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The genus Fagonia L. in Egypt

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Résumé.

L'auteur présente une révision critique des espèces égyptiennes du genre *Fagonia* L. En plus des caractères macroscopiques employés par les divers auteurs dans le passé, des données microscopiques sont prises en considération: la structure des poils et du pollen. La répartition géographique des espèces à l'intérieur et à l'extérieur de l'Egypte est discutée.

Dans l'aire considérée on peut distinguer 18 espèces au lieu des 12 précédemment connues, qui forment trois groupes naturels. 4 espèces et 3 variétés sont décrites pour la première fois.

Zusammenfassung.

Die Ägyptischen Arten der Gattung *Fagonia* L. werden einer kritischen Revision unterzogen. Neben den schon bisher von den verschiedenen Autoren berücksichtigten makroskopischen Merkmalen werden neu die mikroskopischen von Haargestalt und Pollenmorphologie in Betracht gezogen. Die Verbreitungsverhältnisse inner- und ausserhalb Ägyptens werden besprochen.

Statt wie bisher 12 können im Gebiet 18 Arten unterschieden werden, die sich auf drei natürliche Gruppen verteilen lassen. 4 Arten und 3 Varietäten sind als neu beschrieben.

Summary.

A critical revision of the Egyptian species of *Fagonia* L. has been undertaken. In addition to the macroscopical characters employed by several authors in the past, microscopical features are taken into consideration: in particular the structure of hairs and pollen morphology. The geographical distribution of the species in- and outside Egypt is discussed.

Instead of the 12 species known, one can recognize 18 species within the region, forming 3 natural groups. 4 species and 3 varieties are described as new.

Fagonia L. is a genus of *Zygophyllaceae* known from the warm arid regions of all continents except Australia. It comprises about 40 species which are geographically restricted to: a. Mediterranean and Saharo-Sindian belt; b. Subtropical regions of North and South America; c. South Africa.

Within each of these phytcgeographical regions, there are certain *Fagonia*-species which are restricted only to that region. Thus, *F. cretica* L. is a typical

Mediterranean species. Fagonias of the New World are known not to occur in the Old World and vice versa. PORTER (1963 : 115) pointed out that the North American species of *Fagonia* are distinct from the South American ones.

Up to the present *Fagonia* has remained one of the most critical genera of the *Zygophyllaceae*. Many species are very close to each other and are moreover linked by intermediate forms which make a species delimitation rather difficult.

Thus OLIVER (1868) treated all the Fagonias in Tropical Africa as one collective species, *F. cretica*. As a general distribution of this species he gives (p. 287) the Mediterranean region, South Extra-Tropical Africa, the warm dry parts of Asia, Western North America and South America ! However, he adds that the more important forms of this variable species, especially those recorded from Nubia and adjacent areas, are regarded by many botanists as being of specific rank.

ANDREWS (1950) included *F. cretica* among the plants occurring in Sudan. But from his description (p. 124), his illustration (p. 125, fig. 75) and the geographical distribution given, it is clear that his plant is *F. parviflora* Boiss. and not *F. cretica* which only occurs in the Mediterranean region. All the Sudan material of *Fagonia*, kept in the CAI herbarium, supports this idea and was found to represent typical *F. parviflora*.

During the past few years, considerable collections of *Fagonia* have accumulated in the Herbarium of the Faculty of Science, Cairo University (CAI), in connection with the work on a vegetation map of Egypt. Furthermore it was found that much of the *Fagonia* material in other Egyptian herbaria was erroneously determined. A revision of the Egyptian material was therefore urgently needed. In addition it would be a useful complement to a similar revision, published by OZENDA and QUÉZEL (1956), on the *Zygophyllaceae* of North Africa and Sahara.

North Africa seems to be the centre of distribution of the genus in the Old World. About 20 *Fagonia*-species, including several endemics, are known from this area.

Up till now, the treatment of the Oriental species of *Fagonia* by BOISSIER (1867) remains the most accurate and illustrative. His system, which has been adopted and modified by others in modern times, is based upon the following characteristics: 1, testa of the seed, whether foveolate, punctate or smooth; 2, branches, whether quadrangular and sulcate, or whether terete and striate.

OZENDA and QUÉZEL (1956) also took into consideration other criteria when trying to distinguish between the different species. They rejected the great importance which BOISSIER ascribed to the quadrangular or terete stems and emphasized that this was of no reliable systematic value. They found that the degree of hairiness could be of some help in certain (but not in all) cases, and used this feature for separating e.g. *F. arabica* (hairy and glandular) from *F. zilloides* (glabrous). They also considered the size of the capsule important and distinguished between two major groups, one with capsules about 4 mm across, the other over 5 mm. The persistence of the calyx below the mature fruit also proved to be of systematic importance.

