

## The genus *Ephedra* in NE Tropical Africa

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*Summary.* Three species of *Ephedra* are reported from NE Tropical Africa: *E. somalensis* sp. nov., *E. foeminea* and *E. foliata*. The endemic new species *Ephedra somalensis* is described, illustrated and compared with the most closely related species. All species are keyed out, their ecology described, and relevant distribution maps given.

### INTRODUCTION

After completing the account of the genus *Ephedra* for the *Flora of the Arabian Peninsula* (Freitag & Maier-Stolte 1996) which revealed the remarkable number of 7 species, we studied the available material from NE Tropical Africa. We have slightly extended the geographical circumscription of this region as defined by Friis (1992) by including SE Sudan and N Kenya (see maps 1 – 3). Fewer species might be expected from this region because, in the Old World, *Ephedra* has an essentially temperate distribution (see maps in Musaev (1978: fig. 1, 8); Caveney *et al.* (2001: fig. 1)). However, mountains of the region offer more moderate temperatures and suitable subhumid to arid climates, thus resembling some higher mountain regions of the New World tropics where representatives of the genus also occur.

Previously only *Ephedra alte* C. A. Mey. and/or *Ephedra aphylla* Forssk. were reported from the area (Stapf 1889, Pirota 1908, Pearson 1917, Hutchinson & Bruce 1941, Glover 1947, Andrews 1950, Gilliland 1952, Cufodontis 1953, Pichi-Sermolli 1957, Melville 1958, Friis 1992). Thulin (1993: 16) also listed *Ephedra foliata* Boiss. in C. A. Mey. for Somalia. However, Freitag & Maier-Stolte (1989) have shown that *E. alte* is a mixture of male specimens of *E. aphylla* and female specimens of *E. foliata*, so that specimens labelled with these names could all belong to one species. The presence of *E. aphylla* was always doubtful because that species is a strictly SE-Mediterranean element (Freitag & Maier-Stolte 1989: map 1).

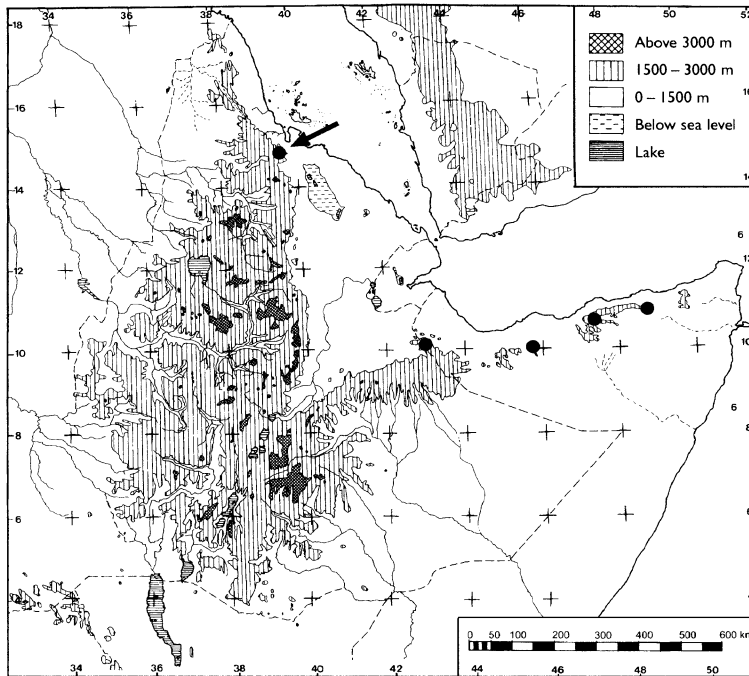
We studied the NE African material of the genus *Ephedra* in the herbaria of BM, FT, K, LE, P and UPS. We were unable to see the material at ETH. This is unfortunate because *Ephedra* probably has a wider distribution in E and C Ethiopia. Besides confirming *E. foliata* we also detected *E. foeminea* Forssk. from the mountains of Djibouti and Eritrea.

