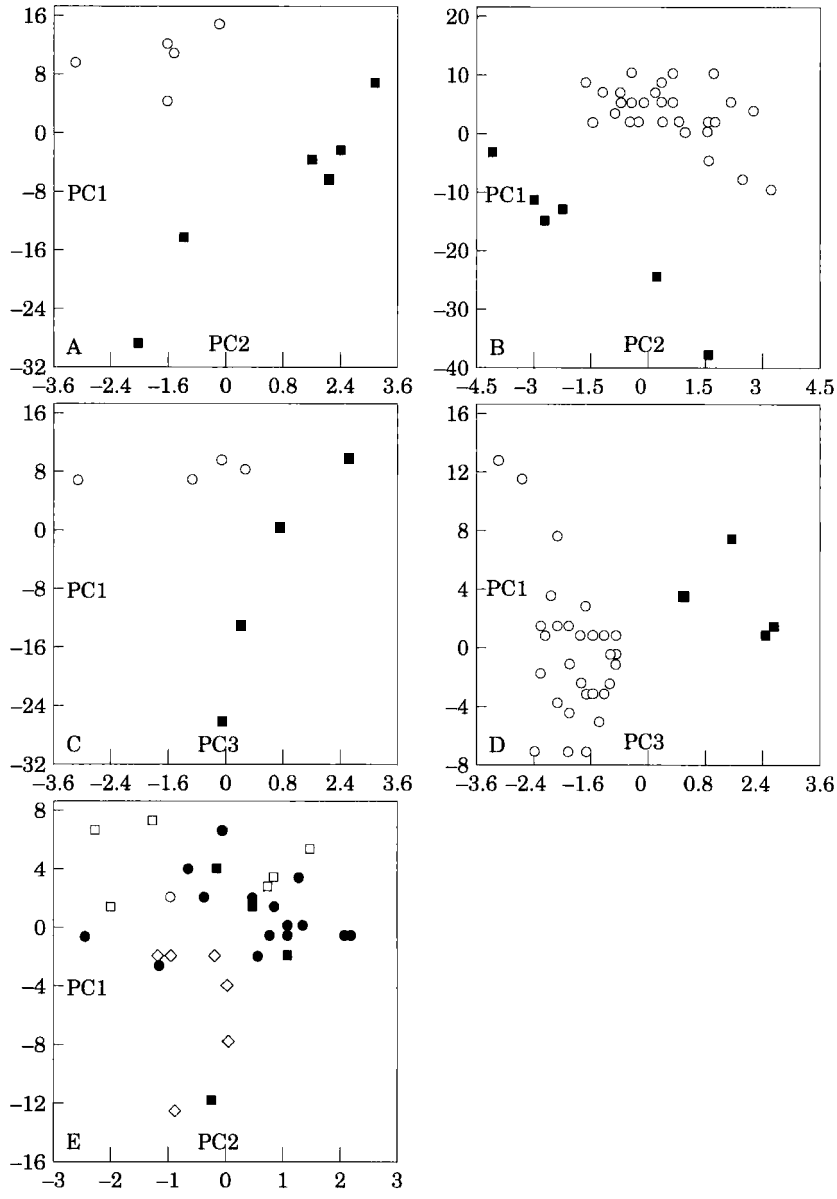

Figure 5. PC analyses comparing pairs of *Echiochilon* species. The characters used are listed in Table 2. (A) *E. cyananthum* (○) and *E. arabicum* (■), the two first axes account for 97% of the variation. (B) *E. persicum* (○) and *E. arabicum* (■), the two first axes account for 99% of the variation. (C) *E. callianthum* (○) and *E. arabicum* (■), the first three axes account for 99% of the variation (PCI 96%; PC3 1%). (D) *E. persicum* (○) and *E. cyananthum* (■), the first three axes account for 97% of the variation (PCI 87%; PC3 5%). (E) The former species now included in *E. persicum*, the former species are labelled as follows: *E. nubicum* (○), *E. persicum s.s.*, (●), *E. thesigeri* (□), *E. vatkei* (■), *E. verrucosum* (◇), the first two axes account for 97% of the variation.

Pairs of species that are sometimes difficult to separate were analysed and the analyses are presented in Figure 5. The first analysis shows that there is a clear separation between the two species *E. arabicum* and *E. cyananthum* (Fig. 5A), which

were treated as one species before this publication. The variable contributing most to the variation in the first axis (PC1) is leaf length, although corolla length and leaf width (in descending order, as in the following cases) also contribute. Corolla length, throat width and calyx lobe length contribute most to the variation in the second axis (PC2).

Echiochilon arabicum is also clearly separated from *E. persicum* (Fig. 5B), with leaf length, corolla length and leaf width contributing most to the variation in the first axis and corolla length and throat width contributing most to the variation in the second. *Echiochilon arabicum* is also distinct from the new species *E. callianthum* (described below; Fig. 5C), with leaf length and leaf width contributing most to the variation in the first axis and the colour of the hairs in the throat together with throat width, leaf width and corolla length contributing most to the variation in the third (PC3). The second axis was not used because it was less informative with respect to species delimitation than the third. I also made a comparison of *E. cyananthum* (another new species described below) and *E. persicum* (Fig. 5D) and found them clearly separate. The variable contributing most to the variation in the first axis is the leaf length; the colour of the hairs inside the throat, leaf width, corolla length and calyx lobe length contribute the most to the variation in the third.

Echiochilon persicum and *E. cyananthum* were also compared with *E. baricum* (a third new species described below). Since there were only two observations of *E. baricum* the results from these analyses are less informative, even though they are not grouped together with the observations from the other species.

The last analysis (Fig. 5E) shows the different original species *E. nubicum*, *E. persicum s. s.*, *E. thesigeri*, *E. vatkei*, and *E. verrucosum* here recognized as one species, *E. persicum*. The former species *E. albidum* is also included in the new circumscription of *E. persicum* based on qualitative characters discussed in the taxonomy part of this paper, but it is not included in the PCA since the only specimen did not possess any flowers and would therefore reduce the number of possible characters used in the analysis drastically. These former species mentioned above are not possible to separate in any of the studied characters, both quantitative and qualitative.

These PCAs show that the species related to and most similar to *E. persicum* (i.e. *E. baricum*, *E. cyananthum*, *E. arabicum* and *E. callianthum*) may be separated from *E. persicum* and from each other not only in qualitative characters but also in combinations of quantitative characters, and thus give stronger support to the new species delimitations.

SEXUAL SYSTEMS, DISPERSAL MECHANISMS AND SEED GERMINATION

The species of *Echiochilon* seem to be insect-pollinated. In the field in Yemen in 1992, I observed several possible pollinators of the families *Bombyliidae* and *Syrphidae* visiting the flowers of *E. callianthum* and *E. kotschyi*. There were no fruits produced by the plant grown in the greenhouse (*E. kotschyi*), suggesting that this species has no mechanisms for self-pollination.

In *Echiochilon* there are no obvious adaptations, such as the glochidia found on the nutlets of several Boraginaceae genera, e.g. *Cynoglossum*, for dispersal by animals. The nutlets of *Echiochilon* have no hooks or viscous secretion which would suggest that the bare nutlets are dispersed by animals. In many cases the *Echiochilon* nutlets

are kept within the somewhat enlarged calyces even after the calyces have withered. It is possible that these calyces are dispersed by the wind, as small tumble-weeds. In one species, *E. callianthum*, the calyces are enlarged when the nutlets mature, and the calyx lobes recurved. This forms a suitable unit for wind dispersal.

The calyces containing the mature nutlets might be distributed by grazing animals (camels and goats) by adhesion of the pointed hairs on the edges of the calyces. Animal dispersal in Boraginaceae plants with nutlets without glochidia is seen in *Asperugo procumbens*, where the persistent calyces have hooked hairs and the calyces containing the nutlets or even larger parts of the plant is spread by animals (Hilger, 1985).

In other species the absence of mechanisms may be adaptive. The location of the mother plant has been suitable for survival and seed set, and hence may be so for future generations. In *E. fruticosum* seeds are seldom found on the plants collected, and the explanation might be that the seeds easily fall off when mature. The possibility of dispersal by sand storms should also be considered.

The seeds of *Echiochilon* collected during the field trip to Yemen and also some taken from herbarium material were extremely difficult to germinate. None of the seeds from herbarium material, and only one single seed from the field trip, germinated. Different treatments, piercing with a needle, heating (50°C, 12 h), soaking (24–48 h) and combinations of the treatments, were performed on *c.* 20–60 seeds of each of four species (collected in Yemen) sowed during four years. The only seed that germinated had been pierced, put into soil and continuously watered for a year, then not watered for a month and subsequently watered for a few months.

To improve the germination results I tried a method described in Qi *et al.* (1993). The pericarp and testa were removed after the nutlets had been soaked in water for 10 minutes. Then the seeds were incubated in darkness in sterile Petri dishes, on two filter papers (sterile) wetted with 5 ml sterile distilled water. At least 80% of the seeds germinated after only 2–4 days, so the technique was very successful. However, it was difficult to transfer the young seedlings to soil, and humidity needed careful control.

TAXONOMY OF *ECHIOCHILON*

Echiochilon Desf., *Fl. Atlant. 1:* 166, t.47 (1800). *Chilochium* Raf., *Ann. Gén. Sci. Phys. 8:* 269 (1821). *Exioxylon* Raf., *Fl. Tell. 4:* 85 (1836). Type species: *Echiochilon fruticosum* Desf.

Leurocline S. Moore, *J. Bot. 39:* 257. Type species: *Leurocline lithospermoides* S. Moore.

Echiochilopsis Caball., *Trab. Mus. Nac. Ci. Nat., Ser. Bot. 30:* 10. Type species: *Echiochilopsis coerulea* Caball.

Tetraedrocarpus O.Schwartz, *Mitt. Inst. Allg. Bot. Hamburg 10:* 212. Type species: *Tetraedrocarpus arabicus* O. Schwartz.

Description. Perennial (rarely annual) herbs or shrublets; STEMS moderately to richly moderately to richly branched, ± erect, spreading or procumbent, ± glabrous to densely covered with erect, hooked or appressed disc-based or bulbous-based eglandular hairs, sometimes also with glandular hairs on some or all parts of the plants. LEAVES simple, alternate, with the lowest pairs opposite or all opposite, not

petiolate, with scattered discs only from the hairs on the lower surface and on the margins to densely covered with erect, hooked or appressed disc-based or bulbous-based hairs. FLOWERS either in clearly defined many-flowered cymes terminating the branches or interspersed among the leaves all the way along the branches, not forming clearly defined terminal inflorescences, pedicellate; bracts like the leaves, in the terminal cymes gradually tapering upwards. CALYX 5-lobed, less than half as long to equalling the corolla tube, with the lobes equal to very unequal in size; only scattered discs or disc-based or bulbous-based hooked hairs on the margins and midrib on the outer surface, or ± densely covered with erect or appressed disc-based hairs on the outer surface and sometimes even with appressed hairs on the inner surface. COROLLA 5-lobed, actinomorphic, slightly zygomorphic with the adaxial side somewhat prolonged, to strongly zygomorphic with the adaxial side distinctly prolonged and the two adaxial lobes forming an erect upper lip different in shape from the 3-lobed lower lip, ± funnel-shaped, usually with a waist, variously white, blue, and yellow-coloured; throat without invaginations or appendices, ± densely villose inside; lobes rounded to rounded triangular. STAMENS five, included to exserted; filaments equal or unequal in length, dorsiventrally flattened, inserted at equal or unequal heights in the corolla tube; anthers narrowly oblong, affixed above the middle, laterally compressed; connective very narrow and inconspicuous. Pollen 2–3-colporate or colpate, square to rectangular in equatorial view and rectangular-rounded to rounded (when 2-aperturate) or rounded triangular in polar view (when 3-aperturate). OVARY deeply 4-lobed, with an elongate narrowly pyramidal gynobase with the nutlets attached along the sides, bearing the style on the top of the gynobase; the two stigmas subterminal, with a bifid or only notched sterile tip protruding beyond the stigmas. NUTLETS white, beige, reddish or brown, ovoid to cordate, ± smooth and shiny to verrucose, with conoidal apex; attachment ventral and basal; sulcus narrow, extending from the tip to the base; areola rounded to triangular or boomerang-shaped with down-curved ends.

A genus with 14 species with a distribution in Mauritania, Morocco, Algeria, Tunisia, Libya, Egypt, Sudan, Djibouti, Somalia, Ethiopia, Kenya, Israel, Jordan, Iran, Saudi Arabia, Bahrain, United Arab Emirates, Oman, and Yemen.

KEY TO THE SPECIES OF *ECHIOCHILON*

1. Outer surface of corolla glabrous or with glandular hairs only 2
1. Outer surface of corolla with eglandular hairs, sometimes also with glandular hairs 6
2. Glandular hairs on vegetative parts and corolla absent; corolla zygomorphic with a two-lobed upper lip..... 3
2. Glandular hairs abundant on vegetative parts and outside the corolla; corolla zygomorphic, obliquely funnel-shaped, with a ± heart-shaped upper lip..... ..... 8. *E. longiflorum*
3. Stigmas ± horizontal; sterile tip of the style ± clavate, with a small notch or depression at the tip; leaves triangular and leathery, or obovate to oblong and fleshy and covered with appressed eglandular hairs below 4
3. Stigmas oblique to strongly oblique; sterile tip of the style conspicuously bifid; leaves (narrowly to broadly) lanceolate, oblanceolate to oblong and of normal,

somewhat leathery texture, or ovate and somewhat fleshy (with eglandular hair discs below), or obovate and fleshy (thickly covered with bulbous-based eglandular hairs) 5

4. Leaves triangular, leathery, with rigid, white, cone-shaped, hooked bulbous-based eglandular hairs on margins and midrib ..... 6. *E. simonneaui*
4. Leaves obovate or oblong, fleshy, with the lower surface fairly densely covered with appressed disc-based eglandular hairs and the upper surface with scattered appressed disc-based eglandular hairs ..... 5. *E. chazaliei*

5. Corolla with a ± distinctly heart-shaped upper lip; nutlets reddish and heart-shaped in dorsal outline or beige to whitish and ovoid in dorsal outline..... ..... 8. *E. longiflorum*
5. Corolla with the upper lip not distinctly heart-shaped; adaxial lobes of the same shape and size as the abaxial lobes; nutlets brownish, ovoid in dorsal outline... ..... 7. *E. lithospermoides*

6. Most leaves opposite 7
6. Most leaves alternate..... 8

7. Corolla large (tube *c.* 7.5–9 mm long), narrowly funnel-shaped, with glandular hairs (usually abundant) on the vegetative parts and corollas.... 12. *E. collenettei*
7. Corolla small (tube *c.* 3.2–3.7 mm long), broadly funnel-shaped, without glandular hairs on the vegetative parts and corollas ..... 1. *E. jugatum*

8. Flowers interspersed among the leaves along the whole of the branches, not in well defined cymes terminating the branches ..... 2. *E. kotschyi*
8. Flowers in cymes terminating the leafy branches 9

9. Flowers zygomorphic, blue, pink or white and pink 10
9. Flowers actinomorphic or only slightly zygomorphic, mostly white or yellowish 14

10. Vegetative parts covered with loosely appressed to spreading sharp pointed eglandular hairs, and the whole plant covered with glandular hairs; corollas with an expanded throat with patent lobes ..... 14. ***E. callianthum***
10. Vegetative parts covered with appressed eglandular hairs (only spreading on the margins of the leaves and calyces); glandular hairs mostly in the inflorescence when present; corollas obliquely trumpet- or funnel-shaped..... 11

11. Adaxial corolla lobes larger than the abaxial, pink or white with pink mottlings in the throat, outer part of the corolla densely covered with curly to straight appressed hairs ..... 9. ***E. baricum***
11. All corolla lobes ± equal in size, blue (rarely white), sparsely or densely covered outside with hairs on throat, waist and lobes..... 12

12. Margins of the calyx lobes and bracts normally blue, red or hyaline; nutlets ovoid or narrowly ovoid in dorsal outline, often bent, saddle-like, in side view, not conspicuously verrucose, not ridged ..... 4. *E. fruticosum*
12. Margins of the calyx lobes or bracts green; nutlets ovoid in dorsal outline, ± straight back, verrucose and with at least one longitudinal ridge on the dorsal side 13

13. Corolla 8.5–9 mm long, with spreading lobes; nutlets with two extra ridges on the sides of the longitudinal dorsal ridge; leaves rather closely appressed to the stem..... 13. *E. arabicum*

13. Corolla 5–5.5 mm long, with spreading to patent lobes; nutlets with only one longitudinal dorsal ridge; leaves either closely appressed to the stem or recurving. ..... 10. ***E. cyananthum***

14. Hairs inside corolla throat white; sterile tip of style at least 1.5–2 times longer than the height of the stigmas, conspicuously bifid; nutlets ovoid, to broadly ovoid, not ridged ..... 3. *E. johnstonii*

14. Hairs inside corolla throat yellow; sterile tip of style shorter than, or at the most equal in length to the height of the stigmas, somewhat bifid or with only a small depression at the tip; nutlets ovoid, often with one to three longitudinal ridges on the dorsal side ..... 11. *E. persicum*

1. Echiochilon jugatum

Echiochilon jugatum I.M.Johnst., *J. Arnold Arbor 38:* 282 (1957). Type: Bent 21, Oman, Dhofar mountains, Mirbat, coast, 1895 (K holopype)

Description. Perennial shrublet with a woody base, up to 50 cm high, much-branched, prostrate with ascending branches. STEMS and older parts of branches with grey bark, on older parts split up and flaking, young branches green and somewhat ribbed, densely covered with appressed disc-based hairs; internodes up to 5(−10) mm long. LEAVES fleshy, opposite, connate, triangular to oblong, 3.2–6(−9) × 1.3–2.5 mm, acute to subacute at the apex, clasping at the base, usually recurving, densely covered with appressed disc-based hairs on both surfaces and on the margins; midrib sometimes visible on the dorsal side; margins flat. FLOWERS spread among the leaves, opposite a leaf-like bract or in the axil of a leaf, not forming a well-defined inflorescence; pedicel *c.* 0.5–1.3 mm long. BRACTS like the leaves. CALYX covering the tube of the corolla; lobes 5, ± free, ovate, ± equal in size, (2−)3–3.5 × 0.8–1.9 mm, in fruit somewhat larger, acute at the apex, densely covered with appressed disc-based hairs on outer surface, inner surface glabrous or with the upper half covered with disc-based hairs, without a tuft of hairs at the base inside; midrib sometimes conspicuous in fruit; margins flat or almost so, sometimes ciliate with spreading disc-based hairs. COROLLA white, cream or yellow, actinomorphic, funnel-shaped, 3.9–5.5 mm long, yellow (brownish) villose inside the throat, below the constriction glabrous or sparsely hairy, at the base sometimes with a ring of brownish hairs, outside sparsely hairy on the lobes; tube 3.2–3.7 mm long, 1.3–2.4 mm in diam. at the base, slightly widened and slightly narrowed again to a not very well marked waist near the middle, 1.8–2.9 mm in diam., widened to 1.5–4.3 mm in diam. at the throat; limb flat or with the lobes spreading or erect; lobes rounded to oblong, 0.8–2 × 0.8–2.4 mm, apex rounded; margins of the lobes sometimes crisped. STAMENS borne in the throat at equal heights, 2.2–3 mm above the base, sometimes just below the apex of the corolla tube; anthers exserted, ± equal, 1.2–1.8 mm long; filaments equal in length or rarely somewhat unequal, 0.5–1.8 mm long. STYLE 1.1–1.6 mm long; stigmas horizontal or almost so, 0.1–0.2 mm high, surmounted by a bifid sterile tip protruding *c.* 0.02–0.08 mm beyond the stigmas. NUTLETS white to beige, narrowly ovoid to ovoid in dorsal outline, 2–3 × 1.3–2.9 mm, acute at the apex, smooth or almost so, not ridged, not keeled, usually 1–3 developing, attachment ventral and basal; sulcus narrow, extending from just below the tip to the base,

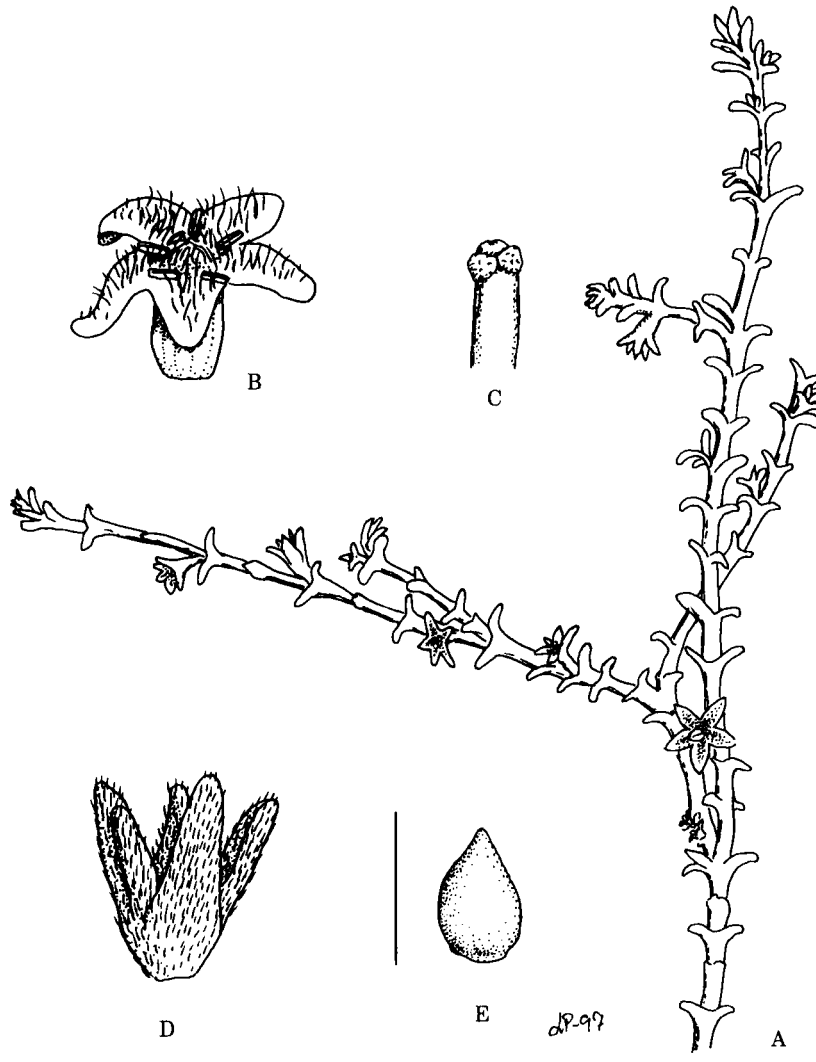

Figure 6. *Echiochilon jugatum*. A, habit. B, corolla. C, stigmas and the sterile tip of the style. D, calyx. E, nutlet. A from Cope 54, Oman; B–E from Miller 6461, Oman. Scale bar: A = 10 mm; B & D = 5 mm; C = 1 mm; E = 2.5 mm.

above the base expanding into the areola; areola triangular or rounded triangular, 0.3–0.5 × 0.7–1.1 mm (Fig. 6).

Distribution and habitat. Echiochilon jugatum is known from Bahrain, Qatar, United Arab Emirates and Oman (Fig. 7). It grows mostly on soft sand, often on sand dunes, sometimes on sand over limestone. The known altitudinal range is from sea level to 200 m.

Vernacular names. Halmit (Oman), Silli (United Arab Emirates, Abu al Abyad).

Variation and taxonomic remarks. Echiochilon jugatum is a small prostrate shrublet with ascending branches. All leaves are opposite with connate leaf bases. It looks as if

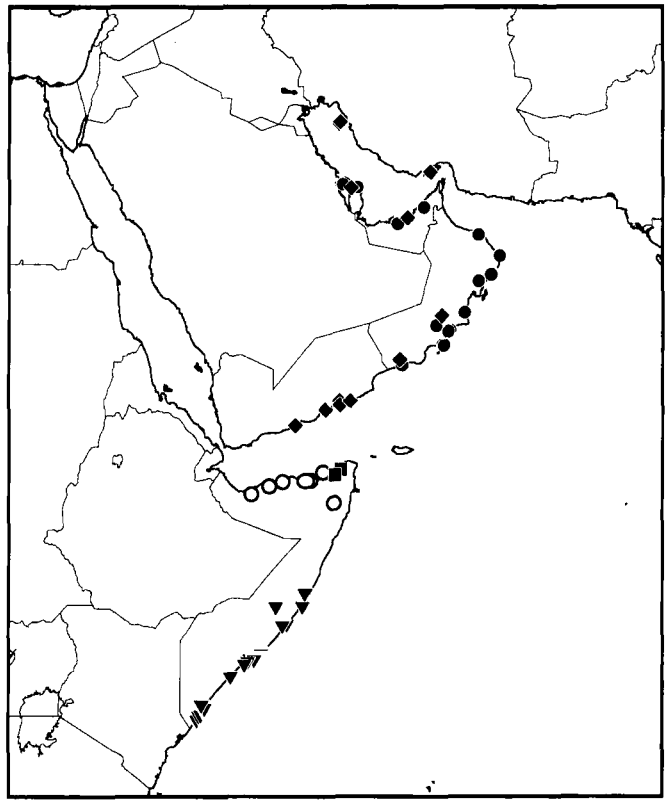

Figure 7. Distribution of *Echiochilon baricum* (■), *E. cyananthum* (○), *E. johnstonii* (▼), *E. jugatum* (●), and *E. kotschyi* (◆).

each leaf pair and a cone-shaped part of the stem were mounted together one by one. In notes on a herbarium sheet it is said to be very fragile. The flowers are most often borne opposite a leaf-like bract and spread along the whole leafy branches. The whole plant is densely covered with appressed, not obviously disc-based, hairs giving the plant a grey or silvery impression.

The closest relative of *E. jugatum* is *E. kotschyi. Echiochilon jugatum* differs from *E. kotschyi* in having all the leaves opposite, *E. kotschyi* has only the lowermost leaves opposite if any.

Material studied. "Red Sea", Nimmo *s.n.* (K). BAHRAIN: 11.iii.1950, Good 224 (BM, K); off Al Budayyi rd. near "Mariana" Al Muharraq, 1965, Carpenter 16 (K); Dry deserty areas of Sar, 10.x.1983, Alder 6 (E); Sar, 20.iv.1985, Phillips 16 (K); sand dunes E of "Tazayir" Beach, 15.i.1985, Cornes 262 (E). QATAR: Jabal al Fuwayrit, 7.ii.1971, Willcox 74 (BM). UNITED ARAB EMIRATES: Dubayy: 22.iii.1937, Holmes 351 (K); south of "Hafas", Jabal Ali, 6.iii.1986, Müller-Hohenstein 86059 (E); Jabal Ali, 8.iii.1986, Müller-Hohenstein 86085 (E). Abu al Abyad Island (Abu Dhabi), 30.iii.1948, Thesiger *s.n.* (BM). OMAN: "Wadi Shibun", 11.ii.1947, Thesiger *s.n.* (BM); "Khor Ghanadha", 9.i.1950, Popov GP 511 (E); Central: near Ra's al Hadd, 5.xi.1933, Gilson-Murray Expedition K 10 (K); 21°35′N, 59°18′E, 17.i.1986, Cope 42 (K); 21°38′N, 59°16′E, 19.i.1986, Cope 54 (K); 25.ii.1986, Gallagher 7696/

5 (K). Qurun al Quwayn, 31.i.1950, Popov GP 531 (E); near Duqm, 20.i.1968, Popov 68/2 (BM). Dhofar: southern Ourem, 19° N, 56° E, 14.ii.1968, Popov 68/25 (BM); hills above Ra's ash Sharbatat, 18°03′N, 56°22′E, 24.xii.1980, Hughes & Gallaghe 7895/18 (E); limestone cliffs above Ra's ash Sharbatat, 18°00′N, 56°27′E, 29.ix.1984, Miller 6461 (E, K); maritime sand hills near Sahil al Jazir, 9.i.1950, Guichard KG 93 (E); Wadi Ghadun, near Sahil al Jazir, 9.ii.1947, Thesiger *s.n.* (BM).

2. Echiochilon kotschyi

Echiochilon kotschyi (Boiss. & Hohen.) I. M. Johnst., *J. Arnold Arbor. 38:* 283 (1957). *Lithospermum kotschyi* Boiss. & Hohen. In Boiss., *Diagn. pl. orient. 1(4):* 49 (1844). *Sericostoma kotschyi* (Boiss. & Hohen.) Franch., *Sert. somal.:* 47 (1882). Type: Kotschy 15, Iran, Jazireh-ye Khark ("Karak"), Jan 1842 (W lectotype, selected by Riedl (1967); isolectotype K).