STANDLEY (1911), in his treatment of the American *Fagonia*-species, also emphasized the importance of glandularity and pubescence, whereas JOHNSTON (1924) laid more stress on the stipular development in the corresponding species.

PORTER (1963) in his systematic treatment of the genus used a combination of these two criteria. He claimed that absolute size is not always a reliable character. A variation may accompany the change of climatic conditions, e.g. precipitation. He considered pubescence and stipular type to be more constant under such conditions.

In the following treatment, an attempt is made to benefit from all the criteria enumerated above. Additional features are also taken into consideration.

A detailed study of the anatomy of the shoots, made by the author, seems to support BOISSIER's idea of the systematic value of quadrangular and terete stems. In the present treatment this criterion has not been made use of, but it should be taken into consideration in a more extensive monographic work covering the whole genus.

Pollen morphology and hair structure have also proved to be of great systematic value. Chromosome counts, on the other hand, are extremely difficult in this genus (personal communication from Professor S. EID). Only two chromosome numbers are known up to the present, viz. *F. densa* Johnst. (n = 10, Porter : 117), and *F. cretica* L. (n = 9, Darlington, quoting NEGODI).

In the following account, the abbreviations used for the phytogeographical regions in Egypt are those adopted in TÄCKHOLM et al.: *Students' Flora of Egypt*.

The following collections have served as a basis for the present study:

CAI. The Herbarium of Botany Department, Faculty of Science, Cairo University.
CAIM. The Herbarium of Agricultural Museum, Dokki, Giza.
CAIH. The Herbarium of Desert Institute, Mattaria, Cairo.

In addition, many standard works concerned with the Flora of Egypt have been consulted, among which may be mentioned: FORSKÅL (1775), DELILE (1813), BOISSIER (1867), HART (1891), ASCHERSON & SCHWEINFURTH (1889), SICKENBERGER (1901), BLATTER (1919), RAMIS (1929), POST-DINSMORE (1932), TÄCKHOLM (1956).

The method that has been used for the study of hairs, was to fix strips of epidermal tissue in " FAA"-solution (Formaldehyde, Acetic-Alcohol).

For the pollen studies two different methods were used:

1. Acetolysis method (Erdtman: 6-9). Useful for the study of stratification and exine sculpture, but which apparently reduces the size of the pollen grains.

2. Methyl-green Glycerine-jelly method (Wodehouse : 106-107). Does not reduce the size of the pollen, but on the other hand gives less details concerning the exine structure.

The measurement of pollen size is the mean obtained from at least 40 readings on pollen grains treated by the second method, all of the same species but representing different individuals. ERDTMAN's system has been adopted (Erdtman : 12-20) for pollen description and terminology.

According to the author's opinion there are 18 well defined *Fagonia*-species in Egypt. The following key has been constructed for their identification. The key does not intend to represent any natural or phylogenetical relationship between the species. It is purely artificial, and meant for practical use only. The species are: *F. arabica*, *F. bischarorum*, *F. boulosii*, *F. bruguieri*, *F. cretica*, *F. elba*, *F. glutinosa*, *F. indica*, *F. isotricha*, *F. kassasii*, *F. latifolia*, *F. microphylla*, *F. mollis*, *F. myriacantha*, *F. sinaica*, *F. taeckholmiana*, *F. thebaica*, *F. tristis*.

1 All leaves unifoliolate 2
1* Lower leaves tri-, upper unifoliolate 4
2 Plant spineless. . . . . *F. taeckholmiana*
2* Plant spiny 3
3 Plant annual; leaflet oblong-linear, sessile; calyx deciduous . . *F. elba*
3* Plant perennial; leaflet ovate-lanceolate, short-petioled; calyx persistent in fruit . . . . . *F. indica*
4 Leaves long-petioled, petiole at least twice as long as the middle leaflet 5
4* Leaves short-petioled, petiole not longer than the middle leaflet 6
5 Plant annual, glabrous . . . . . *F. kassasii*
5* Plant perennial, covered with stalked glands with adherent sand *F. microphylla*
6 Spines as long as or longer than the leaves 7
6* Spines shorter than the leaves 13
7 Leaves cylindrical 8
7* Leaves flat 9
8 Plant glabrous. . . . . *F. thebaica*
8* Plant hairy . . . . . *F. tristis*
9 Plant hairy; compound glands present 10
9* Plant glabrous or glandular-pubescent, but then of simple hairs or glands 11
10 Plant densely hairy; branches erect; flowers up to 12 mm across *F. tristis* var. *boveana*
10* Plant sparingly hairy or glabrous; branches prostrate; flowers up to 16 mm across . . . . . *F. mollis*
11 Fruit 4 mm long and broad, with persistent calyx 12
11* Fruit over 5 mm long and broad, with deciduous calyx; plant glandular-pubescent or covered with glands with adherent sand (var. *viscidissima*) *F. arabica*
12 Spines and internodes short; plant pubescent . . . . . *F. bruguieri*
12* Spines and internodes long; plant glabrous . . . . . *F. myriacantha*
13 Flowers about 15 mm across 14
13* Flowers less than 10 mm across 18
14 Sand-adhering glands present . . . . . *F. glutinosa* var. *grandiflora*
14* The same absent 15
15 Pale green sand plant with fleshy leaves . . . . . *F. boulosii*
15* Dark green rock plant with non-fleshy leaves 16
16 Capsule less than 5 mm across . . . . . *F. sinaica*