Several specimens collected at higher elevations from N Somalia and SE Eritrea had been named as *E. alte* or *E. aphylla*. Both these taxa are shrubby in habit, differing conspicuously from *E. foliata* and *E. foeminea* which are both climbers. After

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MAP 1. Distribution of *Ephedra somalensis*.

comparing them with all other species known from the Mediterranean and SW Asia (Freitag & Maier-Stolte 1994), including Arabia (Freitag & Maier-Stolte 1989, 1992, 1996), we became convinced that they represent a new species. One sheet kept at K (*Capt. Audy*, Museum 12260), carries a small label with two very delicate pencil drawings of male “flowers”, headed “*Ephedra* sp. nov.” and the signature R. Melville, 23.10.51. This is Ronald Melville, who contributed the account of the gymnosperms for the *Flora of Tropical East Africa* (Melville 1958). This “*Ephedra* sp. nov.” is not mentioned in the account; Somalia is not covered by FTEA, so this is not surprising. Most of the specimens are sterile, and only one bears staminate cones. For several years we tried without success to obtain material with seed cones and eventually decided to describe the new species without having seen the female organs, because other characters of vegetative and male specimens separate it unmistakably from all other species. This manuscript had already been submitted when Mats Thulin informed us that during his last visit to Somalia (May 2002) he had found female specimens, which he kindly made available to us immediately.

The morphology of *E. foeminea* and *E. foliata* has been dealt with by us in previous papers, so they are included here only for completeness and for distributional and ecological information.

The nomenclature of species not belonging to the genus *Ephedra* follows Friis (1992) and Thulin (1993, 1999, and pers. comm.).

KEY TO THE *EPHEDRA* SPECIES IN TROPICAL NE AFRICA

1. Pith dark brown; plant erect, up to 2.0 m, with conspicuously parallel branches  
 ..... 1. *E. somalensis*  
 Pith white; plant climbing, pendant or spreading weakly on the ground ..... 2
2. Margins of the leaf sheaths and bracts glabrous; peduncles of the seed cones  
 usually curved; "anthers" 4 – 6 per "flower" ..... 2. *E. foeminea*  
 Margins of the leaf sheaths and bracts minutely ciliate; peduncles of the seed  
 cones usually straight; "anthers" 3 – 4 per "flower" ..... 3. *E. foliata*

## ENUMERATION OF SPECIES

1. *Ephedra somalensis* Freitag & Maier-Stolte **sp. nov.** ab *E. major* Host vaginis foliorum latioribus quam altis, galbulis foemineis cum bracteis 4-paribus intimis fere liberis differt; ab *E. pachyclada* Boiss. ramulis tenuioribus, vaginis brevioribus distinguenda, ab *E. foeminea* Forssk. et *E. foliata* Boiss. in C. A. Mey. habitu non scandente, "antheris" 6 – 8 non 4 – 6/3 – 4, medulla fusca diversa est. Typus: Somalia, Sanaag region, below Tabah gap N of Erigavo, 10°47'N 47°17'E, 1600 m, rocky limestone slope with *Buxus hildebrandtii* and *Dracaena ombet*, 19 May 2002, Thulin 10986, ♀ (holotypus UPS, isotypi K, KAS).