Description: Perennial shrublet with a woody base, up to *c.* 25 cm high, much-branched, prostrate (erect). STEMS and older parts of branches with whitish or greyish bark, on older parts split up and flaking, young branches green and sometimes ribbed, densely covered with appressed disc-based hairs; internodes up to 6 mm long. LEAVES fleshy, alternate, only the few lowermost opposite if any, triangular to oblong (oblanceolate), 4–9.1 × 1–2 mm, acute to subacute at the apex, clasping at the base, ± recurved, densely covered with appressed disc-based hairs on both surfaces and on the margins; midrib sometimes conspicuous; margins flat. FLOWERS spread among the leaves, opposite a leaf-like bract or in the axil of a leaf, not forming a well defined inflorescence; pedicel *c.* 0.5–1.2 mm long. BRACTS like the leaves. CALYX covering the tube of the corolla; lobes 5, ± free, ovate, ± equal in size, 1–3.5 × 0.7–1.5 mm, in fruit somewhat larger, acute at the apex, densely covered with appressed disc-based hairs on outer surface, inner surface glabrous or with the upper half, or the whole inner surface, covered with disc-based hairs, usually without hairs at the base inside; midrib sometimes conspicuous; margins flat or almost so, sometimes densely ciliate with spreading disc-based hairs. COROLLA white, cream or yellow, actinomorphic, funnel-shaped, 3.2–5.5 mm long, yellow (brownish) villose inside the throat, below the constriction glabrous or sparsely hairy, at the base sometimes with a ring of brownish hairs, outside sparsely hairy on the lobes, rarely somewhat hairy on the upper part of the tube; tube 2–3.2 mm long, *c.* 0.9–1 mm in diam. at the base, slightly widened and slightly narrowed again to a not very well marked waist near the middle (waist sometimes very inconspicuous), 1.3–1.7 mm in diam., widened to 1.5–3 mm in diam. at the throat; limb flat or with the lobes patent or erect; lobes rounded to oblong, 1–1.8 × (0.8)1.2–1.7 mm, apex rounded; margins of the lobes sometimes somewhat crisped. STAMENS borne in the throat at equal or somewhat unequal heights, 1.7–3.5 mm above the base, when unequal the adaxial the highest, the lateral middle, and the abaxial the lowest; anthers exserted or included, ± equal, 0.9–1.3 mm long; filaments equal in length or rarely somewhat unequal, 0.2–1 mm long, when unequal the adaxial the longest, the lateral medium, the abaxial the shortest. STYLE 1.3–1.6 mm long; stigmas horizontal, 0.1–0.2 mm high, surmounted by a bifid sterile tip protruding *c.* 0.02–0.07 mm beyond the stigmas. NUTLETS white to beige, usually shiny, ovoid to broadly ovoid in dorsal

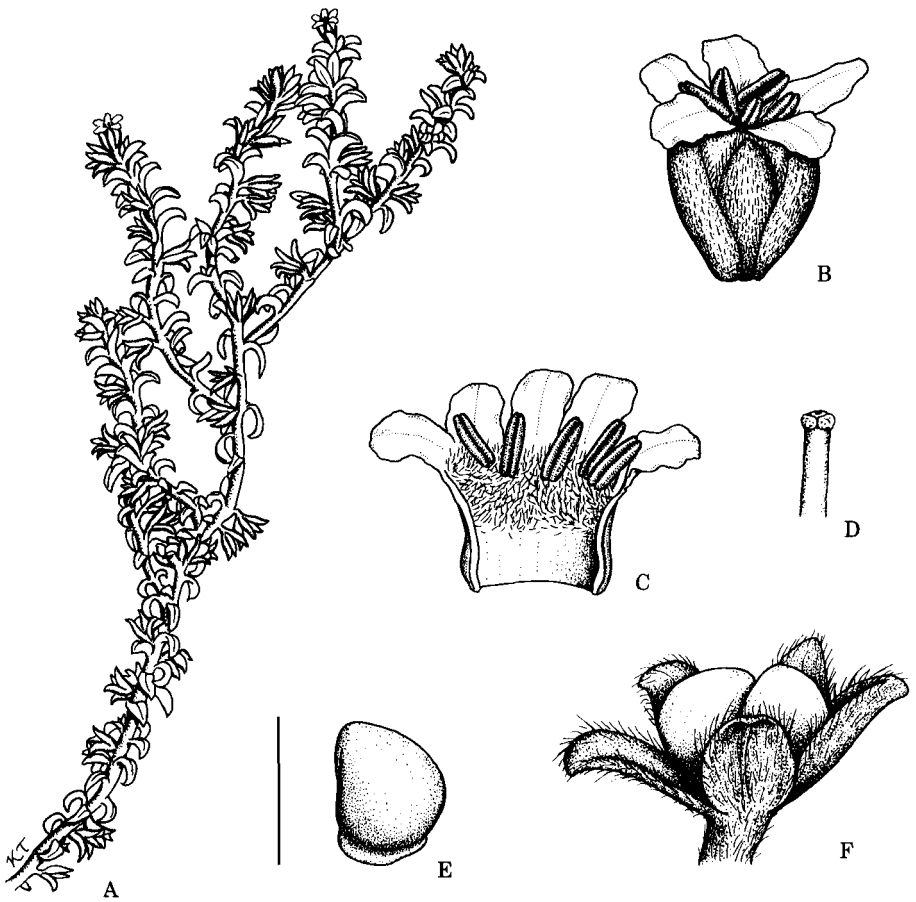

Figure 8. *Echiochilon kotschyi*. A, habit. B, corolla and calyx. C, dissected corolla. D, stigmas and the sterile tip of the style. E, nutlet. F, nutlets in calyx. A from Thulin, Eriksson, Gifri & Långström 8246; B–D from Thulin, Eriksson, Gifri & Långström 8231; E & F from Thulin, Eriksson, Gifri & Långström 8245. Scale bar: A = 15 mm; B, C, E & F = 2.5 mm; D = 1.5 mm.

outline, 1.7–2.6 × 1.2–2 mm, acute or subacute at the apex, smooth or almost so (rarely finely verrucose with small verrucae and with a hint of a ridge on the dorsal side), somewhat keeled on the ventral side, usually 2–4 developing, attachment ventral and basal; sulcus narrow, extending from just below the tip to the base, above the base expanding into the areola; areola triangular or rounded triangular, 0.5–1.7 × 0.8–1.5 mm (Fig. 8).

Distribution and habitat. Echiochilon kotschyi is known from Iran, United Arab Emirates, Oman and Yemen (Fig. 7). It grows on sand, exposed, on coastal plains or some kilometres inland (sometimes over level sandstone rocks), often cushion-forming and binding the sand. The known altitudinal range is from sea level to 30(−150) m.

Variation and taxonomic remarks. Echiochilon kotschyi is not a very common species, but locally it can dominate the landscape (Figs 9, 10). Some variation is found in the symmetry of the corolla, from actinomorphic to slightly zygomorphic with the corolla tube somewhat prolonged on the adaxial side, in the length of the pedicels, stamen

Figure 9. *Echiochilon kotschyi* locally dominates this landscape close to the coast in Hadramaut, Yemen. Almost all of these sand-binding tufts are *E. kotschyi* shrublets.

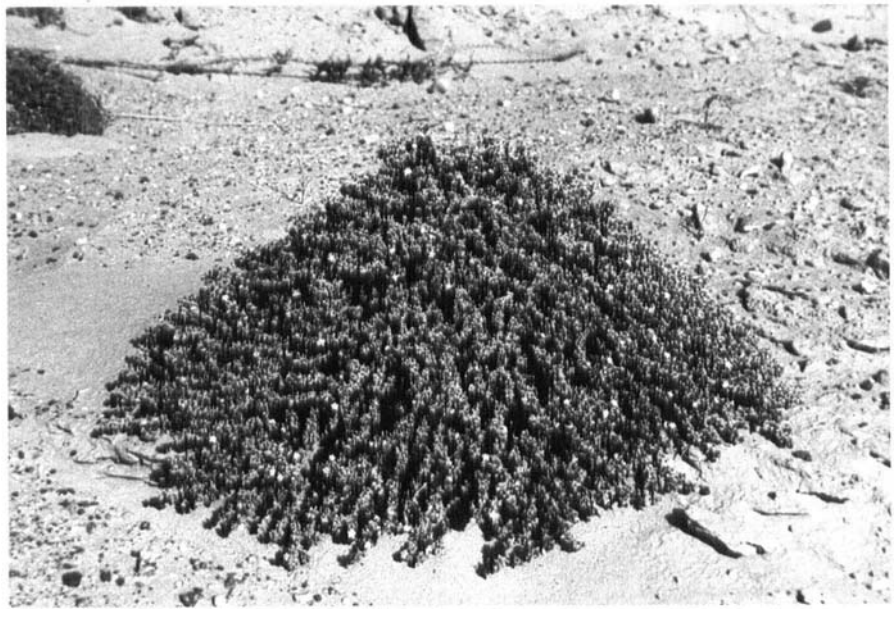

Figure 10. Close-up of an *Echiochilon kotschyi* shrublet (Thulin, Eriksson, Gifri & Långström 8245).

exposure, and in the hair covering of the calyx. Two partly geographically correlated forms can be recognized, one from Iran and one from Yemen with intermediates in the areas in between.

The type and the other specimen from Iran have a somewhat oblique corolla, pedicels *c.* 1 mm, stamens included, and the inner surface of the calyx densely hairy. The plants are sometimes slender and have somewhat recurved leaves.

The specimens from Yemen have a completely actinomorphic corolla, pedicels up to 0.5 mm, stamens exserted, and the inner surface of the calyx glabrous. They have midribs on leaves, and calyces visible on both sides. The young branches are green and ribbed and bear strongly recurved leaves.

The specimens growing in the intermediate areas, (e.g. Oman) have a regular or slightly oblique corolla, pedicels 1–1.5 mm long, the stamens exserted, and the inner surface of the calyx somewhat hairy. The plants are sometimes slender and have somewhat recurved leaves.

E. kotschyi has been reported from Libya (Siddiqi *et al.*, 1986), but from the picture published it looks like a typical *E. fruticosum*, and from the description it seems to be an *E. fruticosum*, even though it has somewhat shorter style than usual and white corollas. This is not unusual among the blue-flowered species of *Echiochilon*.

The closest relative of *E. kotschyi* is *E. jugatum*. *Echiochilon kotschyi* differs from *E. jugatum* in having only the basal leaves opposite if any, compared to all opposite, and in having nutlets with a ventral keel, which is not found in *E. jugatum*.

Material studied. IRAN: Korgo in Sinu persico, 7.i.1842, Kotschy 15a (BM, E, K, M, W); Persian Gulf, Jazireh-ye Qeshm, 29.iv.1949, Behbodi 525 E (W); OMAN: Dhofar: Jiddat al Harasis, 15–20 km ESE of "Yalooni Gravel Plain", 13.x.1984, Miller 6560 (E, K); Al Uyun, 17°17′N, 53°52′E, 8.x.1977, Radcliffe-Smith 5422 (K). QATAR: iv.1975, Mubarak *s.n.* (BM). UAE: Abu Dhabi/Dubayy border, 2.v.1984, Western 640 (E). YEMEN: Hadramaut: Wadi Hajar west of Mayfaah, 24.viii.1949, Guichard KG/HAD/135 (E); Litte Shihr, east of Ar Riyan, 1.viii.1949, Guichard KG/HAD/135 A (E); 113 km from Sayhut on the way to Al Mukalla, 14.i.1985, Sanadiki 127 (E); 113 km from Sayhut, 14.i.1985, Sanadiki 35 (K); 15 km N of Ar Riyan near the pipeline terminal, 14°42′N, 49°29′E, 9.x.1992, Thulin, Eriksson, Gifri & Långström 8231 (UPS); 2 km from Qusayir along rd. to Sayhut, 14°57′N, 50°21′E, 9.x.1992, Thulin, Eriksson, Gifri & Långström 8245 (UPS); 81 km from Qusayir along rd. to Sayhut, 15°09′N, 50°58′E, 9.x.1992, Thulin, Eriksson, Gifri & Långström 8246 (UPS).

3. Echiochilon johnstonii

Echiochilon johnstonii Cufod., *Bull. Jard. Bot. État 32:* 786 (1962). *Heliotropium arenarium* Vatke, *Linnaea 9:* 319 (1882), nom. illeg. (non F.Muell., *Fragm. 6:* 116 (1867–68)). *Sericostoma arenaria* (Vatke) I.M.Johnst., *Contr. Gray Herb. 5:* 92 (1930) nom. illeg. *Echiochilon arenarium* (Vatke) I.M.Johnst., *J. Arnold Arbor. 38:* 280 (1957) nom. illeg. Type: Hildebrandt 1314, Somalia, "Baraua", iii.1874 (B holotype †; K lectotype, selected here; BM, GH (not seen) isolectotypes).

Nomenclatural note. In the protologue of *Heliotropium arenarium*, Vatke (1882) mentioned only one collection, Hildebrandt 1314. The name *Heliotropium arenarium* Vatke is illegitimate since it is a later homonym of *Heliotropium arenarium* F. Muell. The holotype in B was most probably destroyed during World War II, and a lectotype has to be chosen. On the herbarium sheet in K, Johnston has written that there is a fragment of the holotype at GH. The material in GH is not considered since it

is only a fragment. The material in K is more complete than the material in BM and therefore chosen as lectotype.

Description. Perennial herb or shrublet with a woody base, sometimes forming dense cushions, *c.* 3–25 cm high, with numerous moderately to richly branched, prostrate or spreading stems. STEMS and older parts of branches with whitish flaking bark, young branches green, somewhat ribbed, ± densely covered with loosely to closely appressed, usually disc-based hairs, sometimes with glandular hairs; internodes 1–12 mm long. LEAVES alternate, oblanceolate to obovate, sometimes narrowly linear, 5–27 × 0.8–5 mm, subacute or obtuse at the apex, cuneate at the base, fleshy, ± densely covered with loosely to closely appressed, usually disc-based hairs, on both surfaces or at least on the lower surface, sometimes with glandular hairs on both sides; midrib inconspicuous; margins flat or almost so to strongly involute, ciliate with appressed to spreading hairs. FLOWERS in rather dense many-flowered cymes, up to *c.* 10 cm long, terminating the leafy branches; pedicels 0.4–1.1 mm long. BRACTS like the leaves, up to *c.* 8 × 2 mm, gradually tapering. CALYX reaching up to the middle of the corolla or somewhat above; lobes 5, equal to unequal (when unequal one of the abaxial the largest), obovate to lanceolate, 1.2–4 × 0.2–0.8 mm, obtuse to acute at the apex, in fruit somewhat larger up to 5 × 2.1 and united at the base up to 0.5–1.5 mm, ± densely covered with appressed, usually disc-based hairs on the outer surface, sometimes with glandular hairs, the inner surface with scattered appressed hairs or glabrous, with a thin tuft of hairs at the base; midrib not visible; margins flat or sometimes somewhat thickened, ciliate with appressed to spreading hairs. COROLLA white, rarely pale pink, funnel-shaped, ± actinomorphic, 2.8–7 mm long, white villose in the throat, below the constriction sparsely hairy, outside usually sparsely hairy on the lobes, sometimes with glandular hairs, mostly on the throat; tube 1.2–5 mm long, 1–1.3 mm in diameter at the base, slightly widened, then narrowed again to a waist near the middle, 1–1.2 mm in diameter, widened to 3–3.5 mm in diameter at the throat; limb with rounded to oblong lobes, ± equal 0.5–1.5(−2.2) × 0.6–1.6 mm, sometimes with crisped margins. STAMENS borne in the throat at equal heights, 1.6–2.9 mm above the base; anthers included, equal, 0.6–1 mm long; filaments equal in length, 0.1–0.4 mm long. STYLE 1.7–3.5 mm long; stigmas horizontal or almost so, *c.* 0.1 mm high, surmounted by an often very long and sometimes deeply bifid sterile tip with slightly unequal lobes, protruding 0.2–0.6 mm beyond the stigmas. NUTLETS white to pinkish or beige, ovoid to broadly ovoid in dorsal outline, 1.1–1.6(−2) × 0.9–1.8 mm, obscurely tuberculate, not ridged, keeled on the ventral side, sometimes with slightly rostrate apex, usually 2–4 developing, attachment ventral and basal; sulcus narrow, extending from the tip (or just below) to the base, just above the base abruptly expanding into the ± low triangular areola; areola 0.05–0.4 × 0.4–1.2 mm (Fig. 11).

Distribution and habitat. Echiochilon johnstonii is known from southern Somalia up to Mudug Region (Fig. 7). It grows mostly along the coast in grassland or bushland on limestone sand and rocks, and on coral. There are a few collections made further inland in the Mudug and Galguduud Regions, where it is also found on gypsum soil. The known altitudinal range is 10–50(−150) m.

Variation and taxonomic remarks. Echiochilon johnstonii is a distinct species. The specimens growing in the most southern part of the distribution area, Jubbada Hoose Region, are very uniform herbs which tend to have broader and somewhat more fleshy

Figure 11. *Echiochilon johnstonii*. A, habit. B, calyx. C, corolla. D, nutlet. E, stigmas and the sterile tip of the style. All from Friis, Vollesen & Abdisalam 5039, Somalia. Scale bar: A = 10 mm; B & C = 5 mm; D = 2.5 mm; E = 1 mm.

leaves than in the northernmost part, Mudug and Galguduud Regions, where specimens with narrower and somewhat thinner leaves are found. In the intermediate region there is a mixture of growth-forms with both herbs and small dwarf-shrubs with either broad or narrow leaves.

There is one aberrant collection collected furthest to the north of all *E. johnstonii*. It has the actinomorphic corolla and the conspicuously bifid sterile tip of *E. johnstonii* but it has extremely long and narrow leaves and verrucose orange-beige nutlets with an imperfectly developed dorsal ridge, suggestive of the nutlets of *E. longiflorum*. It might be a hybrid or the representative of a form of *E. johnstonii* that has been collected only once.

Echiochilon johnstonii is the sister group to the rest of the *Echiochilon* species, except for *E. jugatum* and *E. kotschyi*. Since *E. johnstonii* has an actinomorphic corolla, it is easy to distinguish from the species with zygomorphic corollas. The species with actinomorphic corollas in the sister group are *E. collenettei* I.M. Johnst. and *E. persicum*. *Echiochilon johnstonii* differs from *E. collenettei* in its shorter corolla-tube (*c.* 1.2–5 mm compared to *c.* 7.5–9 mm), in its conspicuously and sometimes very deeply bifid sterile tip of the style (compared to only notched in *E. collenettei*) and in having

alternate leaves (most of the leaves are opposite in *E. collenettei*). *Echiochilon johnstonii* differs from *E. persicum* in its white hairs inside the corolla tube (yellow in *E. persicum*) and in its very long sterile tip (at least 1.5–2 times longer than the height of the stigmas compared to shorter or at most equalling the height of the stigmas in *E. persicum*).

Material studied. SOMALIA: (Côte orientale d'Afrique), 1847–1852, Boivin *s.n.* (M); 1890, Robecchi-Bricchetti 512 (FT). Mudug Region: 18.2 km S of Xingod along an E of Xingod-Ceel Dibir trail, 6°07.5′N, 48°25′E, 27.vi.1987, Wieland 4666 (K); E of Gawaan, 29 km on rd. between Hobyo and Wisil, 5°19′N, 48°19′E, 28.v.1989, Thulin & Dahir 6665 (K, UPS); dune between Hobyo and Magangib, 18.iv.1924, Puccioni & Stefanini 369 (421) (FT); dune between Magangib and Hobyo, 19.iv.1924, Puccioni & Stefanini 382 (433) (FT); Sea shore 47 km NE of Xarardheere, 30.x.1971, Hemming 3275 (FT). Galguduud Region: 20 km N of Ceel Buur, 26 km N of Bardera on rd. to "Garba Harre", 2°32′N, 42°12′E, Gillett & Hemming 24745 (EA, K); 2–10 km S of Ceel Buur along rd. towards Ceel Dheere, 4°38′N, 46°37′E, 13.v.1983, Thulin & Warfa 4643 (K, UPS); Mareeqa, 20 km SE of Ceel Dheere, 3°45′N, 47°17′E, 7.v.1990, Thulin, Hedren & Dahir 7275 (K, UPS); 21 km on rd. between Ceel Dheere and Cadale, 3°44′N, 47°03′E, 30.v.1989, Thulin & Dahir 6717 (K, UPS); near Ceel Dheere village, 13.ix.1983, Herlocker s.119 (K). Shabeellaha Dhexe Region: Coast rd., 15 km NE of Muqdisho, 2°6′N, 45°37′E, 3.vi.1983, Gillett & Hemming 24433 (K); Close to Warshiikh, 3.iii.1975, Bavazzano 1010 (FT); Between Muqdisho and Warshiikh, 2°3′N, 45°25′E, 26.vii.1959, Moggi & Bavazzano 28 (FT); 7 km NE of Warshiikh on coastal rd, 2°20′N, 45°51′E, 4.vi.1983, Gillett & Hemming 24479 (K); Between Warshiikh and Cadale (10 km beyond Warshiikh), 2°18′N, 45°52′E, 1.viii.1959, Moggi & Bavazzano 341 (FT); Between Muqdisho and Warshiikh, 2°14′N, 45°45′E, 1.viii.1959, Moggi & Bavazzano 413 (FT); Muqdisho: Ciferri 66 (FT); 17.v.1913, Paoli 5 (FT); 17.v.1913, Paoli 10 (FT); 8.viii.1929, Senni 575 (FT); 9.viii.1929, Senni 596 (FT); 9.iv.1939, Corradi 6335 (FT); N outskirts of town, near Lido, 27.iv.1983, Thulin 4423 (K, UPS); near ministry of livestock, Banaadir, 2°01′N, 45°18′E, 1.v.1990, Thulin & Hedren 7125 (K, UPS). Tomb close to Jasiira, 16.x.1981, Pignatti *s.n.* (FT); 5 km SW of Muqdisho, Jasiira Coastal Range Research, 9.vii.1979, Hansen 6071 (K); Muqdisho, 3 km along hwy. S from air port, 18.xi.1983, Kuchar 15386 (K). Shabeellaha Hoose Region: 35 km N of Marka along the coastal rd. to Muqdisho just N of Gandarshe, 1°50′N, 44°58′E, 5.vi.1987, Alstrup & Michelson 120 (K); 2–3 km S of Merka along rd. to Shalaamboot, 1°42′N, 44°47′E, 14.vi.1987, Friis, Vollesen & Abdisalam Sheik Hassan 5039 (B, FT, K). Jubbada Hoose Region: Kismaayo area, E of town along the rd. to sea port, 23.vi.1978, Kasmi, Elmi & Rodol 651 (M); Kismaayo area, E of town along the rd. to sea port, 23.vi.1978, Kasmi, Elmi & Rodal 691 (K); "Sar Uanle" (Kismaayo) 0°37′S, 42°27′E: 7.vi.1973, Bavazzano *s.n.* (FT); 11, 17.vi.1973, Bavazzano *s.n.* (FT); 25–26.vii.1975, Tardelli 119 (FT). Isole Giuba, Jofay, 0°52′–53′S, 42°9′–10′E, 4.ix.1959, Moggi & Bavazzano 2211 (FT); Isole Giuba, Koyama, 14.viii.1975, Bavazzano & Tardelli 670 (FT); Isole Giuba, Guumme, 0°65′–46′S, 42°16′–18′E, 4.ix.1959, Moggi & Bavazzano 2102 (FT); Isole Giuba, "Fuma Nango", 12.viii.1975, Bavazzano & Tardelli 569 (FT); Raas Matooni (Kismaayo), 10.viii.1975, Tardelli & Bavazzano 494 (FT).

4. *Echiochilon fruticosum*

Echiochilon fruticosum Desf., *Fl. atlant. 1:* 167 (1800). Type: Desfontaine *s.n.*, Tunisia, near "Kerwan" (could be Kairouan) (P holotype, only photo seen).

Lithospermum divaricatum Sieber ex Spreng., *Syst. veg. 1:* 543 (1825). *E. fruticosum* var. *sieberi* I.M.Johnst., *J. Arnold Arbor. 38:* 279 (1957). Type: Sieber *s.n.*, Israel, Tel Ashqelon (W, M, K syntypes).

E. fruticosum var. *marginatum* Buxb., *Verh. Zool.-Bot. Ges. Wien. 76:* 61 (1927). Type: Janchen *s.n.*, Tunisia, Aïn Ghrasesia, 1913 (WU lectotype, selected here; isolectotypes WU).

Nomenclatural notes. Echiochilon fruticosum var. *sieberi* is a nomenclatural synonym to *L. divaricatum* since *L. divaricatum* was cited as a synonym to the new variety and Johnston (1957) explicitly stated that it was a nomen novum.

In the protologue of *E. fruticosum* var. *marginatum* Buxbaum only Janchen *s.n.* from Aïn Ghrasesia was mentioned. There are several sheets of the collection present in WU. One of the sheets is labelled "var. *marginatum*" by Buxbaum, and is therefore chosen as lectotype.

Description. Perennial shrublet with a woody base, usually 8–25(−100) cm high, (moderately to) much-branched, ± erect to very low and prostrate with tortuous branches, sometimes with glandular hairs on the vegetative parts in the inflorescence. STEMS and older parts of branches with brown or grey bark, somewhat younger parts with beige or whitish incrusted bark, on older parts split up and flaking, young branches green, ± densely covered with appressed disc-based hairs; internodes up to 8 mm long. LEAVES alternate, narrowly lanceolate to lanceolate-oblanceolate (elliptic or oblong), (2−)4–15 × 1–3 mm, acute to obtuse at the apex, (shortly cuneate) cuneate to attenuate at the base, appressed to the stem to recurving, ± densely covered with appressed disc-based hairs on both surfaces; midrib inconspicuous; margins flat or almost so, ciliate with spreading disc-based hairs. FLOWERS in ± well defined, elongate, ± unilateral, many-flowered cymes, 2–15 cm long, terminating the leafy branches; pedicel *c.* 0.5–0.7 mm long. BRACTS ± like the leaves, often with blue or hyaline (white when dried) margins, up to *c.* 15 × 2.5 mm, gradually smaller upwards. CALYX less than half as long to equalling the corolla tube; lobes 4–5, the adaxial usually missing or rudimentary, free, unequal in size, one of the abaxial the largest, in flower lanceolate, narrowly ovate to narrowly obovate, 2.5–7 × 0.5–1.8 mm, in fruit somewhat larger, acute to subacute at the apex, ± densely covered with appressed disc-based hairs on both surfaces, with a dense tuft of hairs at the base inside; midrib inconspicuous; margins flat or almost so, often blue or hyaline (white when dried), rarely red, ciliate with spreading disc-based hairs. COROLLA blue or pink (probably pink becoming blue), strongly zygomorphic with upper and lower lip, obliquely funnel-shaped, 6–13 mm long, ± densely white or brownish villose inside the throat, below the constriction glabrous and at the base sparsely hairy, outside densely covered on waist, throat and lobes with white or dull whitish hairs; tube 4–7 mm long, the adaxial side 1.5–4 mm longer than the abaxial, 0.8–1.2 mm in diam. at the base, slightly widened and then narrowed again to a waist near the middle, 0.9–1.3 mm in diam., widened to 2–3 mm in diam. at the throat; limb 2-lipped, with the adaxial lobes forming an erect 2-lobed upper lip, 2–4.5 × 3–6.5 mm, extending beyond the often less evidently lobed lower lip, formed by the three abaxial lobes; adaxial lobes rounded to oblong, 1.2–2.3 × 1.2–3.5 mm,

apex rounded; abaxial lobes rounded to rounded-triangular, 1–2.2 × 1.3–3 mm, apex rounded, the middle one often larger than the lateral ones; margins of the lobes sometimes crisped. STAMENS borne in the throat at three different heights 3–5.2 mm above the base; anthers included, equal, 1–1.5 mm long; filaments of three different lengths, 0.2–1 mm long, the adaxial one the longest, the lateral ones medium and the abaxial ones the shortest. STYLE 1.8–2.6 mm long; stigmas oblique to strongly oblique 0.1–0.2 mm high, surmounted by a bifid to deeply bifid sterile tip (sometimes cleft to just below the point where the stigmas meet), protruding *c.* 0.01–0.05 mm beyond the stigmas. NUTLETS beige or whitish, sometimes with dark spots, narrowly ovoid to ovoid in dorsal outline, droplet-shaped or bent, saddle-like, near the middle in side view, when bent the beaked upper half almost parallel with the ventral keel and the broad rounded lower half almost parallel with the base, diverging from the ventral keel at an angle of about 90°, 1.5–2.3 × 0.9–1.5 mm, almost smooth to somewhat verrucose, not ridged, the saddle-like type with a keel on the ventral side, the droplet-shaped type with obtuse ventral side, usually 3–4 developing, attachment ventral and basal or ventral; sulcus narrow, extending from just below the tip to the base or somewhat above, above the base expanding into the areola; areola laterally oblong, droplet-shaped to triangular, often oblique, 0.2–0.8 × 0.4–0.6 mm (Fig. 12).

Distribution and habitat. Echiochilon fruticosum is known from Morocco, Algeria, Tunisia, Libya, Egypt, Syria, Israel, Jordan, and Saudi Arabia (Fig. 13). It grows on open sandy, stony or rocky ground with sparse vegetation in dry deserts or on desert pastures, on sand dunes, on sandy hills or slopes, along wadis, and on coastal planes, sometimes on limestone or gypsum. It is locally plentiful, and sometimes grazed. The known altitudinal range is from just above sea level to 1500 m.

Variation and taxonomic remarks. Echiochilon fruticosum is a rather constant species even though it is widely distributed. It is a beautiful plant with its usually striking clear blue margins of the calyx lobes and bracts giving the inflorescences a sky blue colour. The margins of the calyx lobes and bracts can also be entirely green or hyaline, but are usually blue or more rarely red. The var. *marginatum* was described by Buxbaum (1927) based on material with red margins of the blue-coloured calyx lobes and bracts.

The most important variable characters found are the shape and size of the nutlets. Johnston (1957) gave new rank to the species *Lithospermum divaricatum* and made it a variety of *E. fruticosum*, var. *sieberi*, based on the form with narrowly ovoid nutlets without the saddle-like bend on the dorsal side. Since there is a gradual change from bent nutlets in the western part of the distribution area to narrowly ovoid in the eastern part, with intermediates in Libya and the African part of Egypt, it should just be seen as continuous variation.

The closest relatives of *E. fruticosum* are *E. chazaliei*, *E. simonneaui*, *E. lithospermoides*, and *E. longiflorum*. *Echiochilon fruticosum* differs from all these species in having the corolla densely covered with hairs on the outside.