16* Capsule more than 5 mm across 17
17 Peduncle shorter than capsule; Mediterranean species . . . . *F. cretica*
17* Peduncle longer than capsule; desert species . . . . . *F. bischarorum*
18 Sand-adhering glands present . . . . . *F. glutinosa*
18* The same absent 19
19 Plant with very few hairs 20
19* Plant with abundant spreading hairs . . . . . *F. latifolia*
20 Leaflets pale green, under 5 mm long . . . . . *F. glutinosa* var. *nuda*
20* Leaflets dark green, over 10 mm long . . . . . *F. isotricha*

The *Fagonia*-species in Egypt can be grouped into 3 more or less closely related natural groups (fig. 1), which are:

1. The *arabica-bruguieri* group, including *F. arabica*, *F. bruguieri*, *F. myriacantha*, *F. kassasii*, *F. thebaica*, *F. boulosii*, *F. indica*, *F. taeckholmiana* and *F. elba.*

2. The *glutinosa* group, including *F. glutinosa*, *F. tristis*, *F. mollis*, *F. microphylla*, *F. latifolia* and *F. isotricha.*

3. The *sinaica* group, including *F. sinaica*, *F. cretica* and *F. bischarorum.*

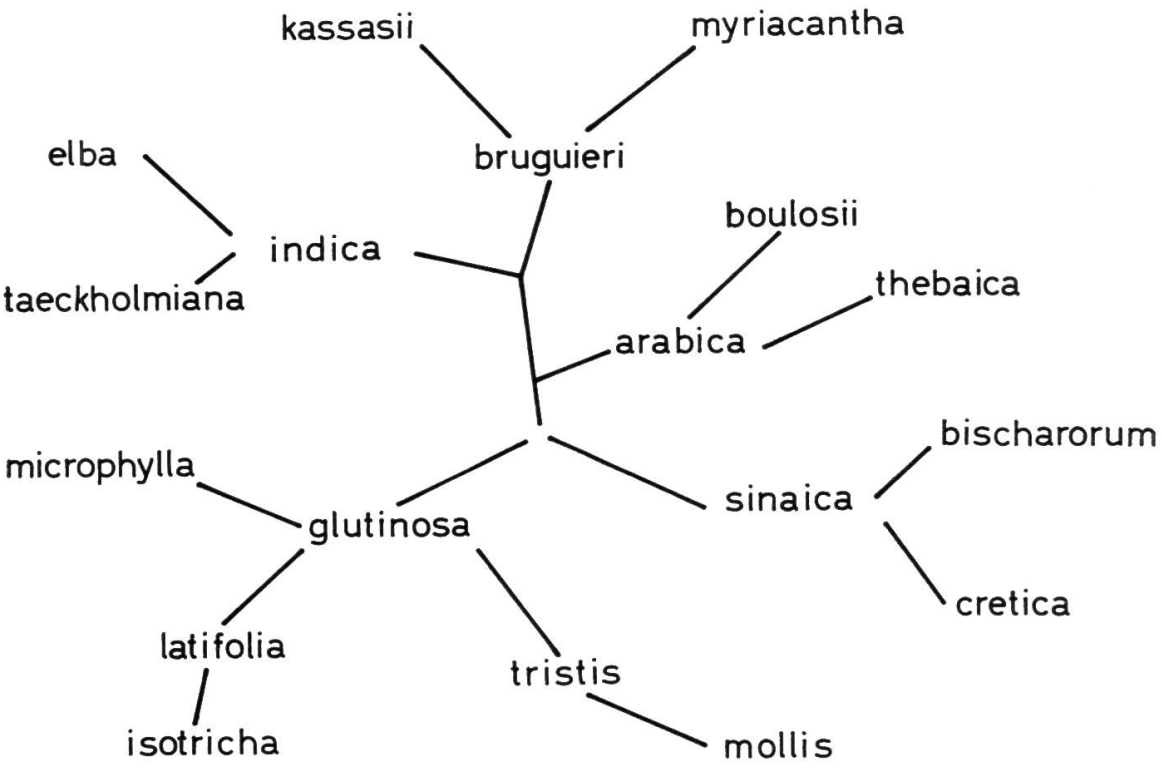

FIG. 1. — Natural groups of *Fagonia* species in Egypt.