*Dioecious shrub*, branching broom-like, up to 90(–200) cm, strictly erect or the main branches bent downwards in older specimens, stems covered by thick, dark grey, longitudinally fissured bark. *Twigs* erect, usually densely fasciculate, delicate, (0.75–)0.9 – 1.2(–1.4) mm thick, greyish green, striate, rough due to a dense covering of warty papillae on the ribs, with dark brown pith. *Leaves* paired, (1.0–)1.2 – 1.7(–2.0) mm long, united for  $\frac{1}{2}$  –  $\frac{2}{3}$ , sheaths scarious, usually wider than long, cylindrical, brownish at base, scarcely bulged, papillose. *Pollen cones* paired, sessile, ovoid, 3 – 4 mm long, flowers in 3 – 5 pairs. *Bracts* roundish to ovate, c. 2.5 × 3 mm, with very narrow hyaline margins. "*Perianth*" obovate, exceeding the bract for up to 0.5 mm. "*Staminal*" column exerted 0.5 – 1 mm; "*anthers*" 6 – 8, sessile or shortly stipitate. *Pollen grains* 37 – 46 × 23 – 32 μm, 5 – 6(–7)-plicate, with distinctly branched grooves. *Seed cones* usually opposite in pairs, sometimes in clusters of 2 – 3, shortly pedunculate, 1-flowered. *Bracts* ovate, with membranous margins, in 4 pairs, the innermost pair connate up to  $\frac{1}{10}$ . Micropylar tube straight or slightly flexuose, total length up to 2 mm (in young cones before anthesis). Seeds unknown. (Figs. 1 – 3).

FLOWERING. March – May.

SPECIMENS STUDIED. ERITREA. "Assaorta: Caribozzo" forest, 2700 m, 19 Aug. 1902, Pappi 2898, sterile (FT! P!); ibid. near "Cohaito" gorge, 2710 m, 11 May 1902, Pappi 5218, sterile (FT!). SOMALIA. NW: 9°56'N 45°40'E, limestone mt, 1590 m, with *Euryops* sp. and *Teucrium polium*, 23 June 1981, Gillett & Watson 23611, sterile (K!). Berdale mt, 10°20'N 43°E, 1530 – 1900 m, in open wood with *Olea*, *Juniperus*, *Tarchonanthus*, *Cordia*, 1 Dec. 1932, Gillett 4682, sterile (K!, FT!, P!). N: Dalal (Erigavo Distr.), 6000', 10 March 1942, Capt. Audy, Museum 12260, ♂ (K!). Daalo (Sanaag Region), 10°46'N 47°19'E, 2050 m, rocky limestone slope with *Juniperus procera* and *Buxus hildebrandtii*, 17 May 2002, Thulin 10925a, ♂ (UPS!, K!, KAS!), ibid., Thulin 10925b, ♀ (UPS!, K!). Below

Tabah gap N of Erigavo (Sanaag Region), 10°46'N 47°16'E, 1800 m, rocky limestone slope with *Buxus hildebrandtii*, *Juniperus procera*, *Pistacia aethiopica*, *Euryops arabicus* and *Dodonaea viscosa*, 17 May 2002, *Thulin* 10944, ♂ (UPS!, K!, KAS!). Ghuraheis 11°01'N 48°53'E, field layer in 60' *Juniperus* forest, on ground and cracks in rock, 1330 m, 20 Aug. 1957, *Newbould* 997, sterile (K!). Al Madu Range, NW of Agasur, in *Juniperus* forest, 1600 – 1650 m, 12 Oct. 1956, *Bally* B11061, sterile (K!).



FIG. 1. *Ephedra somalensis* Freitag & Maier-Stolte, branch from the holotype (*Thulin* 10986, UPS).

The species is additionally cited in schedis (*Gillett* 4682) from Mt Wooble (“Woblah”), c. 10°14'N 43°20'E, 1930 m.

**DISTRIBUTION.** The new species is endemic to the higher mountain ranges of SE Eritrea and N Somalia (map 1). It very probably also occurs along the Eastern escarpment of the Ethiopian Plateau and in the mountains of Djibouti, where similar habitats are reported. Because *E. somalensis* bears a striking similarity to *Periploca visciformis* (*Asclepiadaceae*) as stated by Gillett (in schedis) and Thulin (pers. comm.) it has probably often been overlooked. On the other hand, even in suitable environments *E. somalensis* may occur only locally. Thulin (pers. comm.) at first



FIG. 2. *Ephedra somalensis* in evergreen bushland of the N Somalian mountains; Sanaag region, below Tabah gap N of Erigavo, 1600 m, rocky limestone slope; in the foreground leaves of *Dracaena ombet*, in the background *Buxus hildebrandtii* (photo. M. Thulin).