Material studied. MOROCCO: "Ksar El Jouk, route vers Goulmime", 2.iv.1974, Levalle 7575 (BR); ALGERIA: "Sud Oranais, Tiguiy", v.1922, Alleizette *s.n.* (BR); Prov. de Constantine, 1868, Cossoni 666 (BR); Alger Region: Guyon *s.n.* (M); Alger, iv.1914, Renner *s.n.* (M); desert close to the oasis Bou Saada, 28.iv.1927, Rymers 1126 (BR); Bou Saada, v.1882, Letourneux *s.n.* (E); Baniou, v.1882, Letourneux *s.n.*

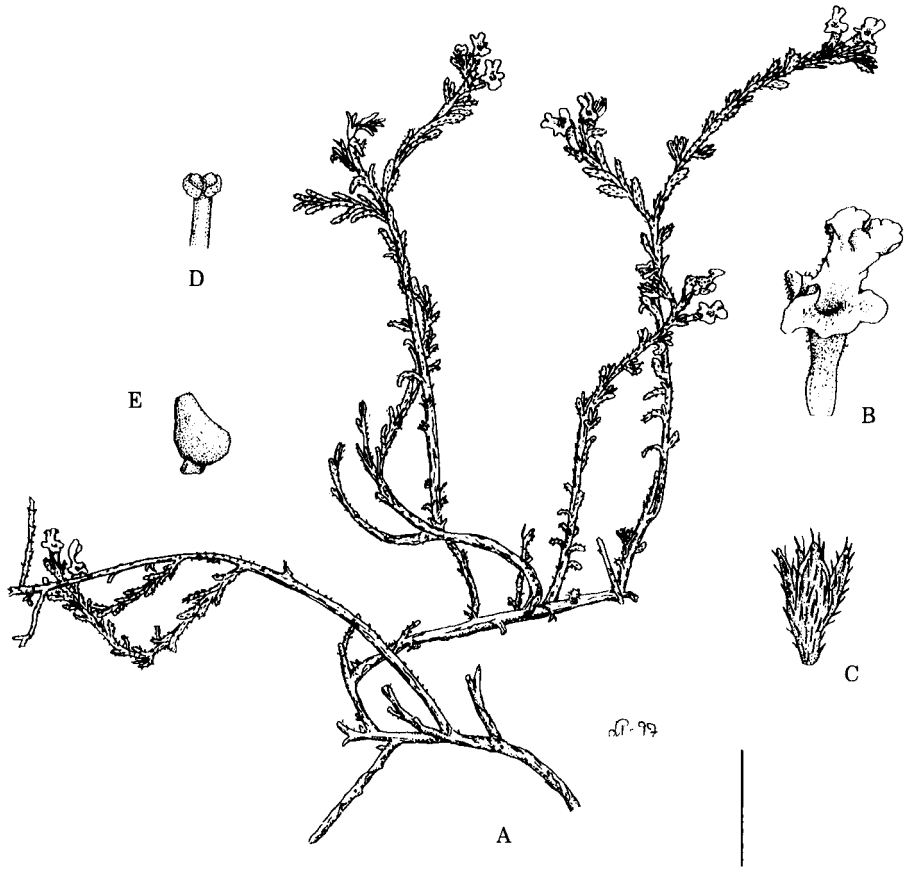

Figure 12. *Echiochilon fruticosum*. A, habit. B, corolla. C, calyx. D, stigmas and the sterile tip of the style. E, nutlet. All from Boulos 1578, Libya. Scale bar: A = 20 mm; B & C = 5 mm; D = 1 mm; E = 2.5 mm.

(UPS); "Gharbi" near Tolga, 23.iii.1933, Maire *s.n.* (S); 115 km from Bou Saada on the Biskra piste, 13.iv.1937, Simpson 371425 (BM). Wilaya de Djelfa: Sidi Maklouf, *c.* 30 km N of Laghouat, 16.iv.1980, Anderberg 431 (S); between Ain el Bell and Laghouat, 2.v.1854, Rebow *s.n.* (S, UPS); 38 km NW Laghouat on rd. to Aflou, 33°56′N, 2°35′E, 6.iv.1980, Podlech 34065 (M); Oasis, desert 25 km east of Ksar el Hirane, 29.iv.1965, Faurel 5609 (BR); Laghouat: 22.iv.1899, Chevallier 46 (HBG, WU); "Ghordaia", 19.iv.1928, Rosseau *s.n.* (BR). Wilaya de Saida: Ain Sefra, v.1913, Rotschild & Hartert *s.n.* (BM); near Sliman close to Ain Sefra, vi.1888, Battandier & Trabut 481 (BR); "Sud-Oranais", surrounding of Ain Sefra, 30.v.1934, Faure *s.n.* (BR, E, S). Wilaya de Biskra: Biskra, "Fountain chaude", 31.iii.1901, Bornmüller & Kügler *s.n.* (B); Cliffs of Cal de Ifa, towards Biskra, 4.vi.1852, Jamin 267 (E, K, W); "Algrei", Biskra, 25.v, 13.ii.1901, Juel *s.n.* (UPS); close to Biskra, 15.iv.1853, Balansa 848 (BM, E, K, W); dry plain south of "Béni-Mora" to Biskra, 23.iii.1856, Schmitt 165 (BM, K, S, W). TUNISIA: 11.v.1883, Cosson, Letourneux, Rebud, Baratte & Bonnet *s.n.* (K); "Djabab", ii.1924, Riley 4135 (K); "Sabanda", 6.iv.1939, Benl 2 (M); "Djerla": 31.iii.1975, Vanden Berghen 9 (BR); steppe near "Imferata", towards

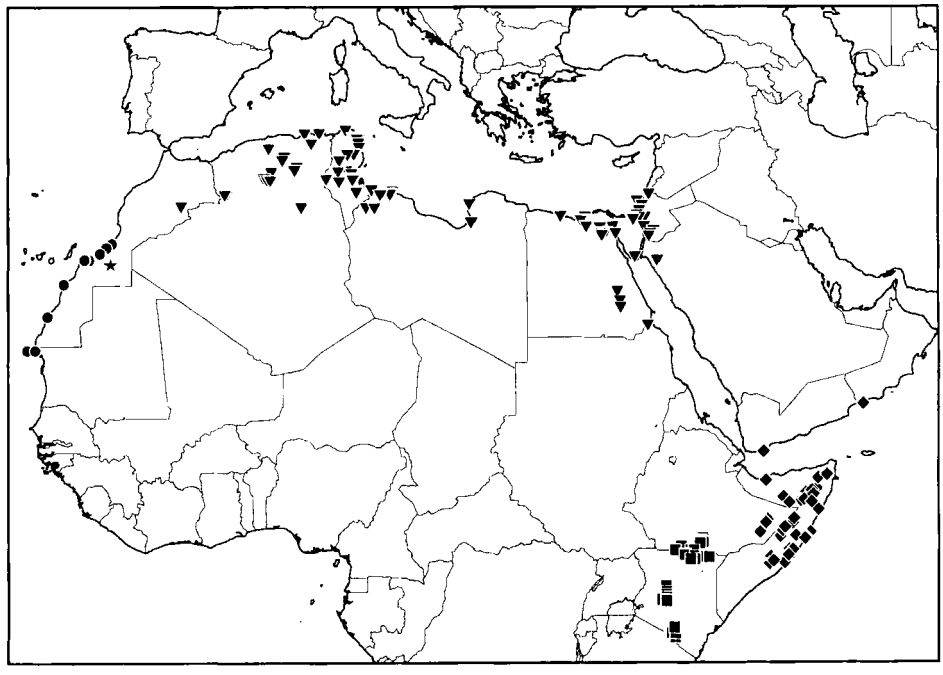

Figure 13. Distribution of *Echiochilon chazaliei* (●), *E. fruticosum* (▼), *E. lithospermoides* (■), *E. longiflorum* (◆) and *E. simonneaui* (★).

"Sidi Yati", 2.iv.1975, Vanden Berghen 18 (BR). Wilayat Tunis al Janubiyah: close to Tunis, 1848, Åberg *s.n.* (S); Hammam al Anf, 21.iii.1986, Murbeck *s.n.* (S, WU); Tunis. Hammam al Anf, 12.ii.1910, Raunkiær *s.n.* (UPS); ca. halfway between "Medinin" and "Karz", 31.iii.1938, Simpson 38077 (BM); Wilayat Nabul: suuroundings of Jabal al Keliat, NW Al Hammamat, 9.iv.1968, Wagenitz 1111 (B); 15 km SE of Qurbus, W side of Jazirat Sharik, 27.iv.1975, Davis & Lamond D.56837 (BM, E); Al Hammamat, 11.v.1883, Cosson, Doûmet-Adanson, Letourneux, Reboud, Barratte & Bonnet *s.n.* (E); 2 km W of Al Hammamat town, 16.v.1984, Davis 70324 (E); desert ca 2 km N Al Hammamat, 9.iv.1968, Hertel 8236 (M). Khalij al Hammamat *c.* 7 km SW Al Hammamat, 13.iv.1968, Hertel 8377 (M). Al Qayrawan: Cherichira, 2.iv.1932, Renz *s.n.* (M); Ayn Ghrasesia, 14.iv.1913, Ginzberger *s.n.* (W, WU); Sousse–Kairouan, Ayn Ghrasesia, 14.iv.1913, Vierhapper *s.n.* (W, WU). Wilayat Sidi Bou Zid: Sidi Bou Zid: 10.v.1961, Zednik *s.n.* (W); 19.iv.1962, Fitz *s.n.* (W). Wilayat Safaqis: 8 km S As Sukhayrah (45 km N Qabis), 34°16′N, 10°02′E, 2.vi.1984, Triebel 1016 (M). Wilayat Qafsah: Gafsa, 22.iv.1924, Buxbaum & Schussing *s.n.* (W, WU); 14 km NE Gafsa on rd. to Kairouan, 34°24′N, 8°53′E, 10.iv.1980, Podlech 34251 (M); W of Wadhraf, 17.ii.1966, Archibald 886 (E, K); 3 km W Tawzar on rd. to El Oued, 33°55′N, 8°06′E, 9.iv.1980, Podlech 34147 (M); Tawzar & Naftah, 1913, Stuhlmann 19 (HBG); "Okar", Naftah, 25.iii.1925, Wall *s.n.* (S); between Al Qasrayn and Sbeitla, 4.iv.1975, Davis & Lamond D.57215 (BM, E). Wilayat Qibili: Qibili: ii.1908, Pitard 443 (K); 1908, Pitard *s.n.* (E, HBG). Wilayat Qabis: oasis Bu Hadma, NW Qabis, iv.1968, Young 139 (BM); in desert near Qabis, 17.iii.1854, Kralik 273 (B, BM, E, K, S, UPS, W); Qabis: wadi near "Khor Ibamema", 24.iv.1854, Kralik *s.n.* (W); 27.iv.1896, Murbeck *s.n.* (BM);

iii.1907, Pitard 197 (B, K); iii.1909, Pitchard *s.n.* (B, BM, W); iii.1909, Pitard *s.n.* (B, S, W); 8.ii.1920, Pitard *s.n.* (B); 20.iii.1925, Wall *s.n.* (S); 15.iv.1954, Pannier 782 (M); 20 km SSE "Davon", 12.iv.1978, Hautzinger *s.n.* (W). 9 km S Qabis, 3.iii.1968, Leippert 7016 (B). Wilayat Tatawin: Tatawin, S de la Tunisie, 7.iv.1975, Vanden Berghen *s.n.* (BR). LIBYA: Ayn Zarah, a few miles from Tripol, 1.iv.1946, Brown *s.n.* (K); Wadi Ayn Zarah, 7.iv.1939, Benl 1 (M); "Kabila Forgian, Sirle", 6.ii.1961, Khalifa el Karamanli 841 (K); "Wadi Ghdea", 16.ii.1961, Mazzocchi 848 (K); between Ajdabiya and "el Aghelia Melch on Nogra", 15.iii.1953, Pampanini 6490 (K); "Garabulli Livestock Ranch", 11.ii.1958, Park 244 (K); "Agri-Vocational School", 4.xii.1957, Park 97 (K); near "Pirida", 25.iii.1939, Sandwith 2004 (K); 15.v.1966, Townsend 66/42 (K); 19.ii.1928, Andreánsky *s.n.* (W); in desertis "Gefara", solo calcereo, 19.ii.1928, Andreánsky *s.n.* (WU); "Wadi Touzist", 8.iii.1952, Guichard KG/Lib/205 (BM); Baladiyat Zuwarah: Ra's al Makhbaz, 29.iv.1912, Vaceari *s.n.* (BM); Sabratah, 17.iv.1933, Bornmüller 823 (B, BM, K, S); W of Tripoli, 19.ii.1966, Archibald 899 (E, K). Baladiyat al Khums: 20–23 km east Tripoli, along the coastal rd. to Al Khums, 8.iii.1967, Boulos 1578 (S). Baladiyat Tarabulus: Tripolis: iv.1932, Baschant *s.n.* (B); near Tajura′, 19.iv.1933, Bornmüller 824 (B); near "Gangaresch", 23.iv.1933, Bornmüller 824b (B); near "Gargaresch", 29.iv.1933, Bornmüller 922 (B, BM, K, S); near University of Libya, 12.iii.1970, Davis 49473 (E, K); 5.iii, Scott Elliot 3108 (BM). Baladiyat Ghadamis: Wadi Kabaw, 5.v.1972, Ali & Khalifa 374 (E). Baladiyat Yafran: Jabal Nafusah, near "Ain Zarga", near Jadu Plateau above escapment, 17.iii.1970, Davis 46663 (E, K). Baladiyat Banghazi: Banghazi: "Gintiana", 4.iii.1883, Ruhmer 243 (BR, E, HBG, S, UPS, W). EGYPT: Andrey 2 (BM); Ausher-Eloy 2405 (BM, K); Gauba 300 (W); "Deliste", Clasion *s.n.* (BM); "Deliste", 1803, Nolte *s.n.* (BM); "Oratieh", 29.iv.1887, Ascherson 1299 (S, W); "Katich", 30.iv.1887, Ascherson *s.n.* (K); "Gabal Gararanra el Osmeat", 5.iii.1945, Davies 8276 (K); Desfontaine *s.n.* (E); "Salebibiya", iii.1823, Ehrenberg *s.n.* (S); on small hill 1,6 km SW of "Flemming Station", 8–11.iii, Scott Elliot 3649 (E); Cairo–Suez, Frauenfeldt 855 (W); 1948, Wall *s.n.* (S); Ra's al Hikmah: 6.iii.1960, Walter 120 (B); 64 km E Marsa Matruh, 12.iii.1969, Wanntorp & Sjödin 2377 (S); 2 Apr 1969, Abbas & el-Shàer (W). W of Alexandria, Marsa Matruh: Hughes *s.n.* (K); 1904, Ball *s.n.* (K); 29.iii.1927, Simpson 4604 (K). Alexandria: iv, collector unknown (HBG); iii.1818, collector unknown (S); 1891, Montbret *s.n.* (W); iv.1836, Wiest 586 (K). near Alexandria: Mar-Apr 1853, Samaritani 3152 (W); iv.1871, Hurst 8/71 (K). near Alexandria, Ar Ramlah: iv.1871, Hurst *s.n.* (BM); 2.iv.1872, Parquet *s.n.* (BM); 4.i.1880, Schweinfürth 588 (K); 1881, Massie-Blomfield *s.n.* (E); 17.i.1913, Bolland *s.n.* (K); 23.iii.1877, Ball 49 (E). between Ar Ramlah and Abonkin, 1872, Parquet *s.n.* (BM); Libyan desert: along the Cairo–Alexandria desert rd. Liberation prov., 50 km S of Alexandria, 26.xi.1968, Lundqvist 5655 (UPS); the western mediterranean coastal strip, Taposiris, 30:57 N, 29:36 E, 26.v.1956, Arvidsson *s.n.* (UPS); Buhayrat Maryut: Burj al Arab Mariut, 10.iii.1944, Davis 6393 B (E, K); Desert rd. Cairo–Alexandria. 70 km before Alexandria, 8.iii.1969, Wanntorp & Sjödin 2053 (S); Cairo. Plateau of Jabal al Muqattam *c.* 5 miles SE Cairo, 6.i, Scott Elliot 3616 (BM); Bahr Bila Ma′ near Cairo, 10.iii.1904, Keller 330 (K); "Wala" by Cairo, 29.iii.1904, Keller 59 (BM, K); Wadi al Halazuni, Cairo, 28.ii.1946, Lupton *s.n.* (BM); South of the Cairo-Suez rd., 20.iii.1922, Simpson 858 (K); Km 32 Cairo-Suez rd., 31.i.1945, Davis 8127 (E, K); Wadi Dijlah, Eastern desert, 22.ii.1965, Holmén *s.n.* (S); Hulwan, Schweinfürth *s.n.* (B); "Wadi et-Jim", Hulwan, 1899, Schweinfürth *s.n.* (B); near Al Ismailiyah, iv.1880, Letourneux 279 (B, K, W); Suez desert, collector unknown

(BR); 4 km E Al Arish, dunes N of the main rd., 31°08′N, 33°49′E, 1.v.1991, Förther 4126 (M); Isthmus of Suez, 1855, Kotschy 1229 (W). Luksor, iii.1904, Muschler *s.n.* (K); Idfu, iv.1904, Muschler *s.n.* (K); Mabad Kawm Umbu, ii.1903, Muschler *s.n.* (K); Jabal Khashab, 28.iv.1922, Simpson 1193 (K); Sinai Peninsula: Montbret 33 (W); "Debbeter Ramlch" & Wadi Humr, xi.1883–ii.1884, Hart *s.n.* (BM); v.1916, White *s.n.* (BM); "Bir Lehfen" S of Al Arish, 21.iii.1928, Täckholm *s.n.* (S); Wadi Humr, near "El Ramla", 14.iv.1937, Shabetai *s.n.* (K). "Sinai & Palestina, Gaza", xi.1883–ii.1884, Hart *s.n.* (BM, K). ISRAEL: 1889, Sabotine *s.n.* (W). Northern District: Arraba, iv.1857, Rothii 22 (M); En Sharona—"Ebene", close to Restaurant Caesarin, 22.ii.1988, Poelt *s.n.* (M). Central District: Nizzanim, 5 km S of Ashdod, 11.v.1985, Liston 7–85–331/4 (BR, E, M); Tel Ashqelon, Crépin 666 (B); Yafo: xi.1832, Bové 421 (BR); 1832, Bové 424 (K, W); 1832, Bové 428 (K); ix.1868, Gay *s.n.* (K). Gaza Strip: in desert between Ghazzah and Khan Yunus, 29.v.1897, Bornmüller 1171 (B); Khan Yunus: 27.v.1897, Bornmüller 1171 (B, BR, E, HBG, K, S, W, WU); 12.iii.1926, Fishelson 350 (K); 8.iv.1933, Samuelsson 3042 (S); 8.iv.1933, Wall *s.n.* (S); Southern District: Be'er Sheva to En Ashlag, 22.xi.1942, Davis 4985 (E, K). Negev: "Ramon Krater", 4.iv.1988, Lang *s.n.* (M); About 8 km E of Dimona desert, 20.iii.1967, Hepper 3263 (K). SYRIA: 1932, Martens *s.n.* (BR). JORDAN: "Luwemia-Nago Ishles", 1955, Poose S/1113 (K). Muhafazat Maan: 20 km NE of Al Quwayrah, 13.iv.1980, Frey & Kürscher VO 5102 (E); near Al Quwayrah camp, 4.iv.1955, Hunting Aero Survey 56 (E); S of Mahattat Ra's an Naqb, 6.v.1955, Hunting Aero Survey 173 (E). SAUDI ARABIA: Mintaqat Tabuk: North Hijaz, 10 km NE of Shiqri, off Tabuk rd., 7.iii.1979, Collenette 977 (K).

5. Echiochilon chazaliei

Echiochilon chazaliei (H.Boissieu) I.M.Johnst., *Contr. Gray Herb. 73*: 50 (1924). *Lithospermum chazaliei* H.Boissieu, *J. Bot. (Morot). 10*: 220 (1896). *Leurocline chazaliei* (H.Boissieu) Bonnet, *Bull. Soc. Bot. France 58*: 38 (1911). *Echiochilon chazaliei f. pallidiflorum* Maire, *Bull. Soc. Hist. Nat. Afrique N. 29 (6–7)*: 437 (1938). Type: Dalmas *s.n.*, Mauritania, Cap Blanc, Banc d'Arguin, 5.v.1895 (P holotype).

Leurocline mauritanica Bonnet, *Bull. Mus. Natl. Hist. Nat. 14*: 403 (1908). Type: Chudeau *s.n.*, Mauritania, "In arenosis Africae occidentalis, circa Port-Étienne", 21.iii.1908 (P holotype).

Echiochilopsis coerulea Caball., *Trab. Mus. Nac. Ci. Nat., Ser. Bot. 30*: 10 (1935). Type: Caballero *s.n.*, Morocco, "Inter Tazarut et Promotorium Non (Ifni)", 11.vii.1934 (MA holotype, only seen on photo).

Echiochilon chazaliei var. *murati* Faurel & Dubuis, *Bull. Soc. Hist. Nat. Afrique N. 50 (7–8)*: 320 (1959). Type: Murat *s.n.*, Mauritania, "Aguerguer, presqu'ile de Cap Blanc", 22.i.1937 (MPU? holotype, not seen).

Echiochilon chazaliei f. *caeruleum* Maire, *Bull. Soc. Hist. Nat. Afrique N. 29 (6–7)*: 437 (1938). Type: Morocco, Goulimine reg., Oued Aoreora, 30.iii.1937, Maire 267 (B neotype, selected here).

Nomenclatural notes. The herbarium and types of Boissieu (*Echiochilon chazaliei*) should be in STR according to Stafleu & Richards (1976). As the type of *E. chazaliei* is not in STR, I consider the type in P to be the holotype.

The name *Echiochilon chazaliei* f. *pallidiflorum* is treated as a nomenclatural synonym

since Maire (1938) in his protologue wrote that it is the main form recognized by Boissieu. Although he chose another name, he intended it to be the form of the type of the species.

The holotype of *E. chazaliei* var. *murati* should, according to Faurel & Dubuis (1959), be in MPU but I have not been able to confirm this information.

In the protologue of *Echiochilon chazaliei* f. *caeruleum* no collection was mentioned, only the area, Aoreora. The collection Maire 267 from Aoreora, B, appears to be the only material available from that region and it agrees with the protologue. Furthermore, Maire 267 was collected the year before Maire published the new form and it is most probable that this collection is the material Maire referred to.

Description. Perennial shrublet with a woody base, up to *c.* 18 cm high, moderately to fairly richly branched. STEMS and older parts of branches, sometimes also younger parts, with white or greyish to yellowish incrusted bark, with prominent leaf scars, on older parts split up and flaking, young branches green, ± densely covered with appressed disc-based hairs; internodes up to 7 mm long. LEAVES alternate, but the basal ones often opposite, spathulate to ± narrowly obovate or oblong, (2–)5–12(−23) × 1.5–4 mm, obtuse or rounded at apex, cuneate or attenuate at base, fleshy, glaucous, somewhat decurrent, ± densely covered with appressed disc-based hairs on lower surface and with scattered (to many) hairs on the upper surface, often covered at base on the lower side with a short incrusted triangular or rounded extension of the crust on the stem, up to *c.* 1 × 1.2 mm; midrib inconspicuous; margins flat or almost so, hairy with appressed disc-based hairs. FLOWERS in quite short few-flowered cymes, terminating the leafy branches, inflorescences sometimes interrupted; pedicel 0.5–1.5 mm long, somewhat decurrent. BRACTS like the leaves, up to *c.* 8 × 1.7 mm, gradually smaller upwards. CALYX reaching nearly up to, to slightly beyond the constriction of the corolla tube; lobes 5, ± free, ± unequal in size, one of the abaxial the largest, in flower elliptic, less often oblanceolate or obovate 3–7 × 1.2–1.9 mm, somewhat larger in fruit, ovate to oblanceolate or obovate, acute to obtuse at the apex, the adaxial the smallest, ± densely covered with appressed disc-based hairs on outer surface, the lower half of the inner surface densely covered with hairs without obvious disc-bases; midrib not visible; margins flat or almost so, hairy with appressed disc-based hairs. COROLLA whitish-rose, mauve or violet-blue, obliquely trumpet-shaped, strongly zygomorphic with upper and lower lip, 11–15(−20) mm long, whitish villose inside the throat, below the constriction sparsely hairy, outside glabrous; tube 7.4–8 mm long, the adaxial side *c.* 1.9–2.9 mm longer than the abaxial, 1.2–1.5 mm in diam. at the base, slightly widened and then narrowed again to a waist near the middle, 1.2–1.6 mm in diam., widened to 2.5–3.7 mm in diam. at the throat; limb with the two adaxial lobes forming the upper lip, 1.7–2.9 × 3.9–7.1 mm, 2-lobed, extending beyond the lower lip formed by the three abaxial lobes; adaxial lobes rounded to broadly ovate, 2–3.9 × 1.8–3.9 mm, apex rounded; abaxial lobes rounded, 1.3–3.5 × 1.8–3.4 mm; margins of the corolla lobes ± crisped. STAMENS borne in the throat at two or three different heights 5–6.1 mm above the base with the adaxial one highest, the lateral in the middle position and the abaxial the lowest or the lateral and the abaxial in the lower position; anthers included, ± equal, 1.3–1.5 mm long; filaments flattened, of two or three different lengths, 0.3–0.7 mm long, the adaxial the longest, when of three lengths the lateral ones medium and the abaxial ones the shortest. STYLE 3.8–4.4 mm long; stigmas horizontal or almost so, 0.1–0.2 mm high, surmounted

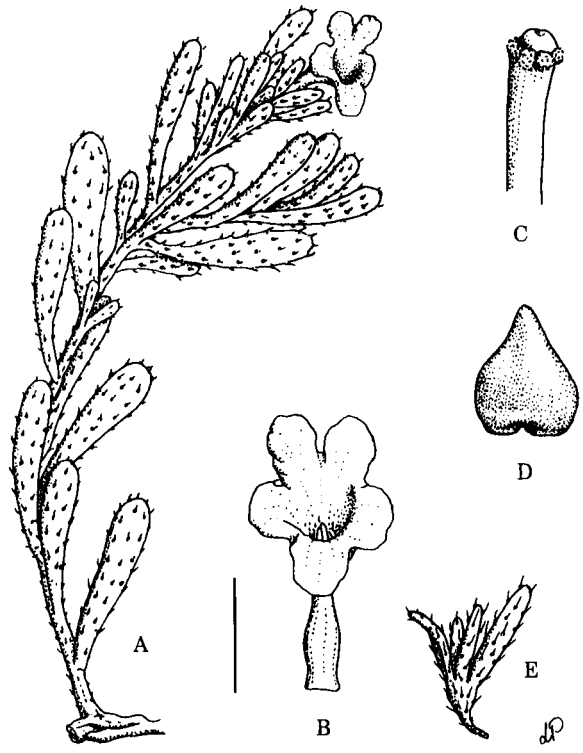

Figure 14. *Echiochilon chazaliei*. A, habit. B, corolla. C, stigmas and the sterile tip of the style. D, nutlet. E, calyx. A, B & E after Caballero (1935); C from Jacquemoud 4146, Morocco; D from Brettes, Panouse & Sauvage 2500 bis, Morocco. Scale bar: A = 10 mm; B & E = 5 mm; C = 1 mm; D = 2.5 mm.

by a sterile tip, somewhat notched or only with a very small depression on the top, protruding *c.* 0.1 mm beyond the stigmas. NUTLETS beige or whitish beige, ovoid in dorsal outline, 3–3.6(−4.5) × 2–3 mm, tuberculate, especially above the middle, or less often smooth, not ridged, not keeled, with coarsely rostrate apex, 1–4 developing, attachment ventral and basal; sulcus narrow, extending from just below the tip to the base, above the base slightly widened then abruptly expanding into the transversely oblong areola; areola 0.5–0.7 × 1.7 mm (Fig. 14).

Distribution and habitat. Echiochilon chazaliei is known from the surroundings of Ifni at the coast of southern Morocco, southwards to Cap Blanc (Nouâdhibou) in Mauritania (Fig. 13). It grows on sandy or stony ground on riverbanks or close to the sea at an altitude of 2–50 m. It is eaten by camels.

Variation and taxonomic remarks. Echiochilon chazaliei is a dwarf shrub with spathulate to narrowly obovate fleshy leaves, covered on both sides with appressed disc-based hairs. The corollas are strongly zygomorphic with a two-lobed upper lip.

Faurel & Dubuis (1959) described a var. *murati* on a collection that was also seen by Johnston (1957). According to the description it seems that the specimen (Murat

s.n., Mauritania, "Aguerguer, presqu'île de Cap Blanc", 22.i.1937; not seen) is unusually large, but I do not find it necessary to keep it as a variety.

There are also two forms described by Maire (1938). The colour of the corolla varies from mauve to violet-blue, and Maire (1938) was of the opinion that there are two different forms. The originally described species belongs to the form *pallidiflorum* which is whitishrose, violet-purple in the throat, while the other form, *caeruleum* is "beautifully" blue, and violet-purple at the base. Forma *caeruleum* is described from Aoreora where it is much more abundant (Maire, 1938) than f. *pallidiflorum*. Dobignard, Jacquemoud & Jordan (1992) found the value of the two forms doubtful because even the white or pink flowers are most often blue at the base.

The branches of *E. chazaliei* are terminated by the inflorescences. When conditions are good a leafy shoot terminated by a new inflorescence can develop at the apex of the inflorescence. This gives the impression that the inflorescences are interrupted. The nutlets most often have a tuberculate surface but they might also have a smooth surface and both types can be found on the same plant. In that case the smooth nutlets grow closer to the tip. It might be that the nutlets get their tubercles at a later stage, even though the smooth nutlets look ripe.