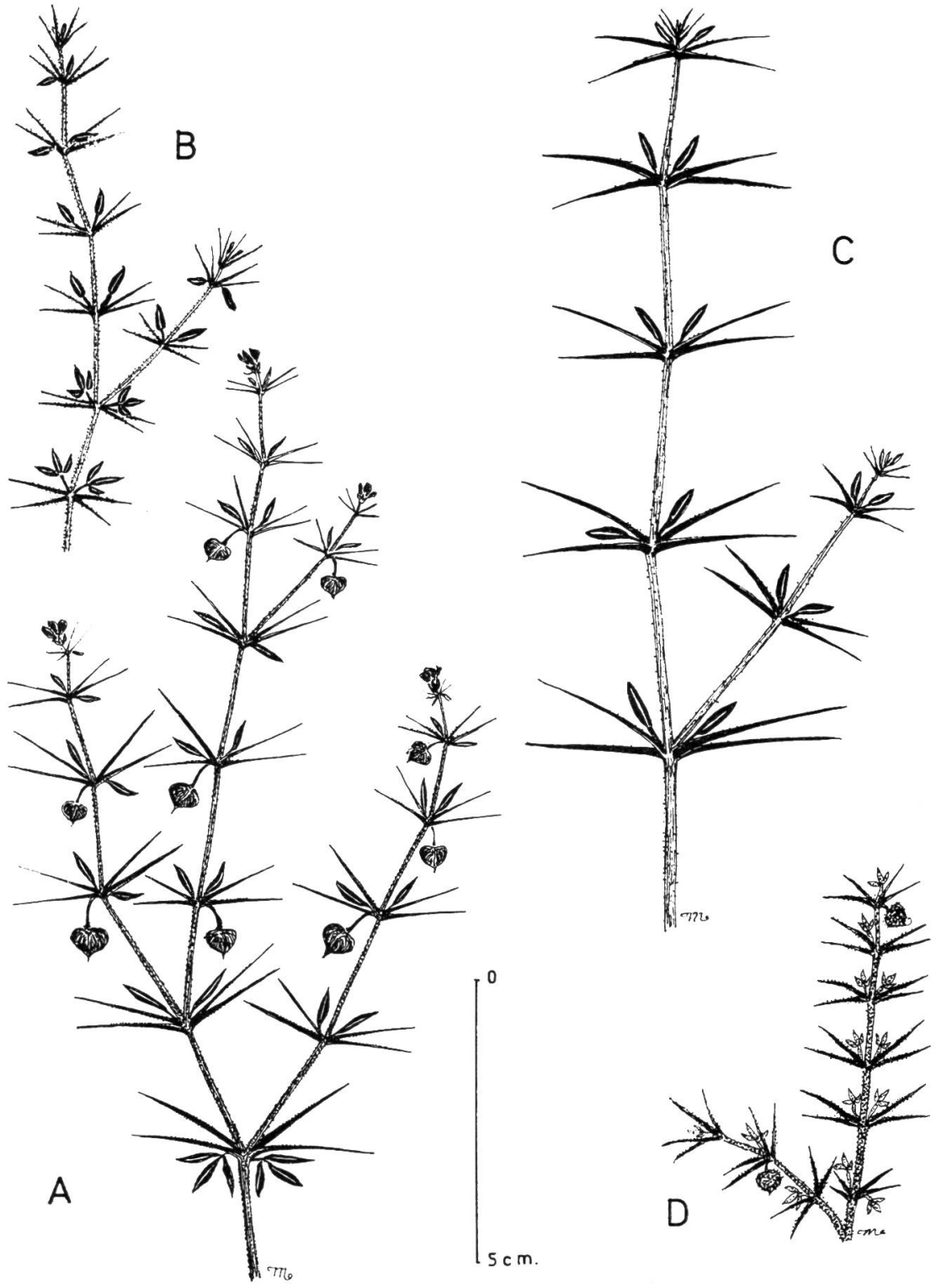

FIG. 2. — A: *Fagonia arabica* L. – B: *F. arabica* var. *imamii* Hadidi – C: *F. arabica* var. *tilhoana* (Maire) Maire – D: *F. arabica* var. *viscidissima* Maire.