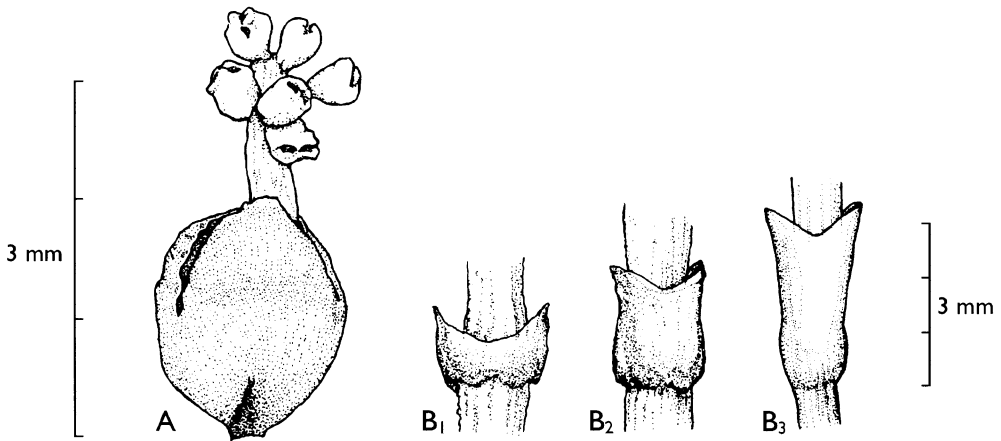


FIG. 3 *Ephedra somalensis*. **A** male flower (*Capt. Audy* Museum 12260, K); **B** nodal sections of branches: **B**<sub>1</sub> *Ephedra somalensis* (*Newbold* 997, K); **B**<sub>2</sub>, *Ephedra pachyclada* subsp. *sinaica* (*Freitag* 19960); **B**<sub>3</sub> *Ephedra major* subsp. *procera* (*Bornm.* 8502).

failed to collect the species in regions where it had been found previously, and no *Ephedra* species is cited in the otherwise very detailed vegetation study of Collenette (1931) from the mountains of NE Somalia.

**HABITAT.** The new species is a typical component of moderately xerophytic evergreen afroontane forests and bushlands. It grows at elevations between (1200) 1400 and 2700 m, usually on N-facing slopes on soils derived from gneiss, schist and limestone but also in cracks of usually somewhat shaded rocky outcrops. Climatic data are not yet available for the mountain areas. However, Gillett (1941) reported from his field studies two rainy seasons (April/May and July/August) and in addition some winter rain, convectional rains and frequent mist. Griffiths & Hemming (1963, see also Friis 1992) estimate annual precipitation of 400 – 700 mm.

The plant communities inhabited by *E. somalensis* are described by Gillett (1932 in schedis, 1941)<sup>2</sup> from the Libah Heleh forest of NW Somalia, just at the Ethiopian border, and by Gilliland (1952)<sup>2</sup> from the Daalo and Surud areas near the Eastern border of former British Somaliland. The first author reported our new *Ephedra* as being abundant in and restricted to the juniper belt. There it is a common shrub in mixed evergreen forests of *Juniperus procera* with varying amounts of *Olea europaea* subsp. *cuspidata* and *Monothecha buxifolia*, together with other shrubs and tall herbs like *Maytenus undata*, *Psiadia arabica*, *Stachys hildebrandtii*, *Coleus albidus*, *Pollichia campestris*, *Galium spurium* subsp. *africanum* and *Umbilicus botryoides*. *Ephedra somalensis* also penetrates into degraded evergreen shrublands dominated by *Dodonaea angustifolia*, *Ficus* spp. and *Teucrium polium* (Gillett & Watson, in schedis). In the Daalo area of NE Somalia the composition of plant communities including *E. somalensis* is similar, but additional associates such as *Dracaena ombet* (Fig. 2) and, in