The closest relatives of *E. chazaliei* are *E. simonneaui*, *E. lithospermoides*, and *E. longiflorum*. *Echiochilon chazaliei* differs from *E. simonneaui* in having spathulate to narrowly obovate or oblong leaves with a rounded or obtuse apex, compared to the triangular leaves with an acute apex. It differs from *E. lithospermoides* and *E. longiflorum* in its only notched sterile tip of the style and its horizontal stigmas, compared to the bifid sterile tip and oblique stigmas found in *E. lithospermoides* and *E. longiflorum*.

The species was named after the yacht Chazalie, owned by the collector of the type, Comte de Dalmas.

Material studied. MOROCCO: Goulimine reg., Oued Aoreora, 22.i.1947, Brettes, Panouse & Sauvage 2500 bis (S). Tarfaya prov.: 8 km SW Tan-Tan on the rd. to Tarfaya, 28°26′N, 11°23′W, 27.iii.1990, Podlech 48574 (G); Wadi 8 km SW Tan-Tan on the rd. to Tarfaya, 28°26′N, 11°23′W, 27.iii.1990, Schuhwerk 90/280 (M); Near Sebkha Tazra, 120 km S of Tan-Tan, 27°56′N, 12°20′W, 19.iv.1989, Jacquemoud 4146 (G); Daya el Aouina 50 km E of Tarfaya, 24.iv.1985, Parker 11 (LIV); 26 km E Tarfaya on the rd. to Tan-Tan, 27°58′N, 12°43′W, 28.iii.1990, Podlech 48632 (G): 26 km E Tarfaya N of the rd. to Tan-Tan, 27°58′N, 12°43′W, 28.iii.1990, Schuhwerk 90/363 (M); 33 km E Tarfaya on the rd. to Tan-Tan, 27°56′N, 12°42′W, 11.iv.1986, Podlech 40449 (G). 20 km NE of Cabo Bojador, 26°08′N, 14°30′W, 20.iv.1989, Jacquemoud 4157 (G). Dekhla: Cabo Barbas, 9.xii.1990, Levalle 13267 (BR). MAURITANIA: Within 100 km from Port-Étienne, 1936, Waterlot 1558 (P); Surroundings of Port-Étienne all the way to Cap Blanc, ii–iii.1909, Caille 25422 (P).

6. Echiochilon simonneaui

Echiochilon simonneaui Faurel & Dubuis, *Bull. Soc. Hist. Nat. Afrique N. 50 (7–8)*: 316 (1959). Type: Simonneau *s.n.*, Morocco, Hassi Janguet Quesat, 1.iv.1959 (P holotype, isotype).

Description. Perennial shrublet with a woody base, *c.* 20–30 cm high, moderately branched ± erect. STEMS and older parts of branches with white, incrusted, flaking bark, young branches green, finely ribbed, scabrid with scattered, rigid, spreading cones-shaped, bulbous-based hairs, often slightly hooked upwards; internodes 2–10 mm long. LEAVES alternate, narrowly triangular, 5.5–12 × 2–3 mm, acute at the apex, somewhat clasping at the base, somewhat decurrent, with white incrusted, rigid, spreading cone-shaped, bulbous-based hairs on the midrib below and the margins, glabrous above, at base on the lower side covered with a long incrusted triangular extension of the crust on the stem, up to 2.2 × 1.2 mm; midrib marked by the hairs, otherwise not very conspicuous; margins somewhat involute, ciliate and thickened by the bulbous bases of the hairs. FLOWERS axillary, subsessile with pedicel up to *c.* 0.5 mm long, somewhat decurrent, in elongate, erect, ± unilateral cymes, terminating the leafy branches, up to 8 cm long. BRACTS like the leaves, up to 12 × 2.8 mm, gradually smaller upwards. CALYX with the largest lobe reaching beyond the constriction of the corolla-tube; lobes 5, very unequal in size, one of the abaxial the largest, in flower narrowly ovate, 5–7 × 1.1–1.4 mm, in fruit narrowly ovate to ovate, 7–8 × 2–2.5 mm, with acute apex, the adaxial rudimentary, with white incrusted, rigid, slightly upwards-hooked or bent bulbous-based hairs on the midrib and margins on the outside, inside prominently hairy at the base; midrib sometimes conspicuous in fruit; margins flat or almost so, ciliate, in fruit somewhat thickened by the cushion-shaped bases of the hairs. COROLLA pink-lilac, narrowly obliquely funnel-shaped, strongly zygomorphic with upper and lower lip, 10.4–14 mm long, whitish villose inside the throat, below the constriction sparsely hairy, outside glabrous; tube 5.6–7.5 mm long, the adaxial side *c.* 2–3 mm longer than the abaxial, *c.* 1.3 mm in diameter at the base, slightly widened, then narrowed again to a waist near the middle, 1–1.2 mm in diameter, widened to 1–1.8 mm in diameter at the throat; limb with the two adaxial lobes forming a v-shaped upper lip, 3.2–4 × 3.6–3.7 mm, extending beyond the three abaxial lobes forming the lower lip; adaxial lobes oblong, 1.7–2.8 × 1.5–1.7 mm, apex obtuse; abaxial lobes rounded triangular, 1.1–2.4 × 1.4–2.2 mm, the middle the largest. STAMENS borne in the throat at slightly unequal heights with the adaxial one at a higher level than the others, 5.8–6.2 mm above the base, the four lower 5.2–5.7 mm above the base; anthers included, equal, 0.9–1 mm long; filaments unequal in length with the adaxial one longer than the others, 0.4–0.5 mm long, the four shorter 0.2–0.3 mm long. STYLE 4–5.2 mm long; stigmas horizontal or almost so, 0.07–0.09 mm high, the abaxial side highest, surmounted by a ± clavate sterile tip with a very small depression on the top, protruding 0.04–0.08 mm beyond the stigmas. NUTLETS beige-brown, ovoid, *c.* 3 × 2.2 mm, tuberculate, not ridged, somewhat keeled, usually 2–3 developing, attachment ventral and basal; sulcus narrow, extending from the tip to the base, above the base slightly widened then abruptly expanding into the transversely oblong areola; areola *c.* 0.33 × 1.5 mm (Fig. 15).

Distribution and habitat. Echiochilon simonneaui is only known from one collection from Morocco (Fig. 13). It was discovered at Hassi Janguet Quesat during a survey. There it forms the dominant vegetation on the slopes of the valley Seguiet el Hamra, SW of the plateau Hamada du Draa. There might be more of it along the valley, but it is not found in the surrounding areas (particularly Hamada du Draa and Zemmour) which have been more thoroughly explored (Faurel & Dubuis, 1959). It is ecologically separated from *E. chazaliei*, which is an oceanic species in contrast to *E. simonneaui*

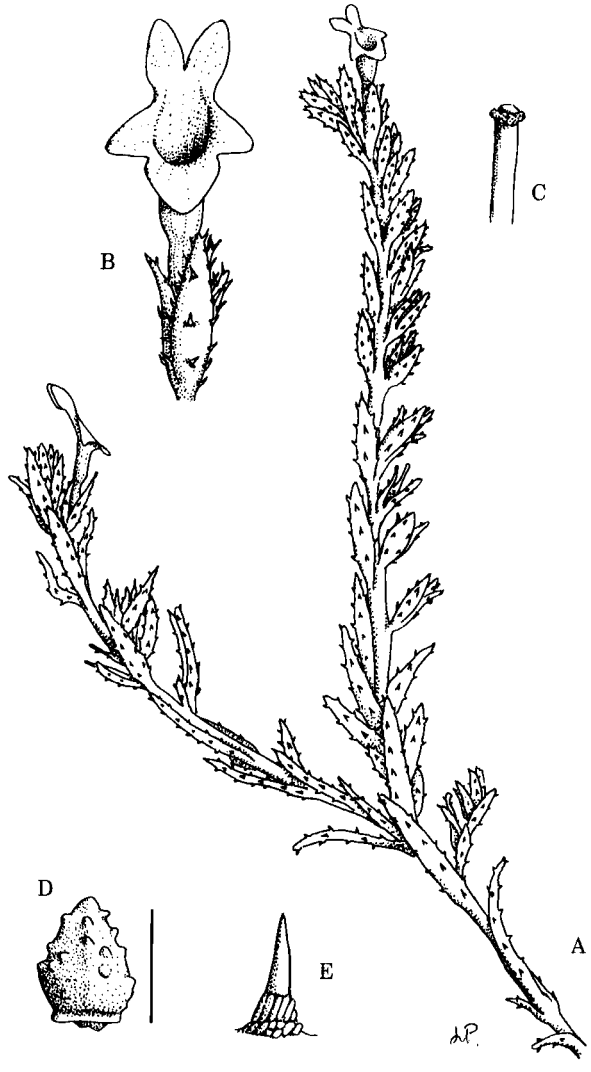

Figure 15. *Echiochilon simonneaui*. A, habit. B, corolla and calyx. C, stigmas and the sterile tip of the style. D, nutlet. E, cone shaped hair with a multicellular base. All from Simonneau *s.n.* (A, B, C & E from the holotype; D from the isotype), Morocco. Scale bar: A = 10 mm; B = 5 mm; C & E = 1 mm; D = 2.5 mm.

which is a semi-desert species with the same type of ecology as *E. fruticosum*. The latter species does not grow closer to the area of *E. simonneaui* than *c.* 800 km (Faurel & Dubuis, 1959).

Variation and taxonomic remarks. This very rare plant is a shrublet with the zygomorphic flowers in elongate unilateral cymes terminating the leafy branches, and leathery, narrowly triangular leaves. It has remarkably thick and rigid encrusted hooked hairs scattered on the vegetative parts of the plants. Everything that is encrusted on this plant, particularly the bases of the hairs and the margins of leaves and calyces, shows a clearly visible structure of empty cells with only the encrusted cell-walls left.

The closest relatives of *E. simonneaui* are *E. longiflorum* and *E. lithospermoides*. *Echiochilon simonneaui* differs from both these species in having a depressed sterile tip of the style only and horizontal stigmas compared to the bifid sterile tips and oblique to strongly oblique stigmas in *E. longiflorum* and *E. lithospermoides*.

Material studied. No specimens other than the type have been collected of this species.

7. *Echiochilon lithospermoides*

Echiochilon lithospermoides (S.Moore) I.M.Johnst., *Contr. Gray Herb. 73:* 50 (1924). 50 (1924). *Leurocline lithospermoides* S.Moore, *J. Bot. 39:* 257 (1901). *Lobostemon lithospermoides* (S.Moore) Baker, in Dyer, *Fl. Trop. Afr. 4 (2):* 60 (1906). Type: Gregory *s.n.*, Kenya, Laikipia, vi.1893 (BM lectotype, selected here).

Nomenclatural note. Three syntypes were cited in the protologue of *E. lithospermoides*, Gregory *s.n.* from Kenya and two unnumbered collections of Delamere from different localities in Ethiopia. Since the two Delamere collections were mounted on the same sheet and not clearly separated, I choose the Gregory collection as the lectotype.

Description. Perennial herb or shrublet with a ± woody base, (15–)30–60 cm high, often glaucous, moderately branched, ± erect. STEMS and older parts of branches with brownish or greyish incrusted, flaking bark, young branches green, finely ribbed, ± hispid with scattered disc-based hooked or bent hairs or only discs; internodes up to 13 mm long. LEAVES alternate, lanceolate to oblong or ovate-lanceolate, 12–25(–45) × 1.5–5 mm, acute to subacute (rarely rounded) at the apex, shortly cuneate at the base, somewhat decurrent, hispid with disc-based hooked or bent hairs or ± covered with only discs below, glabrous above, midrib ± well marked; margins flat or almost so and sometimes thickened by the bases of the hairs, ciliate with ± spreading disc-based hairs. FLOWERS in well defined, elongate, erect, ± unilateral, many-flowered cymes, usually 20–40(–55) cm long, terminating the branches; pedicel 1–2 mm long, somewhat decurrent. BRACTS like the leaves, 8–20 × 2–4 mm, gradually smaller upwards. CALYX equalling the corolla tube, reaching up to the limb; lobes 5, ± free, unequal in size, one of the abaxial the largest, in flower lanceolate, 5–9.5 × 1–1.8 mm, tapering, acute or tapering at the apex, in fruit narrowly ovate, 9–13 × 2–4 mm, acute to acuminate at the apex, the adaxial the smallest, in flower linear to narrowly lanceolate, up to 5 × 0.6 mm, with scattered hooked disc-based hairs on outer surface, inside glabrous except for a few simple hairs at the base; midrib ± conspicuous; margins flat or somewhat involute and sometimes thickened by the bases of the hairs, ciliate with ± spreading disc-based hairs. COROLLA reddish to bluish, strongly zygomorphic with upper and lower lip, obliquely funnel-shaped, 9–15 mm long, white villose inside the throat, below the constriction with short white hairs or almost glabrous, outside glabrous; tube 6.5–8.5 mm long, the adaxial side *c.* 3–6 mm longer than the abaxial, 1–1.2 mm in diam. at the base, slightly widened and then narrowed again to a waist 0.7–1.2 mm in diam. near the middle, widened to 4–8 mm in diam. at the throat; limb with the two adaxial lobes forming the 2-lobed erect upper lip, 4–7 × 5–8 mm, extending beyond the lower lip; lower lip formed by the three abaxial lobes; adaxial lobes rounded, 1.3–2.5 × 2.4–3.2 mm, apex rounded; abaxial lobes rounded, 1.2–1.6 × 2–3 mm, apex rounded. STAMENS borne in the throat at three different

heights, 4.6–6.8 mm above the base, the adaxial one highest, the lateral ones in middle position, the abaxial ones lowest; anthers included, all equal, 1.1–1.3 mm long; filaments of three different lengths, 0.2–0.8 mm long, the adaxial one the longest, the lateral ones medium, the abaxial ones the shortest. STYLE 3.7–4.4 mm long; stigmas oblique, 0.05–0.12 mm high, surmounted by a bifid sterile tip protruding (0.05–)0.1–0.2 mm beyond the stigmas. NUTLETS reddish brown to dark brown, ovoid to broadly ovoid in dorsal outline, 2.1–2.9 × 1.6–2.8 mm, tuberculate, with or without an imperfectly developed longitudinal ridge at the middle of the dorsal side, keeled on the ventral side, with rostrate or conoidal apex, usually 3–4 developing, attachment ventral and basal, sometimes with prominent scar tissue; sulcus narrow, extending from the tip or just below the tip to the base, above the base slightly widened then expanding into the areola; areola triangular to transversally oblong, 0.5–0.8 × 1–1.7 mm (Fig. 16).

Distribution and habitat. Echiochilon lithospermoides is known from Sidamo Region in Ethiopia and from Northern Frontier, Central and Masai Provinces in Kenya (Fig. 13). It grows on grassland, open bushland or in sparse *Acacia* woodland, often in red loam or sandy soil sometimes on limestone. It can also be found as a weed in cultivated fields and on wasteland. The known altitudinal range is 850–2100 m.

Variation and taxonomic remarks. Echiochilon lithospermoides is a shrublet with the zygomorphic flowers in elongate unilateral cymes terminating the leafy branches. The colour of the corolla is often dark reddish. The notes on the colour of the corollas on the herbarium sheets are variable. There are notes of blue, plum-coloured, pink to purple corollas and of blue, plum, purple or red corollas fading to blue, violet, pink, red or purple. I assume that the change of colour goes in the same direction for all individuals and it is probably from pinkish, reddish or purple to bluish. The corollas may also be partly orange and can sometimes have red spots.

The closest relatives of *E. lithospermoides* are *E. longiflorum*, *E. chazaliei* and *E. simonneaui*. *E. lithospermoides* differs from *E. longiflorum* in the shape of the upper lip of the corolla, which is rounded to rectangular rather than heart-shaped, in its wider adaxial corolla lobes, and in its plump dark brown nutlets, rarely with two vaguely expressed basal lobes on the dorsal side, compared to the nutlets of *E. longiflorum* which are cordate and reddish or ovoid and whitish to beige. *Echiochilon lithospermoides* differs from the *E. simonneaui* and *E. chazaliei* in having a conspicuously bifid sterile tip of the style and oblique stigma lobes, and also in the leaf shape and indumentum. *Echiochilon chazaliei* has spathulate to narrowly obovate leaves without visible midrib, covered with appressed hairs, each hair with a discoid base. *Echiochilon simonneaui* has narrowly triangular leaves with slightly hooked cone-shaped hairs on the midrib and margins, each hair with a bulbous base.

Material studied. ETHIOPIA: Sidamo Region. Yabalo: (Boran), 14.vii.1893, Riva & Ruspoli 1479 (FT); (Boran), ii–vi.1937, Cufodontis 479 (FT, W); 19.ix.1953, Bally 9262 (K); 11.i.1954, Mooney 5503 (K); Near airfield 16 km NW of town, 27.v.1974, Sandford in Ash 2628 (K); Old airfield 15 km NNE of Yabalo, 4°59′N, 38°13′E, 14.v.1976, Gilbert & Jefford 4524 (K); 58 km SE of Yabalo on Nairobi rd., 4°50′N, 38°06′E, 24.xii.1974, Ash 2798 (K, UPS). 14 km S of Nagele along rd. to Melka Guba, 18.v.1982, Friis, Mesfin Tadesse & Vollesen 3049 (K, UPS). Nagele: 23.x.1937, Vàtova 231 (FT); 27.ix.1939, Corradi 8237 (FT); 26–29.ix.1939, Corradi 6230 (FT); 2 km SW of Nagele, 17.vii.1962, Burger 1842 (FT, K). 10 km along rd. from Nagele

Figure 16. *Echiochilon lithospermoides*. A, habit. B, corolla and calyx. C, nutlet. D, stigmas and the sterile tip of the style. A–C from Flora of Tropical East Africa (Verdcourt 1991; rearranged and published with permission from Royal Botanic Gardens, Kew), Kenya; D from Gilbert & Thulin 1460, Kenya. Scale bars: A = 20 mm; B = 10 mm; C = 2.5 mm; E = 1 mm.

to Filtu, 5°19′N, 39°40′E, 18.vii.1970, de Wilde 6685 (K, M). 16 km SE of Nagele along rd. to Filtu, 5°15′N, 39°40′E, 2.ii.1972, Friis, Gilbert, Rasmussen & Vollesen 871 (K). Between Mega and Melka Guba, 26.iv.1939, Corradi 6206 (FT); 6 km S of Uacille-Moyale rd., 6.vi.1988, Gilbert & Sebsebe 8700 (K); 6 km SW of Mega, along the track to Sako village, 4°01′N, 38°19′E, 27.ii.1971, de Wilde & Gilbert 380 (K); Mega, 27.iv.1939, Corradi 6389 (FT); Mega, 10.ix.1939, Corradi 6284 (FT); Mega, 8–24.ix.1939, Corradi 6399 (FT); Moyale–Mega rd., 3°44′N, 38°50′E, 10.xi.1952, Gillet 14191 (B, BM, FT, K, S, W); Delamere *s.n.*, Gof at 3800 ft &

between Lé and Tocha, 1898 (BM). KENYA: Northern Frontier Province: Mandera distr., 5 km E of junction of Banisa and Derkali roads, 3°55′N, 40°22′E, 5.v.1978, Gilbert & Thulin 1460 (K, UPS); Banisa, 27.vi.1951, Kirika 92 (K). Rift Walley Province: NE Aberdare, 22.ix.1916, Dowson 551 (K); NE slopes Aberdare, Rumuruti, 22.ix.1916, Dowson 554 (K); Laikipia distr., Inland of Ewaso Narok Swamp, viii.1971, Kokwaro & Mathenge 2816 (K); 3 km N of Kisima farm buildings, 43 km N of Rumuruti, 0°13′N, 36°45′E, 13.xi.1977, Carter & Stannard 360 (K); Kisima Farm, 11.vi.1972, Bally 15039 (M); 40 km N of Rumuruti on rd. to Marala, 10°31′N, 36°38′E, 25.x.1978 Gilbert, Gachathi & Gatheri 5070 (K); Ca. 48 km on Maralal-Rumuruti rd., 21.ix.1974, Williams 7417 (K). Central Province: Sultan Hamud, 30.xii.1971 Kokowaro 2899 (K). Masai Province: N Kilimanjaro, 42 km from Laitokitok on rd. to Kajiado, ix.1952, Bally 8323 (K); Amboseli game reserv, 13.ix.1954, Bally 9863 (K, S); Kajiado distr., 5.ii.1964, Verdcourt 3972 (K); Amboseli-Emali rd., 10.ii.1964, Napper 1723 (K).

8. Echiochilon longiflorum

Echiochilon longiflorum Benth., in Hook.f., *Icon. pl. 13:* 60, plate 1277 (1879). Type: Wykeham Perry 9, Yemen, Aden, iii.1878 (K holotype).

Lobostemon somalensis Franch., *Sert. somal.:* 44 (1882). *Leurocline somalensis* (Franch.) S.Moore, *J. Bot. 39:* 258 (1901). *Echiochilon somalense* (Franch.) I.M.Johnst., *Contr. Gray Herb. 73:* 50 (1924). Type: Revoil 78, Somalia, without precise locality (P holotype).

Echiochilon adenophorum I.M.Johnst., *J. Arnold Arbor. 38:* 276 (1957). Type: Glover & Gilliland 1181, Somalia, Woqooyi Galbeed Region, rocky slopes of Goldither at 400 ft., behind Karin near Berbera, 24.iv.1945 (BM holotype; EA, K isotypes).

Description. Annual to perennial herb or shrublet with a ± woody base, 5–45 cm high, often glaucous, moderately to fairly richly branched, sometimes with glandular hairs, just a few or abundant covering the vegetative parts, and sometimes also the corollas. STEMS and older parts of branches sometimes with chalky-white to beige encrusted, flaking bark and sometimes also with well marked leaf-scars, young branches green, finely ribbed, glabrous to hispid with disc-based or bulbous-based hooked, bent or spreading hairs or only discs; internodes up to 21 mm long. COTYLEDONS sometimes persisting, obcordate, at least when from cordate nutlets, up to 7 × 6 mm, with petiole *c.* 4.5 mm long. LEAVES alternate, or basal ones rarely opposite (in one case most of the leaves are opposite), narrowly lanceolate or narrowly oblanceolate to broadly ovate or obovate, 3–40 × 1–9 mm, acute to obtuse at the apex, shortly cuneate, cuneate or attenuate (rarely clasping) at the base, rarely fleshy, normally spreading or somewhat recurved, sometimes somewhat decurrent, almost glabrous to hispid with disc-based or bulbous-based hooked, bent hairs or ± covered with only discs below, most often glabrous above but sometimes with scattered discs or ± disc-based appressed hairs, more rarely covered with bulbous-based hooked hairs on both surfaces, rarely covered at base on the lower side with a short incrusted triangular extension of the crust on the stem, up to *c.* 2 × 1 mm; midrib well marked or not; margins flat or almost so to strongly involute, sometimes thickened by discs or the bases of the hairs, ciliate with appressed to spreading disc-based or bulbous-based hairs or with discs only. FLOWERS in well defined, elongate, erect, ± unilateral, ± many-flowered cymes, 2–30 cm long, terminating the

branches; pedicel 0.5–4 mm long, sometimes somewhat decurrent. BRACTS like the leaves, 2–25 × 0.5–4 mm, gradually smaller upwards. CALYX less than half as long to equalling the corolla tube; lobes 4–5, ± free (in one case united up to 3 mm), somewhat to very unequal in size, one of the abaxial the largest, in flower narrowly lanceolate to ± narrowly ovate (ovate) 2.5–8.3 × 0.5–2 mm, tapering, acute to obtuse at the apex, in fruit narrowly ovate to ovate, 3–10 × 0.7–3 mm, the adaxial the smallest, in flower linear to narrowly lanceolate, up to 3.6 × 0.8 mm, sometimes rudimentary or absent, with scattered discs or hooked to appressed disc-based or bulbous-based hairs on outer surface, inside glabrous except for a few simple hairs at the base, or rarely with appressed hairs or only discs scattered over the whole surface; midrib in fruit ± conspicuous; margins sometimes somewhat involute and somewhat thickened by discs or the bases of the hairs, ciliate with ± spreading disc-based or bulbous-based hairs or with discs only. COROLLA reddish, bluish, yellowish or white with reddish, bluish, yellowish or white tube sometimes bluish at base, with white, reddish, bluish or yellowish limb with reddish markings or lilac lines, white or less often dull yellowish inside, sometimes purplish orange, yellowish or with reddish or purple markings in the throat, zygomorphic to strongly zygomorphic, with upper and lower lip, obliquely funnel-shaped, 5.6–16 mm long, white villose in the throat, with short white hairs inside the tube or almost glabrous, outside glabrous or rarely with short glandular hairs; tube 3.7–10 mm long, the adaxial side *c.* 0.4–4 mm longer than the abaxial, 0.7–1.5 mm in diam. at the base, slightly widened and then narrowed again to a waist 0.6–1.2 mm in diam. near the middle, widened to 1–4.5 mm in diam. at the throat; limb with the two adaxial lobes forming the v-shaped or heart-shaped upper lip, 0.5–5 × 1.2–5 mm, erect or bent backwards, extending beyond the lower lip; lower lip formed by the three abaxial lobes, sometimes folded to a rim around part of the mouth; adaxial lobes oblong to rounded, 0.5–3.2 × 0.4–2 mm, apex rounded; abaxial lobes elliptic to rounded, 0.5–1.6 × 0.5–2 mm, apex rounded. STAMENS borne in the throat at three different heights or at equal height, 3–7.5 mm above the base, when unequal the adaxial one highest, the lateral ones in middle position, the abaxial ones lowest; anthers included, all equal, 0.4–1.3 mm long; filaments unequal to ± equal in length, 0.1–0.7 mm long, when unequal the adaxial one the longest, the lateral ones medium, the abaxial ones the shortest or the adaxial one longer than the rest. STYLE 1.8–5.6 mm long; stigmas oblique to strongly oblique, 0.04–0.12 mm high, surmounted by a bifid sterile tip protruding 0.02–0.12 mm beyond the stigmas. NUTLETS reddish, beige or grey, conspicuously cordate to ovoid in dorsal outline, 1.3–2.4 × 1.2–2.1 mm, tuberculate, with or without an imperfectly developed longitudinal ridge at the middle of the dorsal side, ventral side keeled or not, with rostrate or conoidal apex, 1–4 developing, attachment ventral and basal; sulcus narrow, extending from the tip or just below the tip to the base, above the base sometimes first slightly widened then expanding into the areola; areola triangular, triangular with down-curved ends, transversally oblong or boomerang shaped with down-curved ends, 0.1–0.6 × 0.3–1.3 mm (Fig. 17).

Distribution and habitat. Echiochilon longiflorum is known from Oman, Yemen, Ethiopia and Somalia (Fig. 13). It grows on open sandy or rocky habitats on volcanic ground, limestone or gypsum, or in grassland or open bushland. The known altitudinal range is from sea level up to about 950 m.

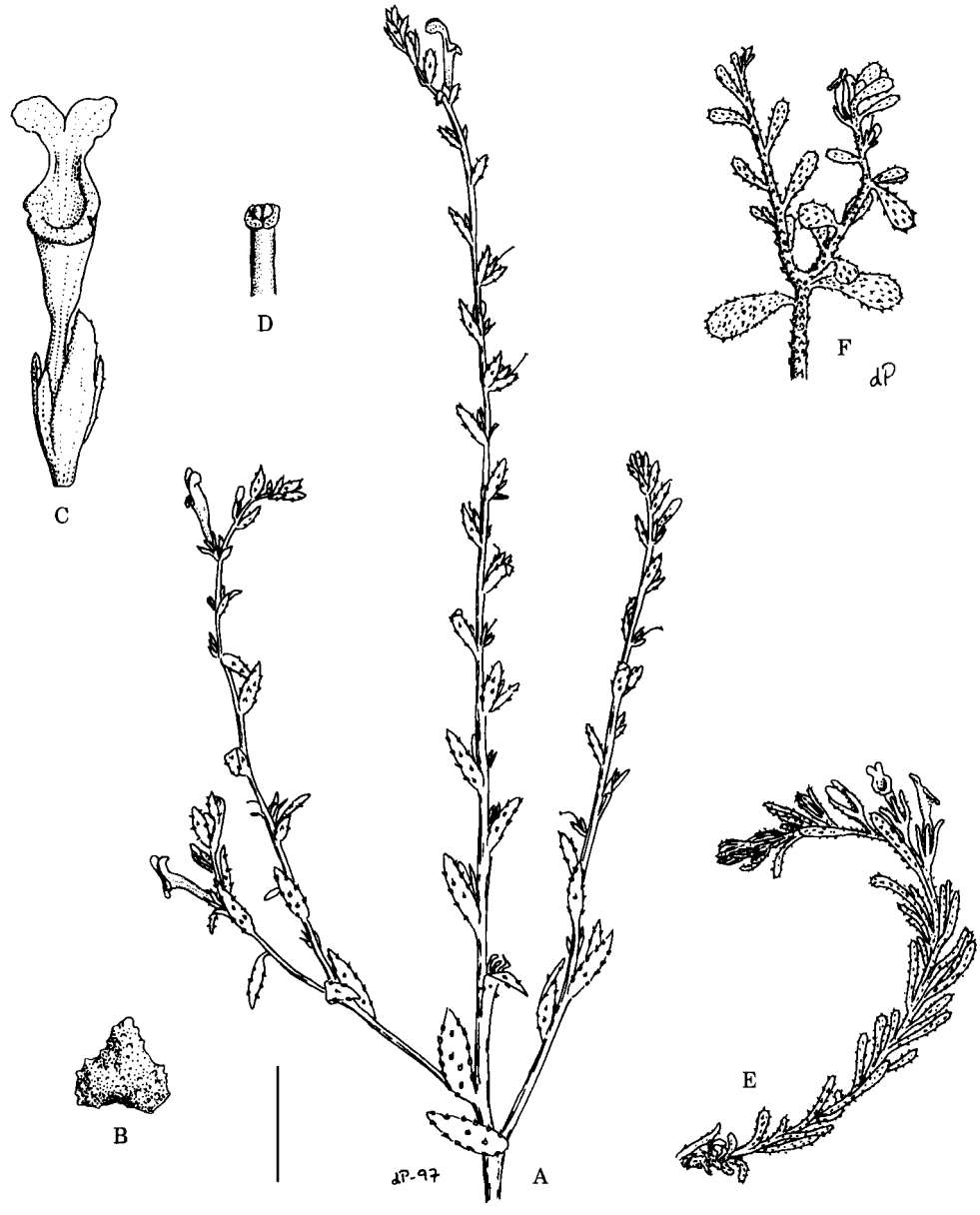

Figure 17. *Echiochilon longiflorum*. A, habit of the form agreeing with the type (group A). B, nutlet. C, corolla and calyx, D, stigmas and the sterile tip of the style. E, habit of group D, the gypsum form from central Somalia. F, habit of group E, the yellow-flowered form from the coast north of Hobyo, Somalia. A & D from Thulin 8500, Yemen. B, C & E from Elmi & Hansen 4094, Somalia. F from Thulin & Dahir 6662, Somalia. Scale bar: A = 20 mm; B = 2.5 mm; C = 5 mm; D = 1 mm; E & F = 10 mm.