Description of species

I. The arabica-bruguieri group

1. **F. arabica** L., Sp. Pl. : 386. 1753.

TYPE: Arabia, *Shaw*, not present in herb. LINN.

Biennial or perennial *shrublet* with erect, terete and striate branches, reaching about 50 cm in height; plant entirely covered with short capitate glands (about 50 μ long; fig. 13 F). *Internodes* long. *Spines* longer than the leaves, often as long as or longer than the internodes. *Leaves* short-petioled, lower ones tri-, upper ones unifoliolate; leaflets linear, mucronate, about 10 mm long. *Flowers* short-peduncled, large, up to 15 mm across. *Sepals* oblong-lanceolate, 4×1.5 mm, glandular. *Petals* 7.5×4 mm, pale pink. *Filaments* to 10 mm long, anthers 1-1.5×0.5 mm. *Pollen grains* 3-colporate, subprolate (24×19 μ), sexine finely reticulate, ora not distinct. *Fruit peduncle* shorter than capsule, reflexed, pubescent and glandular. *Capsule* 5-7 mm broad, 3-5 mm long, pubescent and glandular; calyx deciduous (fig. 2 A).

DISTRIBUTION (map 1): common around Cairo in **Dl** and **Da** sept., elsewhere rare: **Mp** and **O**.

Outside Egypt: rare in the African Sahara, totally absent in Algeria and westwards. Moreover, many records of the species from other places are cited in the literature, which need confirmation. They may be true *F. arabica*, but they may as well represent some other species. Such uncertain records are: Mauritania (Monod), Cyrenaica (Eig), Jordan: Petra (Oppenheimer), Arabia including Saudi-Arabia, Yemen, Aden and Hadramaut (Krause, Blatter, Schwartz), Eastern part of Iran (Parsa), Afghanistan (Schwartz, Cufodontis, Kitamura), British, Italian and French Somaliland (Glover, Cufodontis).

F. arabica var. **viscidissima** Maire, Bull. Soc. Hist. Nat. Afr. Nord 20 : 176. 1929.

TYPE: cp. Ozenda & Quézel; unknown to me.

Leaves usually trifoliolate, succulent, shorter than the spines. The whole plant covered with glands (fig. 13 G), with adherent sand particles (fig. 2 D).

DISTRIBUTION: common among the type.

Outside Egypt the most common variety of North and Central Sahara, more rare southwards in Ahaggar and Tibesti.

F. arabica var. **tilhoana** (Maire) Maire, Bull. Soc. Hist. Nat. Afr. Nord 28 : 349. 1937 = *F. tilhoana* Maire, Bull. Mus. Hist. Nat. (Paris) ser. 2, 4 : 907. 1935.

TYPE: unknown to me.

Internodes and spines longer than in type (fig. 2 C).

DISTRIBUTION (map 1): only recorded from Kharga Oasis, where it may represent a continuation of its occurrence in Central Sahara, where it was supposed to be endemic (sec. Ozenda & Quézel).