<sup>2</sup> Some names used in the original articles have been changed to reflect current usage.

the shrub layer, *Cadia purpurea*, *Euryops arabicus*, *Rhus somalensis*, *Clutia abyssinica*, *Berberis holstii*, *Euclaea racemosa* and *Withania somnifera*, can be found. From the Surud area, Gillett & Watson also mention *Periploca visciiformis*, *Pistacia falcata*, *P. aethiopica* and *Lavandula aristibracteata* as associates. According to Thulin (pers. comm.) the species is said to be grazed by goats.

AFFINITIES. In growth form, pith colour, structure of the pollen cones, shape of the pollen, and ecology, *E. somalensis* fits well with other species of subgroup *Leptocladae sensu* Freitag & Maier-Stolte (1994). In general habit with its thin and scabrous twigs and in its strong affinity to comparatively mesophilous evergreen forests and bushlands it comes close to the Mediterranean *E. major* Host. But the geographically closest localities of that species are far away on Cyprus (*E. major* subsp. *major*), in the Hoggar Mts (*E. major* subsp. *suggarica* Maire), and in the Zagros Mts (*E. major* subsp. *procera*). *Ephedra pachyclada* Boiss., of the same "Leptocladae" group, occurs in the mountains of SW Yemen. Although the leaves of *E. pachyclada* are somewhat similar to those of *E. somalensis* (Fig. 3B), that species is probably more distantly related, since its twigs are much stouter and bluish green. Furthermore, *E. pachyclada* is markedly xerophytic. The more important distinguishing characters of the three species are given in Table 1.

TABLE 1. Character comparison of *Ephedra somalensis* and its closest relatives

	<i>E. somalensis</i>	<i>E. major</i>	<i>E. pachyclada</i> subsp. <i>sinaica</i>
Seed cones			
Pairs of bracts	4	2–3	2–3
Innermost bracts, fused for	up to $\frac{1}{10}$	$\frac{1}{3}$ – $\frac{3}{5}$	up to $\frac{1}{3}$
Length of micropyle (mm)	1.8–2.1	0.5–1.2	2.0–2.5(3)
Leaves			
Total length (mm)	(1.0)1.2–1.7(2.0)	1.5–2.5(3.0)	(1.0)1.5–2.5
fused for	$\frac{1}{2}$ – $\frac{2}{3}$	$\frac{3}{4}$ – $\frac{4}{5}$	$\frac{2}{3}$ – $\frac{3}{4}$
Twig diameter (mm)	(0.75)0.9–1.2(1.4)	(0.5)0.7–1.2(1.5)	(1.0)1.2–2.5(3.0)

In habit and in its brown pith, the new species also resembles the Mediterranean *E. fragilis*. However, that species — like all others of the *E. fragilis* group *sensu* Freitag & Maier-Stolte (1994) — differs in its pollen grains with (7–)9–13(–15) ridges separated by straight furrows and by its papillose leaf and bract margins.

PLANT GEOGRAPHICAL CONSIDERATIONS. The endemic *E. somalensis* adds to the peculiar floristic position of the mountain system of N Somalia and its extension to the west and north-west. Phytogeographically, the region was defined by Friis (1983) as the "eastern escarpment, southeastern slope and Somali mountains centre of endemism" and later (Friis 1992) renamed as the "Transitional area between Afromontane and Somalia-Masai vegetation (TSM)". Examples of other species with similar distribution and ecology (sometimes extending to the mountains of S Yemen, adjacent Saudi Arabia and Socotra) include *Buxus hildebrandtii*, *Barbeya oleoides*, *Cadia purpurea*, *Pistacia falcata* (Friis 1992) and *Stipa keniensis* subsp. *somaliensis* (Freitag