Vernacular names. Kaxandho (Somalia, Hiiraan Region), Kabaageye (Ethiopia, Hararge Region, Uardede well), Sintar (Somalia, Woqooyi Galbeed Region, Karin), Nagaar (Somalia, Hiiraan Region, Jalalaqsi), Xagiin (Somalia, Galguduud Region, Nooleeye village).

Variation and taxonomic remarks. Echiochilon longiflorum is a widespread and variable species. Several partly geographically correlated forms can be recognized, and are described below as groups A–F. The characters that are unique to any of the groups and/or different from the typical *E. longiflorum* (group A) are discussed.

It is possible that some of these forms actually are species, especially group E (see below), the yellow-flowered form from the coast north of Hobyo in the Mudug Region. This form is distinct in leaf and hair morphology, but since it shares flower morphology with the other forms and since there are only gradual differences in size, I choose to keep it as a form of *E. longiflorum*.

The closest relatives of *E. longiflorum* are *E. lithospermoides*, *E. chazaliei* and *E. simonneaui*. *Echiochilon longiflorum* differs from the two latter species in having a conspicuously bifid sterile tip of the style and oblique stigma lobes, and from *E. lithospermoides* in having reddish cordate or whitish to beige ovoid nutlets, compared to the dark brown ovoid nutlets found in *E. lithospermoides*, *Echiochilon chazaliei* has spathulate to narrowly obovate leaves without visible midrib, covered with appressed hairs, each hair with a discoid base. *Echiochilon simonneaui* has narrowly triangular leaves with slightly hooked coneshaped hairs on the midrib and margins, each hair with a bulbous base.

Group A. This group contains and agrees with the type of *E. longiflorum*. It is widespread, the localities are very scattered and the plant appears nowhere to be particularly common (Fig. 17A).

Annual to short-lived perennial herbs, 5–45 cm high, with scattered discs to hispid with disc-based hairs. Leaves lanceolate. Corollas 12–16 mm long, white, yellow, pink, blue, with the upper lip v-shaped, usually bent backwards towards the adaxial side. Nutlets deeply cordate with a rostrate apex.

It grows in the Zufar Region in Oman, the Aden area in Yemen, Togdheer, Bari and Hiiraan Regions in Somalia, and the Hararge Region in Ethiopia. It grows on sand or on dry rocky or gravelly slopes on volcanic ground and with an altitudinal range from sea level up to about 500 m (Mats Thulin, pers. comm.).

One Somali name, Kaxandho, and two other local names, Kabaageye and Kabaaseye, are documented.

This form is very uniform in most characters throughout its distribution range, though there are some characters which are variable. In Oman, Yemen and the Togdheer Region in Somalia it has glabrous stems and only scattered discs on leaves and calyces, in Ethiopia and in the Bari and Hiiraan Regions in Somalia it is ± hispid with spreading hairs. There is a considerable variation in the colour of the corolla. In Oman the corolla is pinkish yellow with powdery blue base, in Yemen the corolla has the tube blue outside and the limb white with red markings, in northern Somalia it has a blue tube and pale lilac limb, in Ethiopia it is lilac or red, and in central Somalia the corolla has a blue outside to the tube and white limb with dark red to purple markings in the throat or the tube white and the limb blue with pink markings in the throat.

Group B. This group is a mixture of forms growing in NE Somalia, some specimens agreeing with group D from central Somalia. The *E. longiflorum* plants with the smallest leaves and flowers are found in this group.

Perennial shrublets, up to 30 cm high, sometimes with plenty of glandular hairs on the vegetative parts, and sometimes also on the corollas. Leaves narrowly ovate to narrowly oblanceolate, with involute or ± flat margins, less hairy to hispid.

Corollas 5–10 mm long, narrow, reddish, bluish, yellowish or white. Nutlets somewhat cordate to ovoid, reddish to beige.

This group is distributed in the Woqooyi Galbeed, Togdheer, Nuugaal and Bari Regions in Somalia. The plants grow mostly on gypsum or limestone, on sandy and stony ground at altitudes between 120 and 950 m.

A local name, Sintar, is documented for the glandular form from the surroundings of Karin.

This group is variable and contains very small to medium size-flowered forms with very short to long leaves. The type of *E. adenophorum* belongs in this group and agrees also with group D, the gypsum-form from Mudug and Galgaduud Regions in central Somalia.

Group C. A form with glaucous, almost glabrous perennials reminding of the typical *E. longiflorum* from Yemen and Oman.

Perennial glaucous herbs, up to 40 cm high, almost glabrous or with scattered discs, older parts of the stems sometimes covered with chalky-white flaking bark with conspicuous leaf-scars. Leaves elliptical, oblanceolate or broadly ovate, subacute to obtuse at the apex, cuneate to clasping at the base, sometimes with an encrusted triangle at the base on the lower side as a continuation of the crust on the, sometimes the lowermost leaf pairs opposite or most of the leaves opposite. Calyx lobes in flower narrowly to broadly ovate with acute to obtuse apex, ± united at the base up to 3 mm, covering the corolla tube only halfway to the constriction. Corollas 11–14 mm long, blue, pinkish or yellowish, with the upper lip ± heart-shaped and not as large as that of the typical *E. longiflorum* (group A). Nutlets more plump than the typical *E. longiflorum*, ovoid to somewhat cordate, beige or reddish beige.

This form is found in the Nuugaal Region in Eyl and in the Bari Region (exact locality not known) in northeastern Somalia. It grows on limestone.

This form has some characters that are unique within *E. longiflorum*, but found elsewhere in *Echiochilon*: the encrusted triangles on the stems at the base of the leaves, the opposite leaves, and the broadly ovate calyx lobes that are united at the base. The calyx lobes also cover a lesser part of the corolla tube than normally found within the species.

Group D. A group of small hispid shrublets, mostly growing on gypsum (Fig. 17E).

Perennial shrublets, 13–20 cm high, hispid, sometimes with plenty of glandular hairs on the vegetative parts, and sometimes also on the corollas. Leaves strongly involute, narrowly lanceolate to narrowly oblanceolate. Corollas 6–10 mm long, white or rarely pinkish or pale blue, sometimes dull yellowish or purplish orange inside the throat (limb with pale lilac lines). Nutlets ovoid to slightly cordate, whitish, beige to reddish beige.

The plants of this form are found in the Mudug and Galgaduud Regions in central Somalia. They grow mostly on gypsum at altitudes between 140 and 350 m.

What is special in this form compared with the rest of *E. longiflorum* is that it often has scattered appressed hairs on the upper surface of the leaves and on the inner surface of the calyx lobes.

Group E. A group of only three collections, but distinct from the other groups in leaf shape and hairs on leaves (Fig. 17F).

Dwarf shrublets, up to *c.* 8 cm high, covered with hooked hairs, each with a multicellular bulbous base. Older parts of the stems have chalky-white encrusted

bark. Leaves obovate (in one collection reddish), rounded at the apex, attenuate at the base, without a visible midrib. Corollas *c.* 6.5 mm long, yellow, with the upper lip heart-shaped. Nutlets somewhat cordate, beige.

This form is found close to the coast of the Mudug Region, north of Hobyo in central Somalia, at an altitude of 15–70 m. It grows on limestone.

Everything that is encrusted on this plant has a clearly visible structure of empty cells with only the encrusted cell-walls left. This is not seen elsewhere in *E. longiflorum*, but only in the related *E. simonneaui*. It also differs from the rest of *E. longiflorum* in that both sides of the leaves are equal and covered with short hooked bulbous-based hairs.

Group F. A local form that reminds of group A except that it forms shrublets. It is quite common in some regions in southern Somalia,

Shrublets, up to 40 cm high, with few disc-based hairs or only discs on the stem, sometimes also glandular hairs covering the whole plant. Leaves oblanceolate or less often oblong, with scattered discs or disc-based hairs on the lower side or only on the margins. Corollas 6.5–12 mm long, white or rarely pale blue. Nutlets ovoid, slightly cordate to cordate, beige or reddish beige.

A form growing in the coastal part of the Galgaduud Region and in the nearby parts of Mudug, Hiiraan and Shabeellaha Dhexe Regions. It grows in open bushland on orange sand or on limestone at an altitude of 90–340 m. These plants are eaten by goats and camels all the year round, and also browsed by game.

Two Somali names for this form are documented, Nagaar and Xagiin.

Material studied. OMAN: Dhofar: 3 km E of Wadi Afal on new road to West, W of Mughsayl, 14.ix.1989, Miller & Nyberg M.9362 (E). YEMEN: Aden or "Terim", v.1930 (K). Aden: 1884, Yerbury 21 (BM); 19.ii.1900, Birdwood *s.n.* (K); viii.1900, Cooke *s.n.* (BM); xii.1927, Moreau 5594 (K);1959, Gold Mohur valley, Waring 155 (K). SOMALIA: Plan W of "Mugub", 2.iv.1949, Guichard 10646 (EA); "Gombaho", iii.1949, Guichard 10761 (EA). Togdheer Region: Dubriat Mt., 10°22′N, 45°10′E, 3.i.1933, Gillett 4787 (K). Bari Region: 10°33′N, 49°39′E, 17.xi.1980, Beckett 584 (EA, K); 15.xi.1980, Beckett 558 (EA, K); 40 km on the Beeli Wacatay to Hamur road, 28.ix.1986, Thulin & Warfa 6149 (UPS, K, MOG); Qardho airstrip, 9°32′N, 49°07′E, 27.xii.1980, Beckett 669 (EA); Qardho airstrip, 9°32′N, 49°07′E, 12.vi.1981, Gillett 23399 (EA, K); 28 km S of Qardho on road to Eyl, 5.i.1973, Bally & Melville 15580 (EA, K). Nugaal Region: 3 km N of Oog, 8°58′N, 46°40′E, 21.vi.1979, Hansen & Heemstra 6202 (EA, K); 9°19′N, 48°36′E, 17.vi.1981, Beckett 1100 (EA, K); Yaka Grasing Reserv, 36 km SE of Qardho 9°10′N, 49°15′E, 26.vi.1979, Hansen & Heemstra 6274 (EA); Hills SW of Laascaanood, 5.ii.1982, Thulin 4199 (UPS); 8 km S of Laascaanood, 30.xii.1972, Bally & Melville 15398 (EA, K); 51 km on the Garoowe-Laascaanood rd., 4.ii.1982, Thulin 4185 (UPS); On the Garoowe-Laascaanood rd., *c.* 30 km from Garoowe, 21.xi.1970, Bavazzano & Lavranos *s.n.* (FT); Garoowe-Halin, 45 km, 8°46′N, 48°29′E, 21.xi.1985, Thulin & Warfa 5387 (E, K, UPS); 8°34′N, 49°06′E, 14.xii.1980, Beckett 729 (EA); 3 km N of Bedeg, E of Eyl, 4.x.1985, Lavranos & Carter 23499 (EA, K); N side of Wadi Nogal between Eyl and the sea about 2 km SE of Eyl, 2.i.1973, Bally & Melville 15482 (EA, K); Wadi Nogal close to Eyl, 25.xi.1970, Bavazzano & Lavranos *s.n.* (FT); Mudug Region: 68 km from Gaalkacyo-Garoowe rd., 14.x.1959, Hemming 1700 (EA, K); Along the bank of stagnant water called "Yameas", 1 km from Gaalkacyo towards Garoowe, 20.xii.1977, Kazmi, Cilmi, Mahmuud & Sulaiman 6 (M); 6°47′N, 47°27′E,

22.v.1979, Gillett, Hemming & Watson 21899/B (K); Wad Gelinsoor, 5.iv.1954, Bally 9590 (EA, K); 40 km on the Cadaado-Gaalkacyo rd., 6°25′N, 46°48′E, 20.xi.1985, Thulin & Warfa 5379 (K, UPS); Coastal rd. 29 km N of Hobyo, 5°34′N, 48°38′E, 29.v.1979, Gillett, Hemming & Watson 22204 (EA, K); 14 km SE of Bagecla on rd. to Hobyo, 5°43′N, 47°45′E, 5.vi.1979, Gillett, Hemming & Watson 22411 (EA, K); Shore at 6°1′N, 48°58′E, 28.v.1979, Gillett, Hemming & Watson 22181 (EA, K); 20 km N of Hobyo on rd. to Jirriiban, 5°29′N, 48°32′E, 28.v.1989, Thulin & Dahir 6662 (K, UPS); 46 km on rd. between Gal Hareeri and Xarardheere, 4°31′N, 47°29′E, 26.v.1989, Thulin & Dahir 6569 (K, UPS); 5 km E of Gal Hareeri, 4°33′N, 47°12′E. 11.vi.1979, Gillett, Hemming & Watson 22567 (EA, K). Galguduud Region: 3 km S of Cadaado along rd. to Dhuusamarreeb, 6°08′N, 46°37′E, 9.xii.1985, Thulin 5641 (UPS); 2 km NW of Mareer-Guur, 5°40′N, 46°25′E, 19.v.1979, Elmi & Hansen 4094 (EA, FT, K, M); 13 km NE of Ali Yabaal, 46°04′N, 47°06′E, 9.v.1990, Thulin, Hedren & Dahir 7368 (K, UPS); Ceel Dheere distr., Nooleeye village, 16.ix.1983, Herlocker s. 130 (K). Hiiraan Region: Buulobarde distr., 1 km from main high way, along rd. to Halgen, 3°56′N, 45°36′E, 13.v.1986, Kuchar 16963 (EA, K); 3.5 km NE of Buulobarde, 10.xii.1983, Kuchar 15731 (K); Main rd. N of Buulobarde, 3°57′N, 45°35′E, 6.vi.1981, Gillett & Beckett 23313 (EA, K); 11 km on rd. between Ceel Baraf and Aadan Yabaal, then 34 km on cutline towards N, then 25 km on cutline towards NE, 3°35′N, 45°50′E, 23.v.1989, Thulin & Dahir 6467 (E, K, UPS); Buulobarde distr. 14.vii.1984, Kuchar 16294 (K); 5 km NE of Jalalaqsi, 24.viii.1987, Kuchar 17380 (K). Shabeellaha Dhexe Region: 179 km NE of Muqdisho on rd. to Xarardheere, 3°26′N, 46°47′E, 25.ix.1985, Lavranos & Carter 23299 (EA, K). ETHIOPIA: Hararge Region: Uardere well, 23.xi.1944, Glover & Gilliland 302 (K); Near Shilabo, 22.xi.1953, Popov 1109 (K).

9. ***Echiochilon baricum*** Lönn **sp. nov.**

Species nova ab *E. cyanantho* Lönn foliis angustis obovatis, 1.5–2 mm latis (in *E. cyanantho* 3–7 mm latis) differt, a *E. cyanantho* et *E. persico* (Burm.f.) I.M. Johnst. corolla zygomorpha cum lobis adaxialibus quam lobo abaxiali et lobis lateralibus grandioribus (lobis corollae in *E. cyanantho* et *E. persico* aequalitius) differt. Type: Thulin & Warfa 6015, Somalia. Bari Region, S of Qandala, "togga" Medlehe, 11°22′N, 50°03′E, 23.xi.1986, (UPS holotype; K isotype).

Etymology. The species is named after the Bari Region in Somalia where it grows.

Description. Perennial herb or shrublet with a ± woody base, up to *c.* 40 cm high, moderately branched, ± erect. STEMS and older parts of branches with whitish bark, on older parts split up and flaking, young branches green, densely covered with appressed disc-based hairs; internodes up to 8 mm long. LEAVES alternate, narrowly oblanceolate, 15–22 × 1.5–2 mm, acute to subacute at the apex, cuneate or attenuate at the base, densely covered with appressed disc-based hairs on both surfaces; midrib inconspicuous; margins involute, ciliate with spreading disc-based hairs on the lower parts. FLOWERS in well developed cymes, terminating the leafy branches; pedicel 1–1.2 mm long. BRACTS narrowly ovate, up to *c.* 8.5 × 1.2 mm, acute or subacute at the apex, gradually smaller upwards. CALYX reaching up to the limb on the abaxial side; lobes 5, ± free, ± equal in size, in flower narrowly ovate with tapering apex, 3–4.5 × 0.8–1.1 mm, in fruit somewhat larger and sometimes ovate, densely covered

with appressed disc-based hairs on both surfaces, with a tuft of hairs at the base inside; midrib inconspicuous; margins flat or almost so, ciliate with spreading disc-based hairs. COROLLA pink or white with purplish to pink and yellow markings in the throat, zygomorphic, obliquely funnel-shaped, 5–7 mm long, whitish villose inside the throat, below the constriction glabrous with or without a ring of brownish hairs at the base, outside densely covered with wavy to ± curly white hairs on the whole tube except for at the very base; tube 2.6–4.2 mm long, the adaxial side 1.1–1.3 mm longer than the abaxial, 1.1 mm in diam. at the base, slightly widened and then narrowed again to a waist somewhat below the middle, 1.2–1.4 mm in diam., widened to 2–3.5 mm in diam. at the throat; limb with spreading lobes; lobes unequal in size and somewhat unequal in shape, the adaxial the largest, rounded to oblong, 1.2–2 × 1.5–2 mm, the abaxial the smallest, rounded to rounded-triangular, 0.7–1 × 1–1.2 mm, the lateral lobes medium sized, rounded; margins not or somewhat crisped. STAMENS borne in the throat at three different heights 1.5–3.5 mm above the base; anthers included, equal, 0.9–1.4 mm long; filaments of two or three different lengths, 0.3–1.1 mm, when of three lengths the adaxial the longest, the lateral ones medium and the abaxial ones the shortest. STYLE 0.9–1.7 mm long; stigmas horizontal, *c.* 0.07 mm high, surmounted by a sterile tip, somewhat bifid or only with a very small depression on the top, protruding *c.* 0.07 mm beyond the stigmas. NUTLETS beige or reddish beige, ovoid in dorsal outline, 1.7–2 × 1.4–1.6 mm, tuberculate, with a ridge on the dorsal side, and sometimes with two extra on the sides, with a keel on the ventral side, with rostrate apex, 1–4 developing, attachment mostly ventral; sulcus narrow, extending from just below the tip to above the base, above the base slightly widened then abruptly expanding into the rounded or rounded triangular areola; areola 0.4–0.5 × 0.5–0.6 mm (Fig. 18).

Distribution and habitat. Echiochilon baricum is known only from the Bari Region in Somalia (Fig. 7). It grows on dry stony ground, in one case along a river bed in a semi-desert plain. The known altitudinal range is 10–250 m.

Variation and taxonomic remarks. Echiochilon baricum is a shrublet with narrowly oblanceolate leaves with a very dense indumentum giving the plant a greyish look. The white or pink zygomorphic flowers are borne in elongate unilateral cymes terminating the leafy branches.

The closest relative of *E. baricum* is *E. cyananthum. Echiochilon baricum* differs from *E. cyananthum* in having narrowly oblanceolate leaves with appressed, very dense indumentum that looks somewhat soft, compared to the strigose-looking oblanceolate leaves found in *E. cyananthum.* The leaf margins in *E. baricum* are conspicuously involute (leaves almost conduplicate) but only somewhat involute in *E. cyananthum.* The corollas in *E. baricum* are zygomorphic with the adaxial lobes distinctly larger than the abaxial, and the middle lobes intermediate. This is not found in *E. cyananthum* neither in *E. persicum* which in part is rather similar to *E. baricum.* The indumentum on the corollas in *E. baricum* is very dense and only sparse in *E. cyananthum* and in *E. persicum.*

Even though there are only two collections of this new species, it differs so much from the other species that I regard it as a new species.

Material studied. SOMALIA: Bari Region: 4 km NE of Dhurbo coastal plain, 11°39′N, 50°23′E, 22.xi.1986, Thulin & Warfa 5947 (K, UPS).

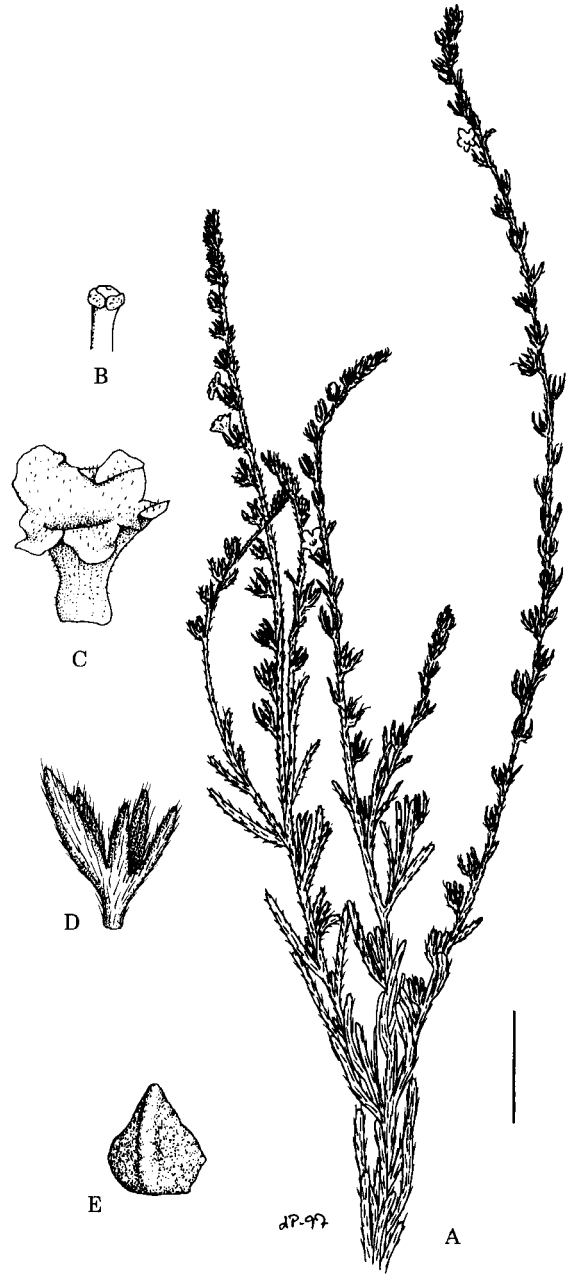

Figure 18. ***Echiochilon baricum* sp. nov.** A, habit. B, stigmas and the sterile tip of the style. C, corolla. D, calyx. E, nutlet. All from Thulin & Warfa 6015, Somalia. Scale bar: A = 20 mm; B = 1 mm; C & D = 5 mm; E = 2.5 mm.

10. ***Echiochilon cyananthum*** Lönn **sp. nov.**

Species nova ab *E. arabico* (O. Schwartz) I. M. Johnst. corolla brevi, 5–5.5 mm longa (in *E. arabico* 8.5–9 mm longis) et porca nucularum unica tribus in *E. arabicoporcis*

differt, ab *E. persico* (Burm.f.) I. M. Johnst. colore indumenti in fauce corollae albo vel candido (in *E. persico* luteo) differt, ab *E. barico* Lönn foliis 3–7 mm latis (in *E. barico* 1.5–2 mm latis) et lobis corollae aequalibus (in *E. barico* lobis adaxialibus quam lobis lateralibus et lobo abaxiali grandioribus) differt. Type: Thulin & Warfa 5584, Somalia, Bari Region: "Ras Hantara", cape about halfway between Boosaaso and Qandala, 30.xi.1985, (UPS holotype; K isotype).

Description. Perennial shrublet with a ± woody base, up to *c.* 40 cm high, moderately to fairly richly branched, sometimes with shortly stalked glandular hairs, 0.05–0.07 mm long, on the vegetative parts in the inflorescence. STEMS and older parts of branches with whitish, beige or greyish incrusted bark, on older parts split up and flaking, young branches green, ± densely covered with closely (loosely) appressed disc-based hairs; internodes up to 5 mm long. LEAVES alternate, oblanceolate, (7.5–)10–13(–17) × 2–7 mm, acute at the apex, cuneate or attenuate at the base, rather closely appressed to the stem to recurving, ± densely covered with appressed disc-based hairs on both surfaces; midrib inconspicuous, sometimes visible on the dorsal side; margins flat or almost so, ciliate with spreading disc-based hairs. FLOWERS in well developed cymes, terminating the leafy branches; pedicel 1–1.8 mm long. BRACTS lanceolate to oblanceolate, up to *c.* 6 × 1.8 mm, acute to subacute at the apex, gradually smaller upwards. CALYX reaching slightly beyond the constriction of the corolla tube; lobes 5, ± free, equal to somewhat unequal in size, when unequal one of the abaxial the largest, in flower lanccolate, 2–2.5(–3.7) × 0.4–1.2 mm, in fruit somewhat larger, acute at the apex, ± densely covered with closely (loosely) appressed disc-based hairs on both surfaces, with a thin tuft of hairs inside at the base; midrib inconspicuous; margins flat or almost so, ciliate with spreading disc-based hairs. COROLLA blue, or rarely white, zygomorphic, obliquely funnel-shaped, (3.4–)4.5–5.5 mm long, white or dull whitish villose inside the throat, below the constriction glabrous or sparsely hairy and with a ring of short brownish hairs at the base, outside sparsely covered with short white hairs on the throat and tube except for at the base, and often with shortly stalked glandular hairs, *c.* 0.05 mm long, on the throat; tube 3–3.3 mm long, the adaxial side *c.* 1–1.5 mm longer than the abaxial, 1–1.2 mm in diam. at the base, slightly widened and then narrowed again to a waist somewhat below the middle, 1.4–1.8 mm in diam., widened to (1.3–)1.8–4 mm in diam. at the throat; limb with spreading to patent rounded lobes; lobes equal or somewhat unequal in size, 0.7–2 × 0.8–2 mm, sometimes with crisped margins. STAMENS borne in the throat at three different heights 1.7–2.8 mm above the base; anthers sometimes shortly exserted, equal, 0.9–1.2 mm long; filaments of three different lengths (or equal), 0.3–0.8(–1.4) mm long, when of three lengths the adaxial the longest, the lateral ones medium and the abaxial ones the shortest. STYLE 1.2–1.5 mm long; stigmas horizontal, *c.* 0.1 mm high, surmounted by a sterile tip, somewhat bifid or only with a small depression on the top, protruding *c.* 0.02–0.05 mm beyond the stigmas. NUTLETS orange-beige or reddish, ovoid in dorsal outline, 1.5–2.3 × 1.7–1.9 mm, usually tuberculate with small tubercles, with a ± conspicuous longitudinal ridge on the dorsal side, a keel on the ventral side, rostrate apex, usually 3–4 developing, attachment ventral and basal; sulcus narrow, extending from just below the tip to the base, above the base slightly widened then abruptly expanding into the triangular areola; areola 0.3–0.6 × 0.7–0.8 mm (Fig. 19).

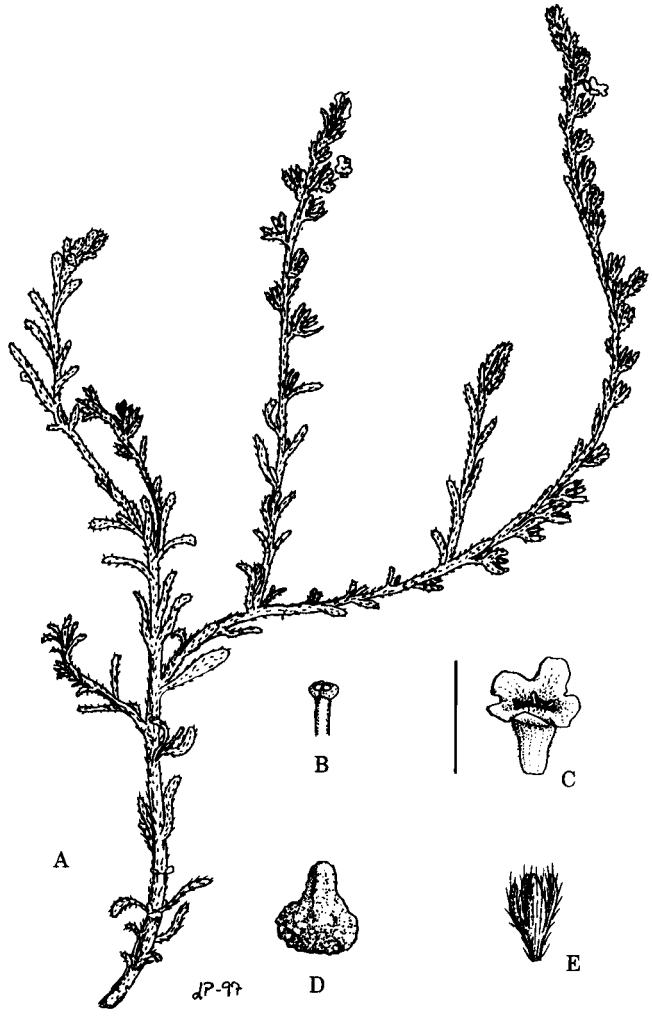

Figure 19. ***Echiochilon cyananthum* sp. nov.** A, habit. B, stigmas and the sterile tip of the style. C, corolla. D, nutlet. E, calyx. All from Thulin 4277, Somalia. Scale bar: A = 10 mm; B = 1 mm; C & E = 5 mm; D = 2.5 mm.