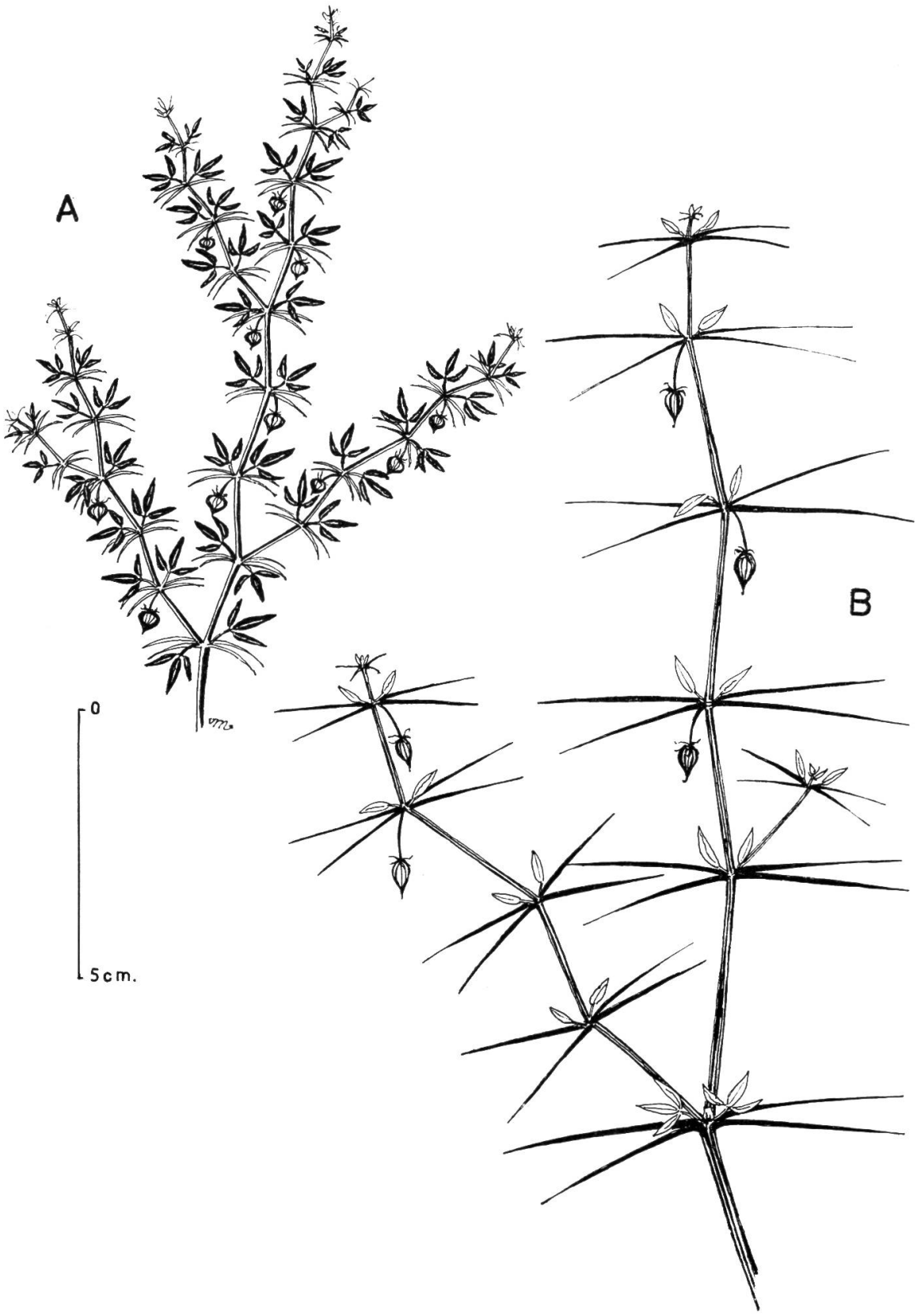

FIG. 3. — A: *Fagonia bruguieri* DC. – B: *F. myriacantha* Boiss.

F. arabica var. **imamii** Hadidi, var. nova [1].

TYPE: near the northern entrance of Faiyum, *M. Imam* (CAI).

A typo differt duratione annuâ, ramis erectis, internodiis et spinis tenuibus, capsulâ multo minore. Facies *F. bruguieri* a quâ distinguitur sepalis deciduis et floribus majoribus, ad 12 mm diam.

Annual with erect branches; internodes and spines more slender. Flowers only up to 12 mm across and capsule smaller than in type. Aspect of *F. bruguieri*, but fruit calyx deciduous and flowers larger (fig. 2 B).

DISTRIBUTION (map 1): endemic in the Libyan desert: type locality.

2. **F. bruguieri** DC., Prodr. 1 : 704. 1824 = *F. echinella* Boiss., Diagn. ser. 1, 8: 123. 1849.

TYPE: between Baghdad and Aleppo, *Bruguière & Olivier* (G).

Biennial or perennial *shrublet* covered with minute unicellular glands; branches procumbent, up to 20 cm in height, distinctly quadrangular and sulcate. *Internodes* short. *Spines* patent, slightly recurved, longer than the small leaves. *Leaves* short-petioled, lower trifoliolate, upper unifoliolate; leaflets succulent, ovate-oblong, mucronate, about 5 mm long. *Flowers* short-peduncled, small, 8 mm across. *Sepals* 2.5× 1 mm, ovate, pubescent, with hairs up to 70 μ in length. *Petals* pale pink, 3.5× 1.5 mm. *Filaments* short, about 6 mm long, anthers 0.6× 0.3 mm. *Pollen grains* 3-colpate, prolate (27× 24 μ), sexine finely reticulate. *Fruit peduncle* as long as, or longer than capsule, reflexed, sparingly hairy. *Capsule* 3-4 mm broad, 4 mm long, style up to 3 mm; fruit calyx persistent (fig. 3 A).

DISTRIBUTION (map 2): common in **Dl, Da** sept., **Di** and **S**; rare in **O**: Siwa (CAIM), **Mma**: Idku, Burg el Arab (CAI) and **Da** mer.: Idfu - Mersa Alam Road (CAI).