1989). Like many of the associated species with a wider but strongly disjunct distribution (e.g. *Monotheca buxifolia*, *Olea europaea* subsp. *cuspidata*, *Juniperus procera*), these taxa seem to represent somewhat xerophytic derivatives of an old Tertiary stock of laurophyllous vegetation (Mai 1995), which managed to survive the dramatic geological and climatic history in the small mountain refugia of the area with comparatively stable environmental conditions. It is tempting to interpret the rather mesophytic nature of *E. somalensis* as a primitive character indicating a more basal evolutionary position of the species. Only *E. major* and *E. foeminea*, among the Old World species, are similarly mesophytic in nature. This hypothesis might warrant checking with molecular studies.

VERNACULAR NAMES (probably used for all *Ephedra* species as well as for *Periploca visciformis*). Somali: hildagorle (Cufodontis 1953); geseriad (Glover 1947), gesoriat (Capt. Audy, in schedis 1942), geesoriyaad (Thulin pers. comm.).

## 2. *Ephedra foeminea* Forssk., Fl. Aegypt.-Arab.: 219 (1775).

*E. campylopoda* C. A. Mey., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt., Sci. Nat. 7 (2): 263 (1846).

*E. fragilis* var. *campylopoda* Stapf, Denkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl. 56, 2. Abt: 56 (1889).

*E. fragilis* subsp. *campylopoda* (C. A. Mey.) Asch. & Graebn., Syn. mitteleur Fl. 1: 258 (1897).

SPECIMENS STUDIED. ERITREA. "Oculé Cusai", Soyrà Mts, torrente "Marabar", 2600 m, 24 Aug. 1902, *Pappi* 1320, (♂ & ♀: FT!; ♂ W!).

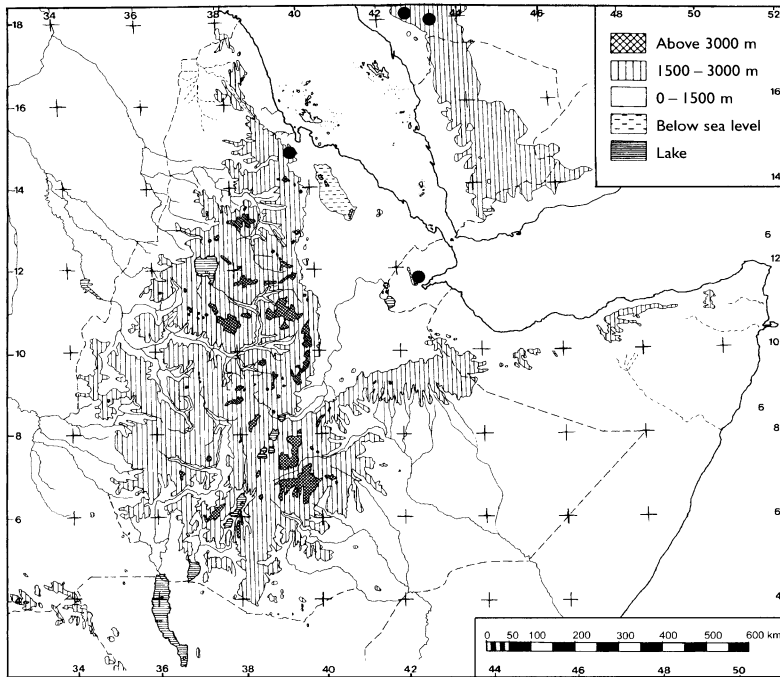
DJIBOUTI. Day Forest, Sept. 1953, *Chédeville* 171, ♀ (FT!).

Probably the two specimens cited in Lebrun *et al.* (1989) from the Day Forest as *Ephedra* sp. aff. *ciliata* also belong here.