Distribution and habitat. Echiochilon cyananthum is known from N Somalia (Fig. 7). It grows in open bushland on sandy, stony or rocky ground, along wadis or on coastal plains, sometimes on shale. The known altitudinal range is from sea level up to about 1800 m.

Variation and taxonomic remarks. Echiochilon cyananthum is a small shrublet with oblanceolate leaves and small not very strongly zygomorphic flowers in well developed cymes terminating the leafy branches. In leaf shape and habit this species is somewhat similar to *E. arabicum*; indeed, Johnston (1957) included material from this species in *E. arabicum. Echiochilon cyananthum* however differs from *E. arabicum* in having only one ridge on the dorsal side of the nutlets and having a smaller corolla, 5–5.5 mm long compared to 8.5–9 mm in *E. arabicum.* Because of these distinctive differences, I regard *E. cyananthum* as a new species.

The closest relative of *E. cyananthum* is *E. baricum*. *Echiochilon cyananthum* differs from *E. baricum* in having oblanceolate leaves (*E. baricum* has narrowly oblanceolate leaves) with a less dense indumentum than that found in *E. baricum*, giving the leaves a strigose impression. The leaf margins in *E. baricum* are conspicuously involute (leaves almost conduplicate) but only somewhat involute in *E. cyananthum*. The corollas in *E. cyananthum* are zygomorphic, but all the corolla lobes are of the same size (the adaxial larger than the abaxial in *E. baricum*), and the indumentum on the corollas in *E. baricum* is very dense and only sparse in *E. cyananthum*.

Material studied. SOMALIA: 10.x.1954, Popov 1190 (K, W photo); Togdheer Region: Dubriyaad mt., 3.i.1933, Gillett 4776 (FT, K, P). Sanaag Region: Coast just E of Cankhor, 22.x.1960, Hemming 2050 (K); "Daaged" delta, Xiis, 18.ii.1945, Glover & Gilliland 715 (BM, E, K); 24 km S of Maydh along the rd. to Ceerigaabo, 9.ii.1982, Thulin 4277 (K, UPS); "Serrutgeb: Auf Kerlh", iv.1875, Hildebrandt 1416 (BM); Escarpment S of Laasqoray, along the road to the "Geldora Pass", 11°03′N, 48°16′E, 20.i.1995, Thulin, Abdi Dahir & Abdisalam Hassan 9189 A (UPS); N of Xidid, 11°04′N, 48°36′E, 21.i.1995, Thulin, Abdi Dahir & Abdisalam Hassan 9208 (UPS). Bari Region: Iskushuban, 18.i.1957, Popov 57/38 (K).

11. Echiochilon persicum

Echiochilon persicum (Burm.f.) I.M.Johnst., *J. Arnold Arbor. 38:* 288 (1957). *Heliotropium persicum* Burm.f., *Fl. indica:* 41, t. 19 (1768). *Sericostoma persicum* (Burm.f.) B.L. Burtt, *Kew Bull. 1949:* 138 (1950). Type: Garcin *s.n.* (G holotype).

Sericostoma albidum Franch., *Sert. somal.:* 46 (1882). *Echiochilon albidum* (Franch.) I.M. Johnst., *J Arnold Arbor. 38:* 285 (1957). Type: Revoil 81, Somalia (P holotype).

Sericostoma verrucosum Beck, in Paulitschke, *Harar:* 457 (1888). *Echiochilon verrucosum* (Beck) I. M. Johnst., *J. Arnold Arbor. 38:* 291 (1957). Type: Hardegger *s.n.*, Somalia, Woqooyi Galbeed Region, near Warabood (W holotype).

Echiochilon kotschyi var. *brevifolia* Bornm., *Mitth. Thüring. Bot. Vereins. 2 (6):* 59 (1894). Type: Bornmüller 522, "Persia australis (Laristan), in collibus arenaceis ad Bender-Abbas", 16.i.1893 (HBG, JE? not seen, K, W syntypes).

Heliotropium albo-hispidum Baker, *Bull. Misc. Inform. Kew. 1895:* 220 (1895). Type: Cole *s.n.*, Somalia, Togdheer Region, "Hammar", Qar Goliis, 9.ii.(1895) (K holotype).

Sericostoma strigosa Deflers, *Bull. Soc. Bot. France. 43:* 120 (1896). *Heliotropium deflersii* O.Schwartz, *Mitt. Inst. Allg. Bot. Hamburg. 10:* 212 (1939). *Echiochilon strigosum* (Deflers) I.M.Johnst., *J. Arnold Arbor. 38:* 286 (1957). Type: Deflers 1075, Yemen, Muhafazat Abyan, "Bilad Fodhli", on the southern slopes of Jabal al Urays, iv.1893 (P? holotype, not seen).

Heliotropium vatkei Baker, in Baker & C.H. Wright, *Fl. Trop. Afr. 4(2):* 39 (1906). *Echiochilon vatkei* (Baker) I.M.Johnst., *J. Arnold Arbor. 38:* 284 (1957). *Heliotropium calcareum* Vatke, *Linnaea 9:* 318 (1882), nom. illeg. (non Stocks, in Hook. *Kew Journ. 4:* 174 (1852)). *Sericostoma calcarea* (Vatke) I.M.Johnst., *Contr. Gray Herb. 5:* 92 (1930), nom. illeg. Type: Hildebrandt 890 a, Somalia, Yafir in Mt. Ahl, iii.1873 (B holotype†; BM lectotype, selected here; isolectotypes GH not seen, W).

Lithospermum persicum Gand., *Bull. Soc. Bot. France. 65:* 62 (1918). Type: Bornmüller 521, "Persia australis (Laristan), in collibus arenaceis ad Bender-Abbas", 19.i.1893 (BM, E, HBG, K, LY? not seen, W isolectotypes).

Echiochilon nubicum I.M. Johnst., *J. Arnold Arbor. 38:* 290 (1957). Type: Schweinfurth 2108, Sudan, Macaur (Makawa) Island, red Sea, lat. 21°, 1864 (BM holotype; isotypes M, P, W).

Echiochilon thesigeri I.M. Johnst., *J. Arnold Arbor. 38:* 292 (1957). Type: Thesiger *s.n.*, Oman, "Jabal Hafit", 25.iv.1948 (BM holotype).

Nomenclatural notes. Bornmüller 522 was the only collection mentioned in the protologue of *Echiochilon kotschyi* var. *brevifolia.* According to Stafleu & Richards (1976), Bornmüller's original types are found in JE. I have not been able to check if there is any extant material of Bornmüller 522 in JE, and therefore leave the question of the typification open.

In the protologue of *E. nubicum* Johnston (1957) stated that the type, Schweinfurth 2108, was placed in K. Subsequent searches have shown that this material is not present in K, but a sheet of Schweinfurth 2108 marked "Type" by Johnston is present in BM. It is likely that Johnston made a mistake when he cited the material, and therefore I regard the material in BM as the holotype.

In the protologue of *Heliotropium calcareum*, Vatke (1882) only mentioned one collection, Hildebrandt 809a. The name *Heliotropium calcareum* Vatke, however, is illegitimate since it is a later homonym of *H. calcareum* Stocks. There is a photo in K of a fragment from GH originally taken from the holotype in B. The holotype in B is most likely destroyed since it has not been traced there. Of the material I have been able to see, the material from BM is slightly more complete, and is therefore chosen as lectotype.

The type of *H. calcareum*, Hildebrandt 809a, was first mentioned by Vatke (1875) under the name *Heliotropium thymoides* Jaub. & Spach (Jaubert & Spach, 1852) with an indication that it might be a new variety.

Bornmüller 521 was the only collection mentioned in the protologue of *Lithospermum persicum.* I have seen material of the collection from BM, E, HBG, K and W, and it is well preserved and rather uniform. According to Stafleu & Richards (1986), Gandoger's herbarium and types are found in LY, but since I have not been able to check if there is any material of Bornmüller 521 in LY, I prefer to leave the question of the typification of *L. persicum* open.

Description. Perennial herb or shrublet with a woody base, *c.* 10–35 cm high, fairly richly branched, ± erect or cushion-forming with ascending branches, sometimes with shortly stalked or unstalked glandular hairs present on the vegetative parts, not very conspicuous. STEMS and older parts of branches with brown or grey bark, often whitish or greyish incrusted, on older parts split up and flaking, young branches green, ± densely covered with appressed disc-based hairs; internodes up to 7 mm long. LEAVES alternate, oblong, narrowly oblanceolate to oblanceolate, 2–17(−22) × 0.5–2(3) mm, acute to obtuse or rounded at the apex, cuneate or attenuate at the base, somewhat recurved, normally spreading or standing out from the stem at an almost right angle, ± densely covered with appressed disc-based hairs on both surfaces; midrib rarely visible on the dorsal side; margins flat or almost so to involute, appressed hairy to ciliate with spreading disc-based hairs. FLOWERS in ± well developed cymes (sometimes interrupted with some flowers below the inflorescence), terminating the leafy branches; pedicel 0.5–1 mm long. BRACTS lanceolate to oblanceolate (linear), up to *c.* 10 mm long and 1.5 mm wide, acute or subacute at the apex, gradually smaller upwards. CALYX *c.* half as long to ± equalling the corolla tube; lobes 5, ± free, equal to somewhat unequal in size, when unequal,

one of the abaxial the largest, in flower narrowly ovate, lanceolate to narrowly oblanceolate or oblong, 1.7–4.2 × 0.5–1.2 mm, in fruit somewhat larger, acute to obtuse or rounded at the apex, ± densely covered with appressed disc-based hairs on both surfaces, with a tuft of hairs at the base inside; midrib inconspicuous; margins flat or almost so, not ciliate or ciliate with spreading disc-based hairs. COROLLA usually white or yellowish, more rarely bluish or reddish, sometimes with bluish or reddish veins, actinomorphic or somewhat zygomorphic, funnel-shaped, 2.5–7 mm long, yellow (brownish) villose inside the throat, below the constriction glabrous or sparsely hairy, sometimes with a ring of hairs at the base, outside covered with short white hairs mostly on the lobes (rarely on the tube), sometimes with yellow hairs on the throat in 5 vertical lines below the sinuses between the lobes, and sometimes with glandular hairs on the throat; tube 2–5 mm long, the adaxial side *c.* 0.5–1.3 mm longer than the abaxial or not at all, 0.7–1.8 mm in diam. at the base, slightly widened and then narrowed again to a waist at the middle, 1.1–2 mm in diam., widened to 1.5–3.5 mm in diam. at the throat; limb flat or ± cup-shaped with patent to erect rounded lobes, 0.5–2 × 0.7–2.1 mm. STAMENS borne in the throat at equal or at three slightly different heights 1.2–3.2 mm above the base, when unequal the adaxial one the highest, the lateral ones medium and the abaxial ones the lowest; anthers included or exserted, equal, 0.8–1.7 mm long; filaments of equal or somewhat different lengths, 0.2–1.6 mm long, when of three lengths usually the adaxial the longest, the lateral ones medium and the abaxial ones the shortest. STYLE 0.6–1.5 mm long; stigmas horizontal or almost so, 0.07–0.16 mm high, surmounted by a sterile tip, somewhat bifid or only with a small depression on the top, protruding *c.* 0.02–0.14 mm beyond the stigmas. NUTLETS whitish, beige or reddish beige, ovoid in dorsal outline, (1.1 −)1.5–2.4 × 1.2–2 mm, evenly verrucose, usually with small verrucae, or verrucose with small and large verrucae, sometimes with a longitudinal ridge (usually formed by some larger verrucae) on the dorsal side and sometimes also with an extra shorter ridge on each side of the ridge, with a keel on the ventral side, with rostrate apex, 1–4 developing, attachment ventral and basal; sulcus narrow, extending from just below the tip to the base, above the base slightly widened then expanding into the triangular areola; areola 0.4–1.5 × 0.3–0.9 mm (Fig. 20).

Distribution and habitat. Echiochilon persicum is known from Bahrain Island, Qatar, United Arab Emirates, Iran, Pakistan, Sudan, Saudi Arabia, Oman, Yemen, Djibouti and Somalia (Fig. 21). It grows on silty, sandy, stony, and rocky ground, on granite, limestone, gypsum, and rarely on red-brown soil, in wadis, on coastal plains, hill tops, and hill slopes, sometimes in soil pockets. It is sometimes grazed probably by goats and camels. One collector says: "Camel fodder, but ruins teeth". The known altitudinal range is from sea level to 2400 m.

Vernacular name. Halmoot (Arabia).

Variation and taxonomic remarks. Echiochilon persicum is a widespread and variable species. Several partly geographically correlated forms can be recognized. The symmetry of the corolla was given much importance in the revision by Johnston (1957), but seems to be variable within a limited range in some species. All the forms mentioned below have corollas slightly oblique or ± regular. Even in the revision, it is obvious that the species with regular corollas can have slightly oblique corollas, and there

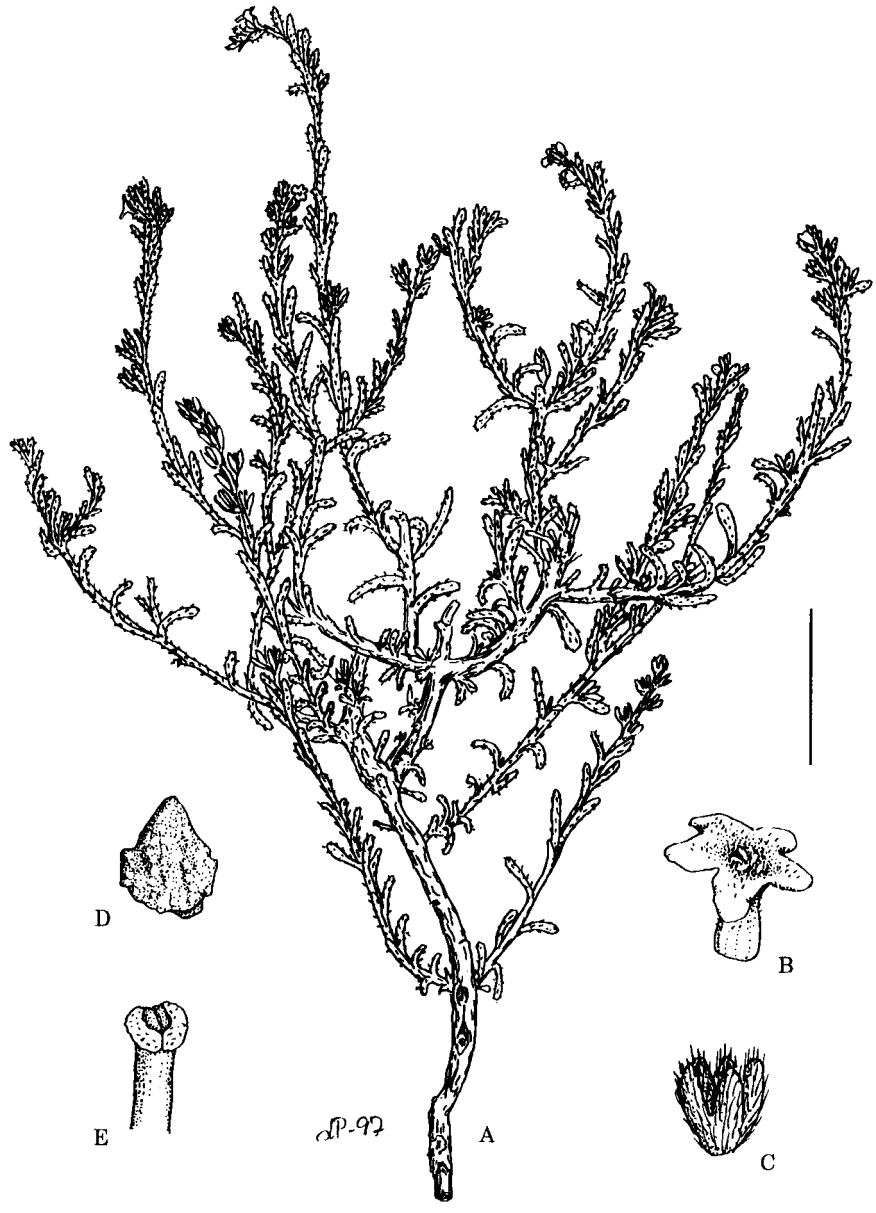

Figure 20. *Echiochilon persicum*. A, habit. B, corolla. C, calyx. D, nutlet. E, stigmas and the sterile tip of the style. All from Thulin, Eriksson, Gifri & Långström 8221, Yemen. Scale bar: A = 20 mm; B & C = 5 mm; D = 12.5 mm; E = 1 mm.

is a continuous variation in obliqueness with some of the species mentioned by Johnston as oblique.

The form agreeing with the type of the species is found in Qatar, Bahrain Island, United Arab Emirates, Oman, Iran, Pakistan, Sudan, Saudi Arabia and Yemen including Socotra. It has been collected only once in Socotra and it was cited by Balfour (1903) as *Heliotropium strigosum* Willd., but it is without doubt an *Echiochilon*.

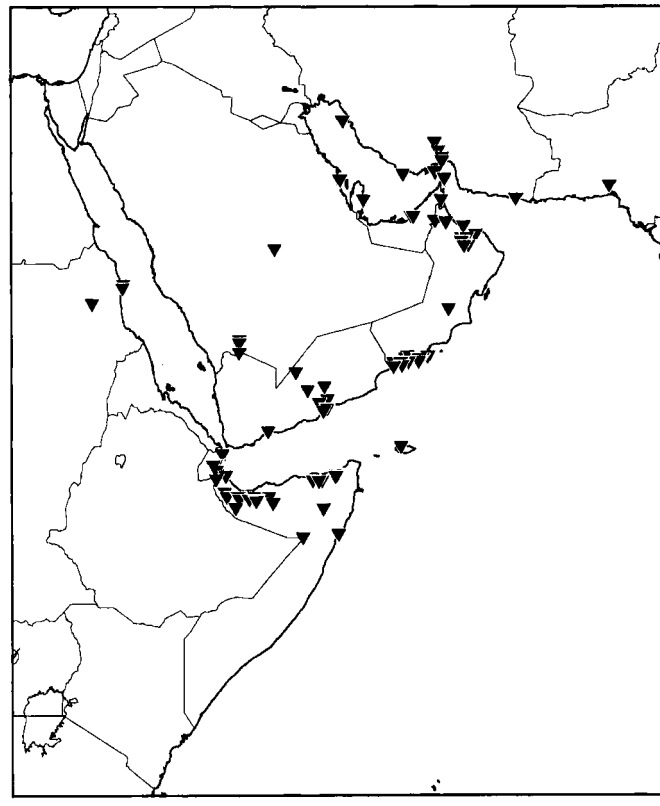

Figure 21. Distribution of *Echiochilon persicum* (▼).

In Sudan, Saudi Arabia and Yemen it is more strigose than in Oman and Iran, where it is more densely hairy giving a more greyish impression. Usually it has nutlets with a dorsal ridge, formed by some larger verrucae, and usually also an extra shorter ridge of the same type on each side.

One of the former species of Johnston (1957) that has to be included in *E. persicum* is *E. strigosum*. Already in the key to the species compiled by Johnston, one can see that they are difficult to separate. Johnston has included the growth area, and that is actually the only "character" that is not overlapping or forming a continuous variation making it possible to separate these two species *sensu* Johnston.

Another of the former species that also has to be included in *E. persicum* is *E. nubicum*. *Echiochilon nubicum* is quite small in all parts but falls within the range of variation of *E. persicum* (also of the former species *E. strigosum*, to which it is most similar).

The form agreeing with the former species *E. thesigeri* is not possible to separate from the form agreeing with the former species *E. vatkei*. Johnston had separated the *Echiochilon* species with corollas hairy on the outside (except *E. fruitcosum* and *E. johnstonii* and those with an abundance of glandular hairs) in two different groups based on the inflorescences, one group with "flowers borne along the leafy stems interspersed among developed leaves, the inflorescence hence interrupted, not distinctly racemose nor unilateral" and the other group with "flowers borne in

elongating unilateral racemose cymes; inflorescence terminating the leafy twig, bearing small bracts but not interrupted by well developed leaves". He placed *E. thesigeri* in the first group and *E. vatkei* in the other together with *E. kotschyi* and *E. jugatum*. *Echiochilon kotschyi* and *E. jugatum* fit this definition very well but *E. vatkei* does not. The inflorescences of *E. vatkei* definitely terminate the branches and they are ± unilateral, sometimes with a few flowers borne among the leaves below the inflorescences, and hence they are interrupted, although this is also found in *E. thesigeri*. The form agreeing with the types of the former species *E. vatkei* and *E. thesigeri* grows in Bahrain Island, United Arab Emirates, Saudi Arabia, Oman and Yemen, and in Sanaag, Bari and Nugaal Regions in Somalia. It has narrow leaves, usually standing out from the stem almost at right angles, and many short shoots developing. This form has rather small nutlets, usually evenly verrucose with small verrucae, and no ridge on the dorsal side. The specimen in Arabia has blue, mauve, white or yellowish corollas, quite often with vertical lines of yellow curly hairs on the outside of the corolla tube altering with the white hairs on the corolla lobes. The specimens in Somalia usually have cream corollas (with brownish margins when dried) and somewhat more imperfectly developed cymes, but specimens with imperfectly developed cymes are also found, e.g. in Oman, although the cymes of these specimens terminate the leafy branches. There is also one specimen found in Cal Miskaat in the Bari Region on gypsum, with extremely long leaves and a sticky (glutinose) surface. It is an extreme example of this form and not possible to separate from the rest of the species. The specimens of this form growing in Eyl in Nugaal Region are very infested by galls, and this is sometimes also seen in specimens from Arabia.

In Saudi Arabia, in particular, there are intermediates between the above mentioned form and the form agreeing with the type of the species. There are all kinds of intermediates, e.g. those with the general appearance of the form agreeing with the type and with vertical lines of yellow hairs on the corolla tube in addition to the white hairs, and with evenly verrucose nutlets without ridges.

In Djibouti and in Woqooyi Galbeed, Togdheer and Bari Regions in Somalia a form agreeing with the type of *E. verrucosum* grows. These specimens look as if they were more softly hairy than the rest of the species; the hairs give that impression because they are somewhat long and 'wavy'. However, it is not possible to separate it as a species because there are no other characters apart from the diffuse hair character separating this form from the rest of the species.

The former species *E. albidum* is, as was stated by Johnston (1957), simply an extremely hairy specimen of *E. persicum* (the above mentioned form). The type from P (the only specimen of the former species) has no flowers left, but from the protologue (Franchet, 1882) one can see that it has slightly oblique corollas with hairs outside only on the lobes, and it fits the description of *E. persicum* (also of the former *E. verrucosum*) in all respects.

The closest relatives of *E. persicum* are *E. arabicum, E. callianthum* and *E. collenettei*. It differs from *E. arabicum* in always being yellow villose inside the throat, whereas *E. arabicum* is almost always white villose inside the throat. Furthermore, *E. arabicum* is moderately branched with the leaves appressed to the stem, while *E. persicum* is fairly richly branched with the leaves normally spreading, standing out from the stem at an almost right angle, or somewhat recurved. *Echiochilon persicum* differs from *E. callianthum* in having actinomorphic or only slightly zygomorphic funnel-shaped corollas, 2.5–7 mm long, compared to the strongly zygomorphic corollas, 9.5–12 mm,

with an expanded, bell-shaped throat found in *E. callianthum*. *Echiochilon persicum* differs from *E. collenettei* in having a funnel-shaped corolla (compared to narrowly funnel-shaped) with a shorter tube (*c.* 2–5 mm compared to 7.5–9 mm), and the leaves alternate and not opposite as in *E. collenettei*.

Echiochilon persicum is also in part quite similar to *E. kotschyi*, but it differs from *E. kotschyi* in having cymes terminating and concentrated to the apices of the leafy branches, and in having verrucose nutlets. *Echiochilon persicum* is also in part similar to *E. cyananthum* but differs from it in the yellow hairs in the throat (white or dull whitish in *E. cyananthum*) and in having mostly white, cream or yellow flowers (blue and very rarely white in *E. cyananthum*).

Material studied. Aucher-Eloy 5001 (K). BAHRAIN: "New Camp", 1.xi.1935, Fernandez 91 (K); Persian Gulf, 14.iii.1950, Good 223 (BM, K). QATAR: 15 km N of Dawhah, 8.iv.1975, Bajwa 1117–75 (K); "Echor", shore, 3.v.1982, Elamin 75 (K). UNITED ARAB EMIRATES: in the "Hatta-mountains", 25 Mar 1986, Müller-Hohenstein 86330 (E); Abu Dhabi, 8.xii.1972, Willcox 287 (K); Abu Dhabi, Jazirat Umm an Nar, Laland by the Muktar Bridge, 16.ii.1973, Willcox 304 (E, K); Jazirat Umm an Nar, just off Abu Dhabi Island, 18.ii.1983, Western 493 (E); Abu Dhabi, N end of summit of "Jebel Hafit" near Al Ayn, 6.v.1973, Western 568 (E); Dubayy, towards "Jebel Hafir", 11 Mar 1986, Müller-Hohenstein 86133 (E); 10 km N of Masafi town, 6.iv.1990, Western 1223 (E). IRAN: Persian Gulf, viii.1878, Floyer 28 (K); "Insula Sheshan", 25–27.ii.1976, Termé & Boussavi 34441 E (W); Fars: Jazireh-ye Khark in Persian Gulf, west shore, 25–27.ii.1965, Grant 17119 (W). Jazireh-ye Kish, 25–27.ii.1976, Termé & Boussavi 34443 E (W); Jazireh-ye Hengam, v.1949, Wykeham Perry *s.n.* (K); near Gahkom, 28°10′N, 55°50′E, 25.iii.1951, Popov GP/51/46 (BM); 40 km NW Bandar Abbas, 2.iv.1972, Kasy 542 (W); 22 km N Bandar Abbas, 10.v.1974, Kasy 618 (W); near Bandar Abbas, 16.i.1893, Bornmüller 522 (HBG, K, W); near Bandar Abbas, 19.i.1893, Bornmüller 521 (BM, E, HBG, K, W); "Thcarbahar", Tis, 6.xii.1919, Parsa *s.n.* (K); "Thcarbahar", Tis, Jan.1940, Parsa *s.n.* (K). PAKISTAN: Hala Range, Borders of Sind & Baluchistan, 66°, Vicary *s.n.* (K). SUDAN: Al Bahr al Ahmar: Nimmo *s.n.* (K); ca 21°, 1896, Bent *s.n.* (K); "Nubishe Küste Abu Risihkisih bei Ras Ranai", 1864, Schweinfürth 2107 (K, W); Mukawwar near "Ras Ranai", 21°N, 28.vi.1864, Schweinfürth 2108 (W). ARABIA: Haylat Saraaf, East on escarpement edge, 3.v.1989, TT/DF 382 (E). SAUDI ARABIA: Ash Sharqiyah: Az Zahran: 1.iv.1934, Dickson 477 (K); 1.iv.1942, Dickson 476 (K); 14.i.1966, Mandaville 519 (K). Ar Riyad: Btween "Sitatah" and Haradah off the Al Kharj-As Sulayyil rd., 1.iii.1987, Collenette 6043 (E, K). Mintaqat Najran: Near Riofinea Camp, Wadi Manfah 50 km NNW of Najran, 27.iv.1979, Collenette 1455 (K); ca. 40 km NNW of Najran, 25.i.1980, Collenette 1646 (E, K); Najran, 15.i.1979, Chaudharg *s.n.* (E). OMAN: "Agebat" village, 28.iv.1987, Western 1062 (E). Ru'us al Jibal: 26°22′N, 56°21′E, 18.iii.1982, Gallagher 6398/28 (E); Shibh Jazirat Musandam, Jazirat Umm al Ghanam, cave on east side, 26°22′N, 56°21′E, 23.ii.1979, Mandaville 7100 (BM); Shibh Jazirat Musandam, Jazirat Umm al Ghanam, north tip of island near Salib, 26°22′N, 56°22′E, 23.ii.1979, Mandaville 7119 (BM). Al Batinah: 8 km SE of Matar as Sib ad Duwali, 26.ii.1976, Radcliffe-Smith 3650 (K); Ar Rustaq, 23°25′N, 57°29′E, 18.iii.1975, Rubens 102 d (E); 5 km Sth. Nizwa-As Sib hwy. junction, 23°34′N, 58°13′E, 19.iii.1982, Maconochie 3264 (E); Hills W of Wadi Sahtan, 24.iii.1976, Radcliffe-Smith 4015 (BM, E, K); "Wadi Mistral", Ghubra Bowl, 23°22′N, 57°39′E, 30.xi.1984, Mc Leish 397 (E); "Qara