Outside Egypt: common in the North and Central Sahara from South Morocco eastwards, rare in the South Sahara (Ozenda & Quézel), Mauritania (Monod, Nagélé), Tripolitania (Eig), British and Italian Somaliland and Erithrea (Glover, Cufodontis), Arabia Petraea (Oppenheimer), Syria (Eig), Lebanon (Thiébaut), Iraq (Blatter, Zohary), Arabia including Saudi-Arabia, Yemen, Hadramaut and Kuweit (Blatter, Schwartz, Burtt & Lewis), Central and South Iran (Schwartz, Parsa, Bornmüller), Baluchistan (Bornmüller, Eig), Afghanistan (Schwartz, Patzak, Kitamura).

F. bruguieri var. **laxa** Boiss., Fl. Or. 1 : 906. 1867 = *F. diversifolia* Boiss., Diagn. ser. 2, 8 : 112. 1853.

TYPE: S Iran near Dalechi, *Kotschy* (G).

Flowers, fruits, and hairiness as in the type but internodes longer. Approaches *F. myriacantha* in its stout appearance, but the latter is still more robust, completely glabrous and seems to be confined to Sinai only.

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[1] This variety is named after its collector, Dr. Mustafa IMAM, Egyptian botanist, who studied the ecology of the Egyptian *Fagonia*-species.