DISTRIBUTION AND HABITAT. The species is here reported from the area for the first time. On labels and in relevant publications (Bavazzano 1972) it is cited as *Ephedra* sp. It occurs at higher elevations in the mountains facing the coast of the Red Sea from c. 1200 – 1500 m in Djibouti and around c. 2600 m in N Eritrea (Map 2). These are the southernmost localities of the E Mediterranean species (cf. Freitag & Maier-Stolte 1989: map 3; Browicz 1991: map 1), and they are loosely linked with the main area of the species by scattered localities in similar habitats along the Western escarpment of the Arabian Peninsula in Saudi Arabia (Miller & Cope 1996: map 70). The species has not yet been recorded from Yemen; the dot in Yemen on map 70 must be an error. The absence of the species from the more southern mountains in NE Tropical Africa might be explained by the reduced winter rainfall.

Detailed ecological information for this species is available only from the famous Day Forest in Djibouti. According to Chédeville (label data) it forms "souvent des bosquets très importante sur les tronc morts de *Juniperus procera*". The *Juniperus* forests themselves are described as dense, rich in epiphytic lichens (e.g. *Usnea* spp., *Anaptychia leucomelaena*), mixed with *Buxus hildebrandtii*, scattered *Olea europaea* subsp. *cuspidata*, *Monotheca buxifolia* and *Ficus vasta*, many subshrubs (e.g. *Euryops*





MAP 2. Distribution of *Ephedra foeminea* in NE Tropical Africa.

*arabicus*, *Psiadia arabica*), a dense cover of herbs during spring including ferns (e.g., *Onychium divaricatum*, *Asplenium aethiopicum*), and many mosses. In ecological terms, these habitats and associations agree well with habitats known from the Mediterranean and W Arabia, where the species occurs only in semi-humid areas or in sites with a good moisture supply.

**3. *Ephedra foliata*** Boiss. ex C. A. Mey., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt., Sci. Nat. 7 (2): 297 (1846).

*E. ciliata* Fisch. & C. A. Mey. in C. A. Mey., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt., Sci. Nat. 7 (2): 290 (1846).

*E. alte* C. A. Mey., Mém. Acad. Imp. Sci. Saint-Pétersbourg, Sér. 6, Sci. Math., Seconde Pt., Sci. Nat. 7 (2): 265 (1846), (♀ specimens).

SPECIMENS STUDIED. SUDAN (Upper, just outside the map): c. 21°N, sea coast up to 1330 m, 1896, *Bent*, ♂ (K!). Red Sea, Jebel Dahand, Dec. 1966, *Kassas et al.* 607, sterile (CAI!).

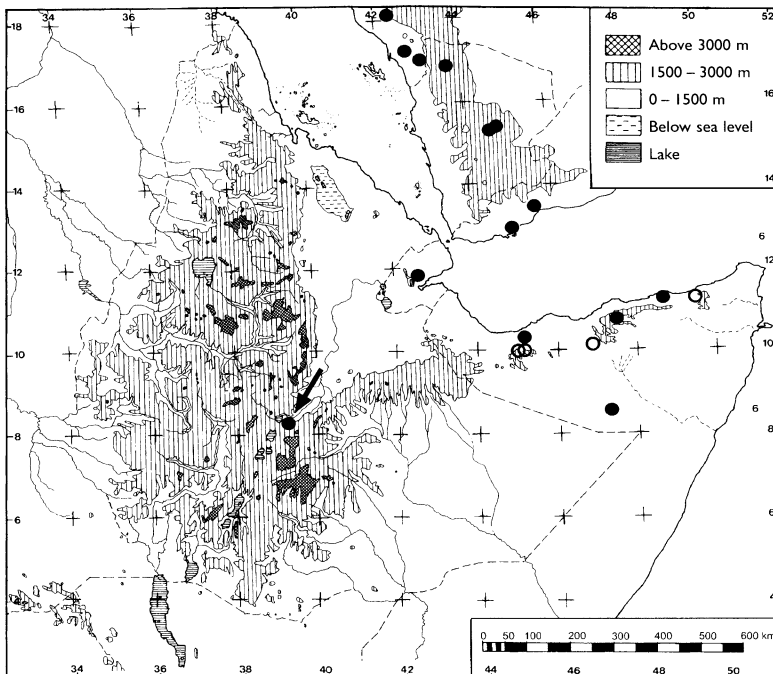
ETHIOPIA. Shewa prov., Awash R., 2 km upstream from Sodere, 8°13'N 39°28'E, 1400 m, 12 July 1975, *Gilbert* 3967, ♂ (K!).