Binnah", above Bilad Sayt, 23°11′N, 57°23′E, 8.v.1987, Gallagher 7959/2 (E); "Wadi Shafam", 23°23′N, 57°19′E, 5.iv.1975, Mandaville 6264 (BM); vicinity of "Birkat Sahfem", 23°10′N, 57°19′E, 18.iv.1975, Mandaville 6584 (BM); vicinity of "Birkat Sahfem", 23°10′N, 57°19′E, 18.iv.1975, Mandaville 6632 (BM); Jabal al Akhdar, Wadi Masdud, trail above Izki, 22°59′N, 57°43′E, 16.iii.1972, Mandaville 3454 (BM); Wadi Kalbu, "Waliyat" Nizwa, 22°58′N, 57°29′E, 6.ix.1984, Ash 74 (E). Dhofar: Jiddat al Harasis: 110 km S of "Yalooni", "Wadi Haifam", 23.ix.1989, Miller & Nyberg M.9531 (E); Jiddat al Harasis: 18 km SE of "Yaloni" near "Awd Themam", 14.ii.1989, Mc Leish 999 (E). Wadi Dawkah, northern foothills of Jabal al Qara′, 17°23′N, 54°00′E, 21.ix.1983, Gallagher 6898/12 (E); 48 km N of Salalah on rd. to Thamarit, 17°21′N, 54°04′E, 5.x.1977, Radcliffe-Smith 5365 (K); Ra's Hasik, SW of Hasik, 17°20′N, 55°15′E, 19.x.1977, Radcliffe-Smith 5581 (K); "Leje" water hole at base of Jabal Samhan, 17°11′N, 54°46′E, 20.ix.1984, Miller 6215 (E, K); W Hajar mts. Wadi Salahi between Tuwaybah and Al Amirah, 9.ix.1980, Edmundson 3324 (E); rd. W of Mughsayl (8 km from Mughsayl), 27.i.1989, Mc Leish 977 (E); rd. 29 km W of Mughsayl, 27.i.1989, Mc Leish 993 (E); Uyun rd. 10 km W of turnoff from Salalah to Thamarit rd., 5.x.1979, Miller 2567 (E, K); Jabal al Qamar, 10.x.1979, Miller 2648 (E); Jebel Qara', 7 km N of "Ravens Roost" on main Salalah to Thamarit rd., 13.x.1979, Miller 2715 (E); 132 km S of Thamarit on "Manston" rd., 21.ix.1984, Miller 6246 (E, K, UPS); "Wadi Fresharee" NW of Sudh, 23.ix.1984, Miller 6327 (E, K); Jabal Samham above Mirbat, 7.ix.1989, Miller & Nyberg M.9184 (E, K); southern foothill of Jabal Samhan ca. 25 km NE of Mirbat, 8.ix.1989, Miller & Nyberg M.9196 (E); Jabal al Qamar, "Sarfait", 11.ix.1989, Miller & Nyberg M.9285 (E, K); Wadi Afal ca. 10 km W of Mugsail on new rd. to west, 16.ix.1989, Miller & Nyberg M.9401 (E, K). YEMEN: "Aden and the Hadramaut, West rd. mile 18", 4.vii.1950, Guichard KG/HAD/331 (E); "Aden, Hadramaut, Jol, 65 km S of Lahi Fort", 16.viii.1949, Guichard KG/HAD/4 (E). Muhafazat Abyan: Jabal al Urays, northern part of mountain, 13°30′N, 45°53′E, 18.x.1992, Thulin, Eriksson, Gifri & Långström 8467 (UPS); Hadramaut: wadi ascending to the "Jol" behind Zamakh, 27.ii.1952, Balls, Popov, Jillin & Gilliland 4212 (K); wadi ascending to "Jol" behind Zamakh, 27.ii.1952, Popov, Jillin & Gilliland 4212 (K); northern "Jol" near Zamakh, 28.ii.1952, Balls, Popov, Tillin & Gilliland 4220 (K); northern "Jol" near Zamakh, 28.ii.1952, Popov, Tillin & Gilliland 4220 (BM); Al Huraydah, 17.ii.1938, Wakefield exp. 40 (K); "Jol", East rd. between Al Mukalla and Say'un, 30.iii.1952, Popov 530 (BM, K); 5 km NE of N Himar in the Masilah oil field, 15°47′N, 49°12′E, 11.x.1992, Thulin, Eriksson, Gifri & Långström 8271 (UPS); Near Ar Riyan airport, 14°39′N, 49°21′E, 9.x.1992, Thulin, Eriksson, Gifri & Långström 8221 (UPS); 1 km from Shuhayr on rd. towards Mukalla, 14°41′N, 49°21′E, 3.x.1992, Thulin, Eriksson, Gifri & Långström 8028 (UPS); 6 km from the turning to the Masilah oil field on the rd. from Say'un to Al Mukalla, 14°57′N, 48°53′E, 7.x.1992, Thulin, Eriksson, Gifri & Långström 8189 (UPS); Al Mukalla, near College of Education, 14°32′N, 49°08′E, 5.x.1992, Thulin, Eriksson, Gifri & Långström 8060 (UPS); 61 km along the pipeline route from the crossing with the Ressib rd., 15°08′N, 49°22′E, 13.x.1992, Thulin, Eriksson, Gifri & Långström 8373 (UPS). Socotra: "Homhil", 1898–99, Ogilvie-Grant-Forbes exp. 159 (E). DJIBOUTI: Gontoy, ii.1956, Chedeville 1434 (FT); between Randa and Day, 27.ii.1956, Chedeville 1087 (FT); Randa-Day rd., 2.iv.1957, Gule 51 (K); Day, 3.iii.1957, Chedeville 1182 (FT); Day slopes, 2 Feb 1954, Desert Locust Survey 1340 (E); The Ouea area, Cercle de Dikhil-Gobaad, 4–9.i.1938, Aubert de la Rûe *s.n.* (P); Gamadda Bourad,

7.v.1959, Chedeville 1326 (FT). SOMALIA: Woqooyi Galbeed Region: Harar, from "Gildessa" to Saylac, 1889, Robecchi-Brichetti 37 (FT); Dobo pass, 5.ii.1933, Gillett 4959 (EA, FT, K, P, S); "Obosha tug area", 3.ix.1953, White 186 (K, W photo); Hargeysa, 9°35′N, 44°1′E, 24.ix.1932, Gillett 4026 (FT, K); Daragodle near Berbera, 7.xii.1892, Riva 257 (13) (FT); near Dagaane, 30.v.1949, Bally B.7266 (EA, K, W photo). Togdheer Region: 17 km N of Shiikh on hills around Huddis, 21.i.1973, Bally & Melville 16069 (K); Huddis, 8.xi.1941, Peck 397 (EA, K); Lafaruug, iv.1885, James & Thrupp *s.n.* (K); "Adda Gallah", iv.1885, James & Thrupp *s.n.* (K); "Hâdu", 10°10′N, 44°08′E, 24.x.1932, Gillett 4448 (K, W photo); E of Dhuwi, 10°01′N, 44°14′E, 30.vi.1981, Gillett & Watson 23670 (EA, K, W photo); Qar Goliis, 26.ii.1906, Drake-Brockman 229 (K); Qar Goliis, 15.v.1906, Drake-Brockman 246 (K); Shiikh, v.1972, Wood 3/72/44 (K, W photo); Shiikh, 1896–97, Lort Phillips *s.n.* (BM); Shiikh, 1897, Lort Phillips *s.n.* (K); Habr Awal, Cadaadley, 20.ii.1899, Donaldson Smith *s.n.* (BM). Sanaag Region: Karin Xaggarood, 10°58′N, 48°52′E, 11.i.1995, Thulin, Dahir & Abdisalam Hassan 8986 (UPS). Bari Region: Cal Miskaat Mts.: between "Toh" and Baqayle, near "Daleelimo", 11°20′N, 49°50′E, 26.xi.1986, Thulin & Warfa 6088 (K, UPS); Bahaya, 11°18′N, 49°49′E, 26.xi.1986, Thulin & Warfa 6061 (K, UPS); in Bahaya area, *c.* 25 km SW of Qandala, 11°18′N, 49°48′E, 4.i.1997, Thulin, Dahir & Osman 9426 (UPS); N of Dasan, 11°13N, 49°50′E, 8.i.1997, Thulin, Dahir & Osman 9476 (UPS); Galgala, 10°59′N, 49°03′E, 1.xii.1986, Thulin & Warfa 6201 (UPS); hills N of Qardho airstrip, 9°33′N, 49°07E, 1.i.1981, Beckett 677 (EA). Nugaal Region: 111 km NW of Eyl, 5.i.1973, Bally & Melville 15557 (EA); 16 km N of Eyl, ca. 2 km N of airstrip, 3.i.1973, Bally & Melville 15528 (K).

12. Echiochilon collenettei

Echiochilon collenettei I.M. Johnst., *J. Arnold Arbor. 38:* 277 (1957). Type: Collenette 196, Somalia, Karin, 10°57′N, 49°24′E, 29.x.1929 (K holotype).

Description. Perennial shrublet with a woody base, sometimes cushion-forming, up to *c.* 25 cm high, richly branched, often with many short shoots developing from the leaf-axils, even from the axils of the bracts. STEMS and older parts of branches with white, encrusted, flaking bark, young branches greenish, ± densely covered with appressed disc-based hairs, ± densely covered with unstalked glands or shortly stalked glandular hairs; internodes short, often about 0.5–1 mm, more rarely up to *c.* 4.5 mm long. Most of the LEAVES opposite, oblanceolate to lanceolate 3.5–11.5 × 1–2 mm, acute (sometimes not pointed) at the apex, cuneate at the base, somewhat decurrent, rather closely appressed to the stem, with scattered disc-based appressed hairs on the lower side or on both sides, ± densely covered with unstalked glands or shortly stalked glandular hairs on both sides, often covered at base on the lower side with an incrusted triangular extension of the crust on the stem, up to *c.* 3 × 1 mm, leaving a distinct pattern of encrusted leaf-bases on the older branches before the bark flakes off; midrib not visible; margins flat or almost so, ciliate with appressed to spreading disc-based hairs. FLOWERS in quite short few-flowered cymes terminating the leafy branches; pedicels 0.7–1.7 mm long. BRACTS like the leaves, up to *c.* 4.5 × 0.9 mm, gradually smaller upwards. CALYX reaching nearly up to – slightly beyond the constriction of the corolla tube; lobes 5, ± free, in flower ±

equal, 3-5 × 0.7–1.4 mm, in fruit subequal with one somewhat larger, with scattered appressed disc-based hairs and ± densely covered with unstalked glands or shortly stalked glandular hairs on the outer surface, the inner surface glabrous, with a thin tuft of hairs at the base inside; midrib visible in fruit; margins flat or almost so, ciliate with appressed to spreading disc-based hairs. COROLLA yellow and/or white, narrowly funnel-shaped, ± actinomorphic, 9–11.8 mm long, yellow villose in the throat, below the constriction glabrous, rarely with a ring of short hairs at the base, outside somewhat hairy on the lobes and on the upper part of the throat, and ± densely covered with glandular hairs on the tube; tube 7.5–9 mm long, 1–1.1 mm in diameter at the base, slightly widened, then narrowed again to a waist near the middle, 1.1–1.2 mm in diameter, widened to 2–4 mm in diameter at the throat; limb with rounded lobes, equal or subequal in size, 1–3 × 1.5–3.3 mm. STAMENS borne in the throat at equal heights, 5–6 mm above the base; anthers included, equal, 1–1.5 mm long; filaments equal in length, 0.4–0.8 mm long. STYLE 2.9–5 mm long; stigmas horizontal, 0.05–0.14 mm high, surmounted by a ± bifid or more commonly, only notched sterile tip, protruding *c.* 0.09–0.16 mm beyond the stigmas. NUTLETS reddish-beige, ovoid in dorsal outline, 1.9–2.2 × 1.5–1.7 mm, tuberculate, not ridged, keeled, with rostrate apex, usually 2–3 developing, attachment ventral; sulcus extending from just below the tip to the base or just above, halfway from the top slightly widened and expanding into the rounded triangular areola; areola 0.5–0.6 × 0.6–0.7 mm (Fig. 22).

Distribution and habitat. Echiochilon collenettei is known from northern Somalia and Oman (Fig. 23). It grows on stony and gravelly ground with sparse vegetation, sometimes on limestone. The known altitudinal range is (60–)495–1150 m.

Variation and taxonomic remarks. Echiochilon collenettei is a small shrublet with opposite leaves, but this is not very easily seen because the internodes are very short. The leaf bases are incrusted leaving a very typical pattern, reminding of snake skin, on older parts of branches which have lost their leaves. It has a disjunct distribution, but is very uniform throughout its distribution area. The single collection I have seen from Oman differs from the collections from Somalia only in being somewhat less hairy in the throat, and in having a more distinct ring of hairs at the base of the corolla than the collections form Somalia which have hairs at the base.

The closest relatives of *E. collenettei* are *E. arabicum*, *E. callianthum*, and *E. persicum*. *Echiochilon collenettei* differs from *E. arabicum* and *E. callianthum* in having an actinomorphic corolla compared to the zygomorphic corollas found in *E. arabicum* and *E. callianthum*. It differs from *E. persicum* in its narrowly funnel-shaped (compared to funnel-shaped) corolla with a longer tube (*c.* 7.5–9 mm) than the tube of *E. persicum* (*c.* 2–5 mm long), and in having most of the leaves opposite, a condition not found in *E. persicum*.

Material studied. OMAN: Dhofar Uyun rd. 10 km W of turnoff from Salalah – Thamarit rd., 5.x.1979, Miller 2566 (E). SOMALIA: Woqooyi Galbeed region: 9°00′N, 44°39′E, 10.xii.1980, Beckett 684 (EA, K). Sanaag region: Between Badhan and Ceerigaabo, 26.vii.1978, Kasmi, Elmi & Rodol 928 (EA); 10°37′N, 48°11′E, 7.vii.1981, Gillett & Watson 23798 (EA, K, W photo); Hills between Buraan and Ceerigaabo, 11.xii.1970, Bavazzano & Lavranos *s.n.* (FT). Bari region: above Galgalo, 28.xi.1971, Lavranos 9037 (E, K); below Galgalo, 11.i.1973, Lavranos & Horwood 10270 (E); Galgalo, 10°59′N, 49°03′E, 1.xii.1986, Thulin & Warfa 6199 (UPS, E,

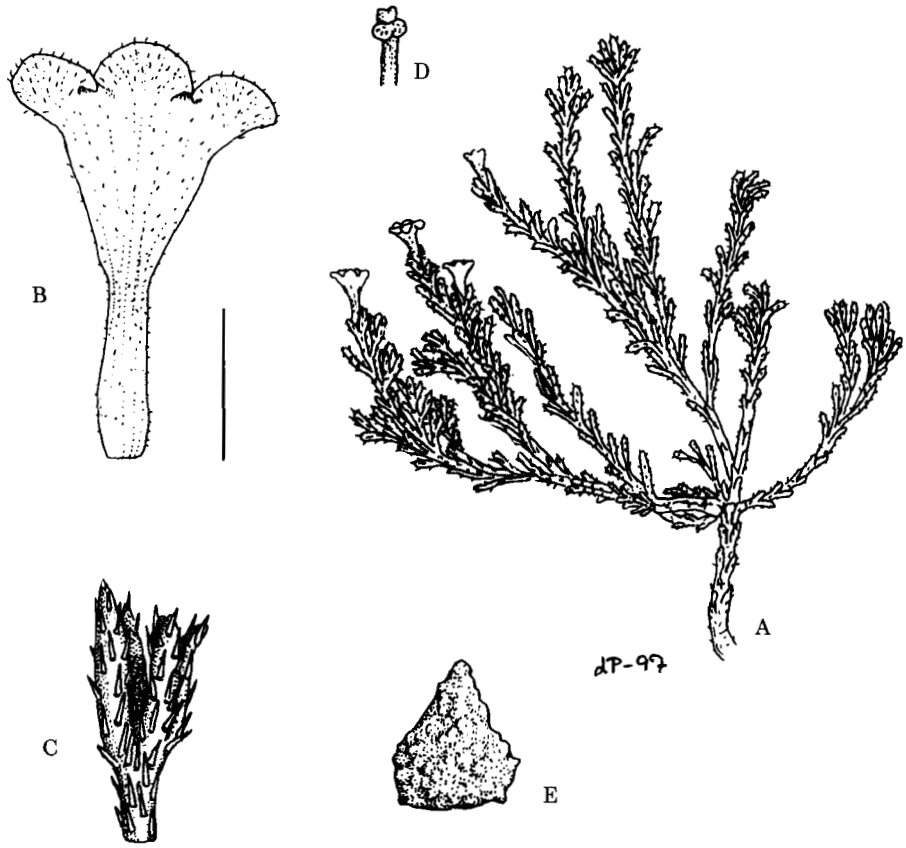

Figure 22. *Echiochilon collenettei*. A, habit. B, corolla. C, calyx. D, stigmas and the sterile tip of the style. E, nutlet. All from Thulin & Warfa 6199, Somalia. Scale bar: A = 20 mm; B & C = 5 mm; D = 1 mm; E = 2.5 mm.

K); Galgalo, 25 km W of Karin, 10°59′N, 49°20′E, 21.xi.1986, Lavranos & Carter 24832 (EA, K). Karkaar Mts., between Qardho and Iskushuban, "God Adde", 23.xi.1985, Thulin & Warfa 5451 (UPS, K); Karkaar area, 96 km NNE of Qardho, 27.vi.1979, Hansen & Heemstra 6288 (EA, K); 142 km NE of Qardho, SW of Iskushuban, 6.i.1973, Bally & Melville 15598 (EA, K, W photo); 132 km NE of Qardho on rd to Iskushuban, 9°55′N, 50°00′E, 13.xi.1988, Lavranos & Carter 24667 (EA, K). Nugaal region: close to the airport, *c.* 16 km from Eyl, 25.xi.1970, Bavazzano & Lavranos *s.n.* (FT); 16 km N of Eyl and *c.* 2 km N of airstrip, 3.i.1973, Bally & Melville 15524 (EA, K).

13. Echiochilon arabicum

Echiochilon arabicum (O.Schwartz) I.M.Johnst., *J. Arnold Arbor. 38:* 289 (1957).

Teraedrocarpus arabicus O.Schwartz, *Mitt. Inst. Allg. Bot. Hamburg. 10:* 213 (1939). Type: Wissmann 1234, Yemen, Hadramaut, Wadi Himam, v.1931 (HBG lectotype, selected by Mill, 1997).

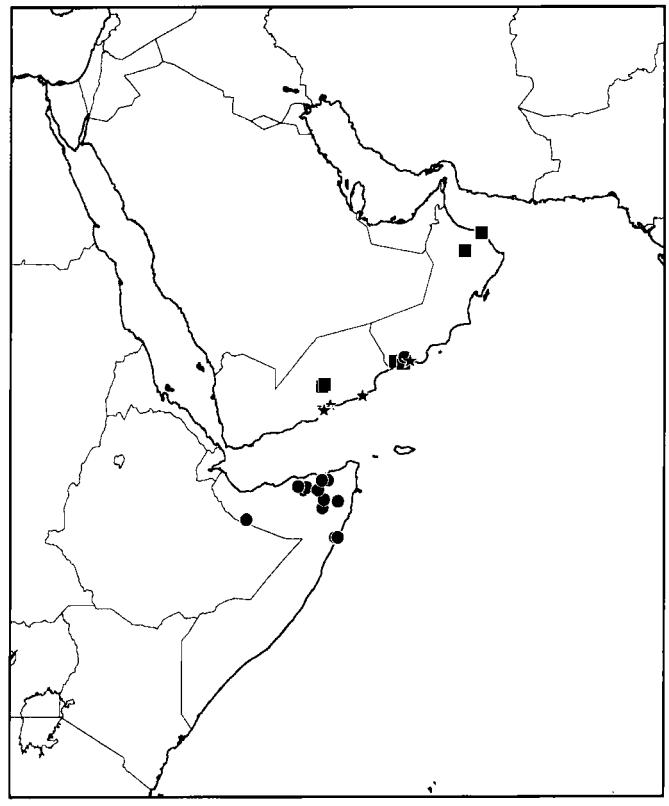

Figure 23. Distribution of *Echiochilon arabicum* (★), *E. callianthum*, (■), *E. collenettei* (●).

Description. Perennial herb or shrublet with a ± woody base, up to *c.* 50 cm high, moderately branched, erect, with unstalked or stalked, 0.07–0.2 mm long, glandular hairs on the vegetative parts in the inflorescence, or more rarely covering the whole plant. STEMS and older parts of branches with brown or grey bark, often whitish or greyish incrusted, on older parts split up and flaking, young branches green, ± densely covered with appressed disc-based hairs; internodes up to 11 mm long. LEAVES alternate, oblanceolate, 11–36(−50) × 3–7 mm, acute at the apex, cuneate or attenuate at the base, usually rather closely appressed to the stem, ± densely covered with appressed disc-based hairs on both surfaces; midrib visible on the dorsal side; margins flat or almost so, ciliate with few spreading disc-based hairs. FLOWERS in well developed cymes, terminating the leafy branches; pedicel 1–1.5 mm long. BRACTS narrowly ovate to oblanceolate, up to *c.* 20 × 2 mm, gradually reducing in width, acute at the apex. CALYX reaching up to, slightly beyond the constriction of the corolla tube; lobes 5, ± free, somewhat unequal in size, one of the abaxial the largest, in flower narrowly lanceolate to oblong, 3–5 × 0.6–1.1 mm, in fruit, 4–6.5 × 0.8–1.5 mm, acute at the apex, ± densely covered with appressed disc-based hairs on both surfaces, with a tuft of hairs inside at the base; midrib inconspicuous; margins flat or almost so, ciliate with spreading disc-based hairs. COROLLA blue, or rarely white, with purplish veins, strongly zygomorphic, obliquely trumpet-shaped, 8.5–9 mm long, white (yellow) villose inside the throat, below the

constriction glabrous or sparsely hairy, outside covered with short white hairs and with usually stalked glandular hairs, 0.05–0.1 mm long, at least on the throat; tube 5–6.5 mm long, the adaxial side *c.* 1.2–2.5 mm longer than the abaxial, 0.8–1.5 mm in diam. at the base, slightly widened and then narrowed again to a waist somewhat below the middle, 1–1.4 mm in diam., widened to 3–4.5 mm in diam. at the throat; limb with spreading rounded lobes, 1–2.2 × 1.2–2.8 mm. STAMENS borne in the throat at two or three different heights 2.5–4.8 mm above the base with at least the adaxial one in a higher position than the others; anthers included, equal, 1–1.2 mm long; filaments of two or three different lengths (or equal), 0.4–2 mm long, when of three lengths the adaxial the longest, the lateral ones medium and the abaxial ones the shortest. STYLE 1.2–2.2 mm long; stigmas oblique or more rarely horizontal, 0.1–0.2 mm high, surmounted by a sterile tip, somewhat bifid or only with a very small depression on the top, protruding *c.* 0.02–0.07 mm beyond the stigmas or not at all. NUTLETS beige or reddish beige, ovoid to broadly ovoid in dorsal outline, 1.9–2.2 × 1.5–1.8 mm, tuberculate, with a longitudinal ridge on the dorsal side and with an extra shorter ridge on each side of the ridge, with a keel on the ventral side, with rostrate apex, usually 2–4 developing, attachment ventral and basal; sulcus narrow, extending from just below the tip to the base, above the base slightly widened then abruptly expanding into the triangular areola; areola 0.2–0.5 × 0.6–0.9 mm (Figs 24, 25).

Distribution and habitat. Echiochilon arabicum is known from SE Yemen and SW Oman (Fig. 23). It grows on open stony or rocky ground, often on hillsides or the slopes of wadi beds, sometimes on limestone. The known altitudinal range is 50–200 m.

Variation and taxonomic remarks. Echiochilon arabicum is a moderately branched shrublet with the oblanceolate strigose leaves usually closely appressed to the stems. It has zygomorphic, usually blue flowers with the adaxial side of the corolla throat prolonged, and the lobes equal in size and shape. The species was treated in a wider sense by Johnston (1957), also including material from *E. cyananthum.*

The closest relative of *E. arabicum* is *E. callianthum. Echiochilon callianthum*, however, has the corolla obliquely funnel-shaped with the expanded throat bell-shaped, the leaves are not closely appressed to the stem and the calyx lobes long and narrow, 5.8–8.1 mm long, compared to 3–5 mm in *E. arabicum.*

Material studied. OMAN: Dhofar: rd. 23 km W of Mughsayl, 27.i.1989, Mc Leish 990 (E); Wadi Athun 8 km W of Mughsayl, 22.v.1988, Mc Leish 874 (E); 4 km W of Mughsayl, 2.ix.1989, Miller & Nyberg 9026 (E). YEMEN: Al Mahrah: 34 km from Sayhut along rd. to Qishn, 15°18′N, 51°24′E, 16.x.1992, Thulin, Eriksson, Gifri & Långström 8436 (UPS). Hadhramaut: Wissmann 1240, Yemen, Hadramaut, near Wadi al Lisb, v.1931 (HBG); 26.xii.1893, Lunt 94 (BM, K); 23 km on the pipeline route starting 15 km NE of Ar Riyan, 14°50′N, 49°31′E, 4.x.1992, Thulin, Eriksson, Gifri & Långström 8044 (UPS); Wissmann 1241, Yemen, Hadramaut, Al Mukalla, v.1931 (HBG); Al Mukalla, near College of Education, 14°32′N, 49°08′E, 5.x.1992, Thulin, Eriksson, Gifri & Långström 8059 (UPS).

14. ***Echiochilon callianthum*** Lönn **sp. nov.**

Species nova ab *E. arabico* (O.Schwartz) I.M.Johnst. lobis calycis longioribus 5.8–8.1 mm longis (in *E. arabico* 3–5 mm longis), lobis corollae longitudine circa

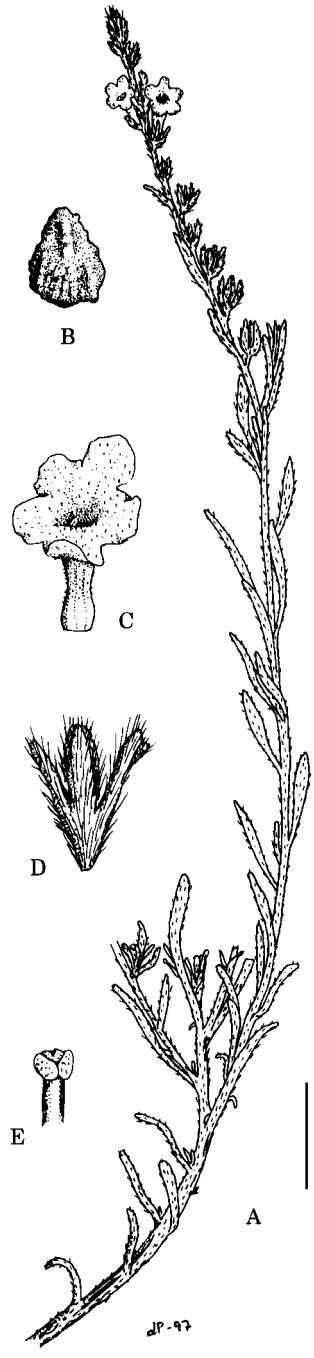

Figure 24. *Echiochilon arabicum*. A, habit. B, nutlet. C, corolla. D, calyx. E, stigmas and the sterile tip of the style. All from Thulin, Eriksson, Gifri & Långström 8436, Yemen. Scale bar: A = 20 mm; B = 2.5 mm; C & D = 5 mm; E = 1 mm.

Figure 25. Photograph showing the appressed leaves and trumpet-shaped corollas of *Echiochilon arabicum* (Thulin, Eriksson, Gifri & Långström 8044, Yemen).

quarta parte tubi corollae super constrictionem brevioribus (in *E. arabico* circa dimidio) et parte tubi corollae super constrictionem oblique in fundi buliformi inflato-campaniformi (in *E. arabico* oblique tubaeformi) differt. Type: Thulin, Eriksson, Gifri & Långström 8272, Yemen, Hadramaut, 5 km NE of N Himar in the Masilah oil field, 15°47′N, 49°12′E, 11.x.1992 (UPS holotype).

Description. Perennial herb or shrublet with a ± woody base, up to *c.* 40 cm high, moderately to fairly richly branched, ± erect, with stalked glandular hairs, 0.1–0.4 mm long, on all parts of the vegetative parts. STEMS and older parts of branches with whitish or beige encrusted bark, on older parts split up and flaking, young branches green, hispid with spreading to appressed disc-based hairs; internodes up to 7 mm long. LEAVES alternate, oblanceolate, 15–17(−20) × 2–3 mm, acute at the apex, cuneate or attenuate at the base, usually standing out from the stem, hispid with spreading to appressed disc-based hairs on both surfaces; midrib inconspicuous; flat or almost so, ciliate with spreading disc-based hairs. FLOWERS in well developed cymes, terminating the leafy branches; pedicel 1–1.5 mm long. BRACTS lanceolate to oblanceolate, up to *c.* 15 × 1.5 mm, acute to subacute at the apex,

gradually smaller upwards. CALYX reaching slightly beyond the constriction of the corolla tube; lobes 5, ± free, unequal in size, one of the abaxial the largest, sometimes much larger than the others, in flower narrowly lanceolate to oblanceolate, (3.5–)5.8–8.1 × 0.5–0.9 mm, in fruit, 7–8(–13) × 1–1.2 mm, acute at the apex, hispid with spreading to appressed disc-based hairs on outer surface and ± densely covered with appressed hairs on the inner surface, with a tuft of hairs inside at the base; midrib inconspicuous; margins flat or almost so, ciliate with spreading disc-based hairs. COROLLA white with purple waist, purple veins on the white throat and blue or purple lobes, strongly zygomorphic, obliquely funnel-shaped with an expanded, bell-shaped throat, 9.5–12 mm long, yellow, pale yellow, or rarely yellow and white, villose inside the throat, below the constriction glabrous, outside covered with short white hairs and stalked glandular hairs, (0.05–)0.1–0.2 mm long; tube 6.2–9 mm long, the adaxial side *c.* 1–1.8 mm longer than the abaxial, 1–1.5 mm in diam. At the base, slightly widened and then narrowed again to a waist somewhat below the middle, 1–1.5 mm in diam., widened to 2.8–5 mm in diam. at the throat; limb with patent rounded lobes, 1–1.2 × 1.2–1.5 mm. STAMENS borne in the throat at two to three different heights 3.2–6.3 mm above the base with the adaxial one in a higher position than the others; anthers included, equal, 0.9–1.4 mm long; filaments of three different lengths, 0.3–1.1 mm long, usually with the adaxial one the longest, the lateral ones medium and the abaxial ones the shortest (rarely the lateral ones the longest). STYLE 1.7–3.1 mm long; stigmas horizontal to oblique, *c.* 0.1 mm high, surmounted by a sterile tip, somewhat bifid, protruding *c.* 0.07–0.1 mm beyond the stigmas. NUTLETS beige to reddish beige, ovoid in dorsal outline, 2–2.2 × 1.5–1.8 mm, tuberculate to almost smooth, with a ± well developed longitudinal ridge on the dorsal side and often with an extra shorter ridge on each side of the ridge, with a keel on the ventral side, with rostrate apex, 1–4 developing, attachment ventral and basal; sulcus narrow, extending from just below the tip to the base, above the base slightly widened then abruptly expanding into the triangular areola; areola 0.4–0.6 × 0.4–0.8 mm (Figs 26, 27).