DJIBOUTI. Gamia, near Day forest, 6 June 1953, *Chédeville* 384, ♀ (FT!).

SOMALIA. NW: Togdheer region, Wagar Mts, exposed hill top of Weid Reb, 29 Dec. 1944, *Glover & Gilliland* 469, ♀ (BM!, K!); *ibid.*, S slopes of Wagar Mts, 1430 m,

26 Oct. 1954, *Bally* 10206, sterile (K!); *ibid.*, Wagar Mts, near Gu'gux 10°00'N 45°26'E, 1400 m, 27 Jan. 2002, *Thulin* 10745, ♀ (UPS); *ibid.*, 28 Jan. 2002, *Thulin* 10746, ♂ (UPS); *ibid.*, 10°02'N 45°25'E, 1600 m, 28 Jan. 2002, *Thulin* 10760 (UPS). N: Sanaag region, Ahl Mts, 1500 m, March 1873, *Hildebrandt*, ♂ (BM!, K!, LE!); 5 km W of Dayaxa, 10°34'N 47°09'E, 1400 m, 31 Jan. 2002, *Thulin* 10778 (UPS). Erigavo distr., rock slopes at Daganyado, 10 Feb. 1944, *Glover & Gilliland* 747, ♂ (BM!), *ibid.*, 10 Nov. 1945, *Glover & Gilliland* 747, ♂ (K!); *ibid.*, Erigavo Grazing Reserve, near guest house, Savannah scrub on gypseous plain, 18 Jan. 1973, *Bally & Melville* 16019, (sterile: FT!,K!; ♂ K!). NE: Bari region, Galgala, 10°50'N 49°03'E, limestone rocks under escarpment, 1100 m, 1 Dec. 1986, *Thulin & Warfa* 6207, ♂ (K!, UPS!); *ibid.*, Al Miskat, N of Dasan, 11°13'N 49°49'E, 1600 m, 7 Jan. 2000, *Thulin, Dahir & Osman* 10185, ♂ (UPS); *ibid.*, 7 Jan. 2000, *Thulin, Dahir & Osman* 10191, ♀ (UPS). Nugaal region: Las Anod (c. 10°15'N 43°17'E), on gypsum, 900 m, 9 Dec.1971, *Lavrinos* 9123, ♀ (K!).

**DISTRIBUTION AND HABITAT.** In the Old World desert region, this widespread Saharo-Sindian/Irano-Turanian species penetrates deeply into true tropical regions, but nowhere as far as in Somalia and Ethiopia (Map 3, cf. also Freitag & Maier-Stolte 1994: map 4; Freitag & Maier-Stolte 1996: map 71). It is the most widespread species of the genus in the area and a typical component of different types of thorn savanna (usually *Acacia* spp.) at elevations from c. 500 – 1,500(– 1,700) m and occurs in both



MAP 3. Distribution of *Ephedra foliata* in NE Tropical Africa; open circles refer to literature records and localities communicated by M. Thulin.

semi-arid and arid climates. More detailed information on the plant communities inhabited by the species is lacking. The habitats are either described as being rocky (limestone, basalt) or made up of gypsiferous soils, as in adjacent areas. The record from C Ethiopia might indicate that the species has a scattered distribution all along the foothills of the Eastern Ethiopian escarpment, connecting the localities in Somalia with those in Djibouti, Eritrea and coastal areas in the Upper Sudan.

#### ACKNOWLEDGEMENTS

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