Distribution and habitat. Echiochilon callianthum is known from SE Yemen and Oman (Fig. 23). It grows on open sandy, stony or rocky ground, on the slopes of wadi beds or plains, sometimes on limestone. The known altitudinal range is 30–900 m.

Variation and taxonomic remarks. Echiochilon callianthum is a fairly richly branched shrublet, hispid with sharp pointed disc-based hairs, and densely covered with glandular hairs all over the plant. The leaves are, on fresh material, often standing out from the stem in an angle of about 45–90°. The corollas are strongly zygomorphic with a narrow waist, expanded throat and patent lobes.

The closest relative of *E. callianthum* is *E. arabicum*, *E. collenettei*, and *E. persicum*. *Echiochilon callianthum* is most similar to *E. arabicum*, but differs from *E. callianthum* in having an obliquely funnel-shaped corolla and the leaves usually closely appressed to the stem. From *E. persicum* it differs in its strongly zygomorphic corollas with an expanded, bell-shaped throat, not found that well developed in any other *Echiochilon* species, and in having a longer corolla (9.5–12 mm compared to 2.5–7 mm). *Echiochilon collenettei* differs from *E. callianthum* in its actinomorphic narrowly funnel-shaped corolla, and opposite leaves.

This new species is in many respects rather similar to *E. arabicum*, but especially when seen in the field, it differs so much in general appearance and in the above mentioned characters that I regard it as a new species.

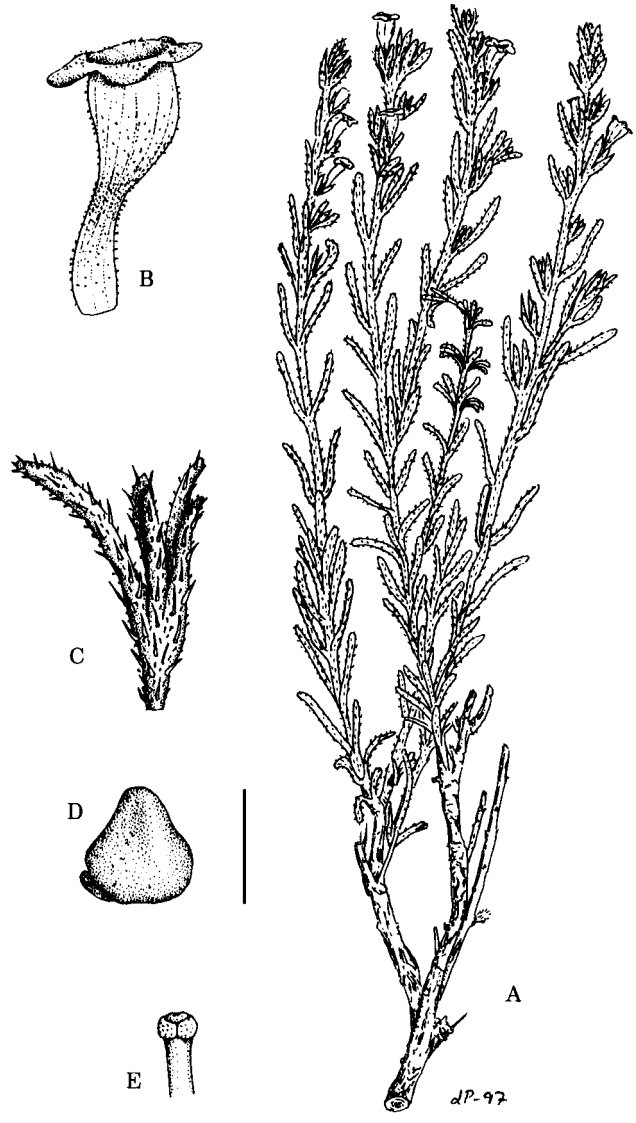

Figure 26. ***Echiochilon callianthum* sp. nov.** A, habit. B, corolla. C, calyx. D, nutlet. E, stigmas and the sterile tip of the style. All from Thulin, Eriksson, Gifri & Långström 8318, Yemen. Scale bar: A = 20 mm; B & C = 5 mm; D = 2.5 mm; E = 1 mm.

Material studied. OMAN: Masqat: Ruwi, 13.iii.1976, Radcliffe-Smith 3908 (BM, E, K). Al Adabah: Adam to Nizwa, 30 km before Nizwa, 15.x.1984, Miller 6577 (E, K). Dhofar: "Manston" to Mudayy rd., 17°04′N, 53°22′E, 22.ix.1984, Miller 6303 (E, K); wadi tributary to Wadi Adawnib, 16°57′N, 53°51′E, 18.x.1977, Radcliffe-Smith 5524 (K). YEMEN: Hadramaut: North Himar area in the Masilah oil field, 15°50′N, 49°12′E, 12.x.1992, Thulin, Eriksson, Gifri & Långström 8318 (UPS); Sunah 1 oil well in the Masilah oil field, 15°47′N, 49°03′E, 12.x.1992, Thulin, Eriksson, Gifri & Långström 8312 (UPS).

Figure 27. Photograph of ***Echiochilon callianthum* sp. nov.**, showing its spreading pointed hairs, the leaves standing out from the stem and its corolla with a narrow waist, an expanded, bellshaped throat and ± flat limb with patent lobes (Thulin, Eriksson, Gifri & Långström 8272, Yemen).

TAXONOMY OF *OGASTEMMA*

Ogastemma Brummitt, *Kew Bull. 36 (4):* 679 (1982).

Megastoma (Benth. & Hook.f.) Coss. & Durieu ex Bonnet & Barratte, *Explor. Sci. Tunisie, Ill. Bot.*: t. 11, Fig. 4–11 (1892–1895); *Expl. Sci. Tunisie, Cat. Pl.*: 301 (1896); non Grassi, *Atti Soc. Ital. Sci. Nat.* 24: 167 (1881)(Algae). Type: *M. pusillum* Coss. & Durieu ex Bonnet & Barratte.

Eritrichium sect. *Megastoma* Benth. & Hook.f., *Gen. Pl. (Bentham & Hooker)* 7: 851 (1876).

Description. Small annual herb; STEMS richly branched from the base, with the lowest branches opposite, densely covered with appressed disc-based hairs. LEAVES simple, the lowest pairs opposite, then alternate, not petiolate, densely covered with appressed disc-based hairs. FLOWERS pedicellate, produced abundantly along almost the whole length of the branches, the first flowers of the young shoots develops in the axil of the at first bifurcating stems; bracts leaf-like, similar to or smaller than the ordinary

leaves. CALYX 5-lobed, reaching beyond the corolla, with the lobes somewhat to distinctly unequal in size, in a somewhat undecided pattern, usually with one of the lobes facing away from the stem the largest and one of the lobes facing closest to the stem the second largest, somewhat enlarged in fruit, the base becoming subglobose and the tips of the lobes join together, densely covered with appressed disc-based hairs. COROLLA usually 5-lobed, actinomorphic, small, subcylindrical; throat not differentiated, with five circular, not well defined, invaginations of the throat; lobes rounded, erect to spreading. STAMENS five, equal, included; filaments dorsiventrally flattened, inserted very low in the corolla tube; anthers ovoid to rounded cordate, affixed at or slightly below the middle, dorsiventrally compressed; thecae distinct, parallel, closely connected at the middle by the very short linear connective. Pollen 3-aperturate (colpate or colporate), round or subprolate in equatorial view, round or rounded triangular in polar view with the apertures situated in the corners when rounded triangular. OVARY deeply 4-lobed, with an elongate narrowly pyramidal gynobase with the nutlets attached along the sides, bearing the short style on the top of the gynobase; the two stigmas terminal, subglobose. NUTLETS beige (reddish), ovoid with a conoidal to somewhat rostrate acute apex, densely verrucose, particularly on the rounded basal part, usually four developing; attachment lateral except for at the broadened lower end where it may be somewhat oblique towards the base; areola narrowly triangular, covering about a third of the length of the ventral side of the nutlet.

A genus with only one species with a distribution in the Canary Islands, northern Africa, and Arabia.

Ogastemma pusillum

Ogastemma pusillum (Coss. & Durieu ex Bonnet & Barratte) Brummitt, *Kew Bull. 36:* 679 (1982).

Megastoma pusillum Coss. & Durieu ex Balansa, *Pl. d'Algérie 1853*: 1035 (1853), nom. nud.; ex Bonnet & Barratte, *Explor. Sci. Tunisie, Ill. Bot*: t. 11, figs 4–11 (1892–1895); *Expl. Sci. Tunisie, Cat. Pl.*: 301 (1896). Type: [Icon] Coss. & Durieu ex Bonnet & Barratte, *Explor. Sci. Tunisie, Ill. Bot:* t. 11, figs 4–11, 1892–1895 (lectotype, selected here).

Nomenclatural note. In the original publication of *Ogastemma pusillum* no material was cited, although an excellent illustration, with analysis, was provided. The illustration is here selected as lectotype.

Description. Annual herb up to *c.* 25 cm high, fairly richly branched, the lowest branches opposite, erect. STEMS and older parts of branches with brown bark, on older parts split up and flaking, young branches green, densely covered with bent to appressed disc-based hairs; internodes up to 15(−28) mm long. LEAVES with the lowest pairs opposite, then alternate, lanceolate, 10–20 × 1.5–2 mm, acute at the apex, cuneate or attenuate at the base, sometimes conduplicate, densely covered with appressed disc-based hairs on both surfaces; midrib visible on the dorsal side; margins flat or almost so, ciliate with spreading disc-based hairs. FLOWERS in cymes terminating the leafy branches; pedicel *c.* 0.5–1 mm long. BRACTS like the leaves, up to *c.* 12 × 1 mm, gradually smaller upwards. CALYX reaching beyond the tip of the corolla; lobes ± free, unequal in size, in flower narrowly lanceolate, the largest

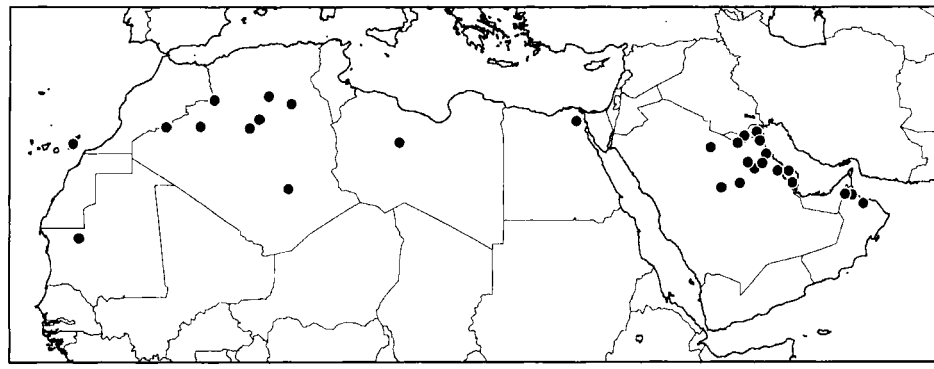

Figure 28. Distribution of *Ogastemma pusillum* (●).

3.2–4.3 × 0.6–0.7 mm, the smallest 2.1–3.2 × 0.2–0.4 mm, in fruit somewhat prolonged, acute at the apex, ± densely covered with loosely appressed to spreading disc-based hairs on the outer surface and appressed hairs on the inner surface, without a tuft of hairs inside at the base; midrib inconspicuous, but visible from the inside; margins flat or almost so, hyaline at the base; best seen in fruit (*c.* 0.2 mm wide in flower, 0.5 mm wide in fruit), ciliate with spreading disc-based hairs. COROLLA white, actinomorphic, subcylindrical, 2.2–2.7 mm long, with an invagination below each corolla lobe, glabrous inside and outside; tube 1.5–2 mm long, *c.* 0.8 mm in diam. at the base, somewhat widened and then narrowed again at the invaginations somewhat above the middle, somewhat widened again to 1.1–1.3 mm in diam. at the throat; limb with (4-)5(−6) lobes, 0.7–0.8 × 0.5–0.9 mm. STAMENS borne in the throat at equal heights 0.4–0.5 mm above the base; anthers equal, 0.3–0.4 mm long; filaments of equal lengths, 0.1–0.2 mm long. STYLE 0.4–0.5 mm long; stigmas horizontal, *c.* 0.09–0.12 mm high, globose. NUTLETS 1.4–1.9 × 1–1.1 mm, with a poorly developed longitudinal ridge on the dorsal side, keeled on the ventral side, attachment ventral; areola 1–1.2 × 0.4–0.6 mm.

Distribution and habitat. Ogastemma pusillum is known from the Canary Islands (Fuerteventura), Mauritania, Morocco, Algeria, Tunisia (cf. Bonnet & Barratte, 1896), Libya, Egypt, Kuwait, Bahrain, Qatar, United Arab Emirates, Saudi Arabia and Oman (Fig. 28). It grows on sandy, gravelly or rocky ground, on sand dunes, rocky volcanic slopes, limestone slopes or on sandstone. The known altitudinal range is from sea level to 1100 m.

Variation and taxonomic remarks. Ogastemma pusillum is a very uniform species. Even though it is widespread it shows very little variation. It is a small, much-branched annual herb with minute corollas that wither and fall off two or three days after they have opened. It starts flowering only a few centimetres tall. The calyces in fruit have a relatively broad hyaline margin on each side of the midrib that makes the bases of the calyces whitish. Much of the variation it shows is found within individuals. A single specimen can have corollas with 4–6 lobes.

Material studied. "South of Jebal", iv. or v.1965: collector unknown 80 (K); collector unknown 141 (K). CANARY ISLANDS (ISLA DE FUERTEVENTURA): Near "Tarjabejo", iv.1912, Burchard 335 (K). MAURITANIA: "Arasal", Chudeau *s.n.* (P); "Bir Igni",

20.ii.1910, Charles 25529 (P); "Mouhden", 20.ii.1910, Charles 25547 (P); Area N and NE of Adrar, 1911–1912, Schmitt 28505 (P). MOROCCO: Province d'Ouarzazate: 25 km SE on rd. 6958 to Tagounite, 30°13′N, 5°36′W, 11.iv.1990, Schuhwerk 90/929 (M). Province de Figuig, El Arja, iii.1913, Pitard 3618 (K). ALGERIA: Joad 19/81 (K); Wilaya de Bechar: Montains of Zerhamra, wadi from plateau 28 km SW Zerhamra (ca. 65 km WSW Beni Abbes), 29°49′N, 2°41′W, 1.iv.1980, Podlech 33699 (M); Wilaya de Laghouat: Hassi el Khannfous, 175 km ENE Timimoun on rd. to El Golea, 29°52′N, 2°00′E, 26.iii.1981, Podlech 35256 (M); Ghardaia: 14 and 17.ii.1902, Chevallier 455 (M, WAG, WU); ii.1902, Chevallier *s.n.* (S); El Golea, 29.iii.1904, Chevalier *s.n.* (K). Wilaya de Biskra: Biskra, 10.v.1853, Balansa 1035 (BM, E, K, P, WAG). Wilaya de Tamanghasser: Tefedest, at the foot of "Garet el Djenoun", 18.iv.1928, Maire 6274 (BM, BR); In Tefedest mts., 10.iv.1928, Maire 840 (P); "Coudia du Hoggan", 8.ix.1928, Mission Saharien Augieras Draper 38 (P). LIBYA: Wadi Tanqazir, 3.iii.1952, Guichard KG/Lib/194 (BM). EGYPT: Bilbays desert, 1837, Schubert *s.n.* (K). KUWAIT: 3 km SW Umm ar Rimam N Jal Az Zawr, 8.iv.1990, Boulos & Ibrahim 17558 (K); "Shu'aib Al-Batin", 25 km E Ash Shiqaya, 17.iv.1990, Boulos & Cope 17685 (E, K); Kuwait aerodrome: Dickson 253 (K); 18.v.1935, Dickson 209 (K); Wadi Al-Batin, 12 km N Al-Sami border station with Saudi Arabia, 17.iv.1990, Boulos & Cope 17614 (K); 35 km NE of Jahra along Al Jahra'-"Al Subbiyah" Rd., 30.iii.1995, Mathew 2633 (K); 60 km to Markaz Hudud as Salmi, frontier station with Saudi Arabia, along the motorway from Kuwait, 19.iii.1990, Boulos & Ibrahim 17157 (BM); Runoff along the coastal highway to Makhfar an Nuwaysib facing Al Ahmadi Port, 7.iii.1985, Boulos & Al-Hasan 15294 (BM); QATAR: iv.1955, Codrai *s.n.* (K). BAHRAIN: Awali rd., 13.iii.1950, Good 215 (K); Jabal ad Dukhan, 16.iii.1950, Good 216 (BM, K). UNITED ARAB EMIRATES: Abu Dhabi, "Jabal Hafit", 20 km S. of Al Ayn, 17.ii.1980, Edmondson 3025 (E). SAUDI ARABIA: 3 km ESE "Ash Shundul (Ma qala)", 11.iii.1970, Mandaville 2819 (BM); "Uaw Tah", 7.iv.1992, Collenette 8117 (K). Al Qasim: Near Az Zabirah, about 200 km N of Buraydah, 21.iv.1981, Collenette 2485 (E, K). Ar Riyad: Thumamah, 80 km NE of Ar Riyad., 11.iv.1992, Collenette 8148 (K); "Dauradini Camp II", 5 km S of camp, 24°46′N, 44°38′E, 9.iii.1983, Collenette 4103 (E, K). Ash Sharqiyah: 27.ii.1970, Mandaville 2720 (BM); 15 km SE Al Qaysumah, 25.iii.1981, Hillcoat 293 (BM); 18 km SW As Saffaniyah, 18.ii.1970, Mandaville 2714 (BM); 2 km S Saudi-Kuwait border, 22.ii.1968, Mandaville 1662 (BM); Abu Hadriyah, 23.iii.1968, Mandaville 1759 (BM); 50 km WN13 km N Abu Hadriyah, 28.iv.1972, Mandaville 3766 (BM); W An Nuayriyah, 20.iii.1968, Mandaville 1843 (BM); 15 km ENE Qaryah al Ulya, 22.ii.1968, Mandaville 1257 (BM); Az Zahran, 20.iii.1964, Mandaville 135 (BM); Az Zahran, 3.iv.1968, Mandaville 1831 (BM); 8 km W "J. Dab", 22.ii.1968, Mandaville 1315 (BM). OMAN: "Jabal Hafit", 25.iv.1948, Thesiger *s.n.* (BM); Vicinity of "Birkat Sahfan", 18.iv.1975, Mandaville 6592 (BM); W Hajar mts: "Wadi Salahi" between Tuwaybah and Al Amirah, 9.iii.1980, Edmondson 3321 (E); "Wadi Sahtan", *c.* 30 km from Ar Rustaq, 9.iv.1982, Maconochie 3373 (E).

TAXONOMY OF *SERICOSTOMA*

Sericostoma Stocks ex Wight, *Icon. Pl. Ind. Orient. (Wight) 4 (2):* 15, t. 1377 (1848). Type: *S. pauciflorum* Stocks ex Wight.

Description. Perennial herb or shrublet; STEMS moderately to richly branched, ± erect, spreading or procumbent, ± densely covered with closely appressed disc-based hairs. LEAVES simple, the lowest pairs of the shoots opposite, then alternate, not petiolate, ± densely covered with appressed disc-based hairs. FLOWERS in short few-flowered cymes, pedicellate; bracts few, leaf-like, smaller than the ordinary leaves. CALYX 5-lobed, reaching up to or slightly beyond the limb of the corolla, with the lobes equal, ± densely covered with appressed disc-based hairs. COROLLA 5-lobed, actinomorphic, funnel-shaped; throat not differentiated, without invaginations or appendices in the throat; lobes almost as long as the tube, narrowly triangular or oblong, rounded at the apex. STAMENS five, equal; filaments dorsiventrally flattened and very narrowly triangular, inserted just below the apex of the corolla tube; anthers exserted, narrowly oblong, affixed above the middle, laterally compressed; connective very narrow and inconspicuous. Pollen 2-colpate, square in equatorial view, elliptic in polar view. OVARY deeply 4-lobed; gynobase flat or somewhat depressed in the middle, with circular scars from the nutlets, bearing the style directly from the discoid gynobase; the two stigmas terminal, with a small, somewhat bifid, sterile tip deep sunken between the stigmas, never surpassing the terminal stigmas. NUTLETS brownish, ovoid, ± smooth and shiny to somewhat verrucose or tumulose, with conoidal apex, usually 1–2 developing; attachment basal, with a prolonged stipe; sulcus narrow, extending from the tip to the base; areola ± rounded. A genus with only one species with a distribution in the Pakistan and western India.

Sericostoma pauciflorum

Sericostoma pauciflorum Stocks ex Wight, *Icon. Pl. Ind. Orient. (Wight) 4 (2):* 15, t. 1377 (1848). Type: [Icon] Wight, *Icon. Pl. Ind. Orient. (Wight) 4 (2):* t. 1377, 1848 (lectotype, selected here).

Nomenclatural notes. The original publication of *Sericostoma pauciflorum* is a detailed illustration with analysis. The only text accompanying the illustration, besides the name, is a locality. No material was cited. There is a collection by Stocks from the locality cited available (Stocks 61), but it has the same collection number as two other sheets from two other localities, of which one has a description stating "new genus". Because of the situation with several collections with the same number, I choose the illustration as lectotype.

In addition to the above mentioned situation, there is another collection, Stocks 473, also with a description stating "genus novum".

Description. Perennial herb or shrublet with a ± woody base, up to *c.* 40 cm high, moderately to richly branched, ± erect, spreading or prostrate. STEMS and older parts of branches with brown bark, often beige or greyish encrusted, on older parts split up and flaking, young branches green, ± densely covered with closely appressed disc-based hairs; internodes up to 15 mm long. LEAVES alternate, but the lowest pairs on the shoots opposite, lanceolate, 3–30 × 1–5 mm acute at the apex, cuneate at the base, normally spreading or recurved, ± densely covered with closely appressed disc-based hairs on both surfaces; midrib visible on the dorsal side; margins flat or almost so, hairy with appressed disc-based hairs. FLOWERS in short few-flowered (3–6 flowers) cymes, terminating the leafy branches and small side branches, ± glomerate

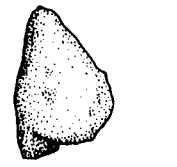

Figure 29. *Sericostoma pauciflorum.* Nutlet with a vertical stipe. From Raizada 23878, India. Scale bar = 2.5 mm.

and *c.* 5 mm in diam. in bud and somewhat more loose in later stages; pedicel 0.5–1 mm long. BRACTS 1–3, lanceolate with acute apex, 3–7.5 × 1–1.5 mm, ± densely covered with closely appressed disc-based hairs on lower surface, hairs on upper surface mostly around the midrib. CALYX lobes ± free, ± equal in size, in flower narrowly ovate, 2–2.5 × 1–1.3 mm, in fruit somewhat larger, acute (subacute-obtuse) at the apex, ± densely covered with closely appressed disc-based hairs on the outer surface, glabrous on inner surface, no tuft of hairs inside at the base; midrib inconspicuous, but visible from the inside; margins flat or almost so, hairy with appressed disc-based hairs. COROLLA white, actinomorphic, funnel-shaped, 3–4 mm long, white villose inside the undifferentiated throat, below glabrous except for a ring of hairs at the base, outside with a few short hairs on some of the lobes; tube 1.6–2.4 mm long, 1–1.1 mm in diam. at the base, widened to 1.6–2.6 mm in diam. at the throat; limb with patent lobes; lobes 1–2.2 × 1.2–2.8 mm. STAMENS borne in the throat 1.4–2.2 mm above the base; anthers equal, *c.* 1–1.2 mm long; filaments of equal length, *c.* 0.8–1 mm long, flattened, very narrowly triangular, *c.* 0.2 mm wide at the base. STYLE *c.* 1–1.2 mm long; stigmas horizontal, *c.* 0.2–0.6 mm high. NUTLETS 2.2–2.5 × 1.5 mm, with a poorly developed longitudinal ridge on the dorsal side, somewhat keeled on the ventral side; areola *c.* 0.5 mm in diam (Fig. 29).

Distribution and habitat. Sericostoma pauciflorum is known from Sind in Pakistan and from the States of Gujarat and Maharashtra in India (Fig. 30). It is also reported from Rajasthan (Bhandari, 1990).

It grows on sandy and rocky ground, and has also been reported as a weed in tomato fields. The altitudinal range is not mentioned on any of the collection seen.

Variation and taxonomic remarks. Sericostoma pauciflorum is a small straggling shrub with flowers in short compact cymes on the tips of the branches and on small side branches. The leaves are quite variable in size; very small-leaved forms as well as large-leaved forms can be found. In other characters *Sericostoma pauciflorum* is a quite uniform species.

Material studied. PAKISTAN: Baluchistan: Bela, Sonmiani: 25°25′N, 66°40′E, 8.iv.1965, Rechinger 27545 (M, W); 25°25′N, 66°40′E, 8.iv.1965, Rechinger 27546 (W). 45 km from Karachi on way to Bela, 16.i.1970, Abedin 4267 (B); Karachi to Sonmiani, 8.iv.1965, Lamond 257 (E); Near Hab Chauki, 25°05′N, 66°55′E, 30.iv.1965, Rechinger 28585 (M, W). Sind: Stocks *s.n.* (BM, M, S, W); 1804, Stocks 473 (K); "Jemidar Ka Landa" near Karachi, Stocks 61 (K); Karachi dist.: between "Damloti" and Khadeji, ENE of Karachi: 29.iv.1965, Rechinger 28499 (B, K, M, W); 29.iv.1965, Rechinger 28501 (B, M); 29.iv.1965, Rechinger 28515 (B, K, M, W); 29.iv.1965, Lamond 735 (E); 29.iv.1965, Lamond 740 (E). Karachi: "Hab Malabar", Stocks, Law & c. *s.n.* (K); Clifton, 20.iv.1956, Jafri 1403 (BM, E); Near

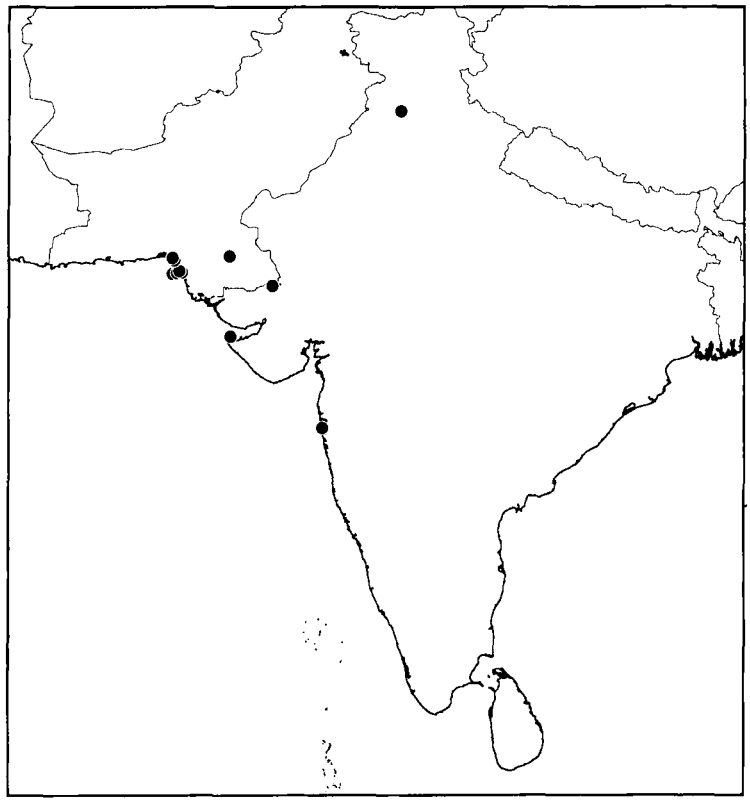

Figure 30. Distribution of *Sericostoma pauciflorum* (●).

Drig rd., opposite National Stadium, 6.v.1956, Jafri 1430 (E). Between Hawks Bay and Bungalow village, 6.iv.1965, Kazmi 864 (M); Cape Monze W Karachi: 6.iv.1965, Rechinger 27516 (M, S, W); Rd. to Cape Monze, W of Karachi, 6.iv.1965, Lamond 254 (E). "Deesa-Kurrachr", Stocks 61 (K); "Baikur near Deesa", Stocks 61 (K); Nagar Parkar, 28.vii.1963, Popov GP 63/349 (BM). INDIA: Punjab: Drummond 25987 (K); Drummond 25986 (K); Drummond 25988 (K). State of Gujarat: Bet Island, 13.x.1953, Raizada 23878 (K). State of Maharashtra, Bombay: Broach *s.n.* (E); Dahlzell *s.n.*; 24.ii.1912, Chibber *s.n.* (K).

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