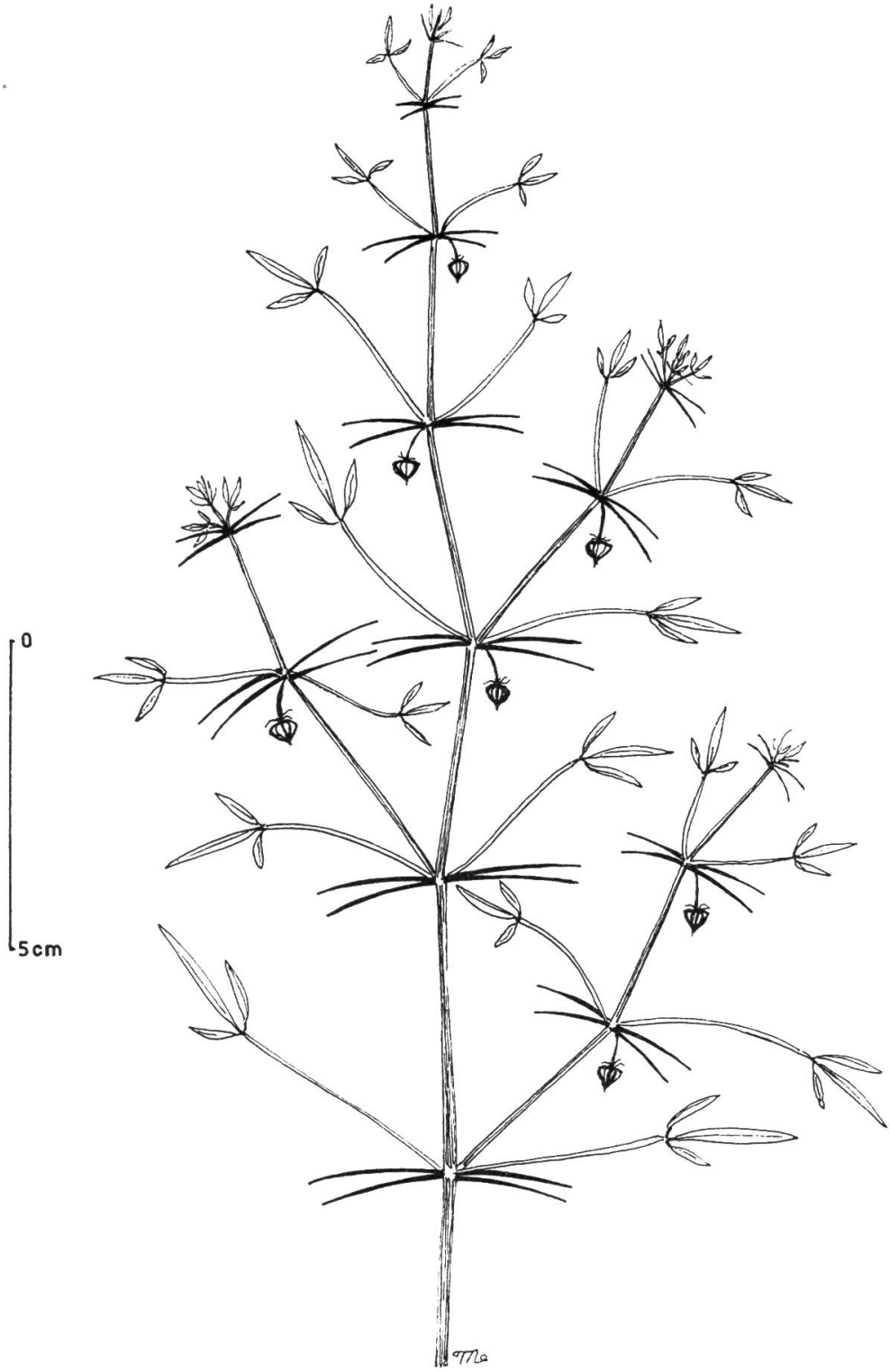

FIG. 4. — *Fagonia kassasii* Hadidi.

DISTRIBUTION: common among the type in **Da** sept., particularly along the Cairo-Suez road and on the Red Sea coast from Ataqa southwards to Abu Darag; in Sinai: rare (W. Feiran).

Outside Egypt: Central Sahara: Tassili des Ajjer (Ozenda & Quézel: 44, as *F. bruguieri* var. *myriacantha*) and eastwards into Arabia, e.g. Riyadh (CAI) and Bahrein (*Schimper 251*, *Fernandez 14*, quoted by Burtt & Lewis: 395, as ?*F. myriacantha*).

3. **F. myriacantha** Boiss., Diagn. ser. 1, 8: 123. 1849 = ?*F. schimperi* C. Presl, Bot. Bemerk.: 30. 1846 (sec. Boiss., Fl. Or.; if right, this name has the priority).

LECTOTYPE: Sinai mountain valleys, *Boissier* (G).

Biennial or perennial pale green *shrublet* with glabrous prostrate angular and sulcate branches. *Internodes* long. *Spines* over 4 cm long, patent, sharp, with the aspect of *Asparagus stipularis*. *Leaves* short-petioled to subsessile, lower ones trifoliolate, upper ones unifoliolate; leaflets oblong-linear, about 5 mm long. *Flowers* over 10 mm across, on a slender peduncle, 10 mm or more in length. *Sepals* almost glabrous, 3×1.5 mm. *Petals* flesh-coloured, 7×8 mm. *Filaments* about 10 mm long, anthers 0.9×0.5 mm. *Pollen grains* 3-colpate, prolate, spheroidal (30×28 μ), sexine distinctly reticulate. *Fruit peduncle* as long as or longer than capsule, sparingly hairy. *Capsule* 3-4 mm broad, 5 mm long, with persistent calyx (fig. 3 B).

DISTRIBUTION (map 2): common in wadis in the mountain region of Sinai (Post 1 : 268), material from W. Sheikh, W. Feiran, etc. kept in CAI, CAIM; else rare, **Da** sept.: Cairo-Suez road (CAI).

Outside Sinai only known from adjacent parts of the Arabic desert (Blatter, Post). The records from Kuweit (Burtt & Lewis) and from Central Sahara (Ozenda & Quézel: 44, as *F. bruguieri* var. *myriacantha*) may belong to *F. bruguieri* var. *laxa* Boiss., which resembles *F. myriacantha*. Compare Boissier, Fl. Or. 1 : 906. 1867, for the differences between them.

4. **F. kassasii** Hadidi, spec. nova [1].

TYPE: Red Sea coast at Gebl El-Faraied, 12.2.1961, *Kassas et al.* (CAI).

Planta annua, ramis erectis vel procumbentibus, glabris, suffrutescentibus, subtetragonis, faciebus sulcatis. *Internodia* longa. *Spinae* patentes vel recurvatae foliis breviores. *Folia* longe petiolata, petiolo quam intermedium foliolorum duplo vel ultra longiore; foliola 3, breviter petiolulata, linearia vel anguste ovata, intermedium ad 25 mm longum, laterales breviores. *Flores* ad 10 mm diam., pedunculo tenuissimo, ad 5 mm longo suffulti. *Sepala* subglabra, 3×1.5 mm. *Petala* rosea, 5×3 mm. *Filamenta* brevia, ad 5 mm longa, antherae 0.6×0.3 mm. *Grana pollinis* 3-colpata, prolata (30×21 μ); sexine minute reticulata. *Pedunculus fructifer* recurvus, pubescens, tenuis, capsulâ aequilongus vel longior. *Capsula* 3-4 mm lata, 4 mm longa, hirta; stylus c. 3 mm longus; calyx persistens.

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[1] Named after the Egyptian botanist, Professor Mohammed El KASSAS, who was the first to collect the plant.

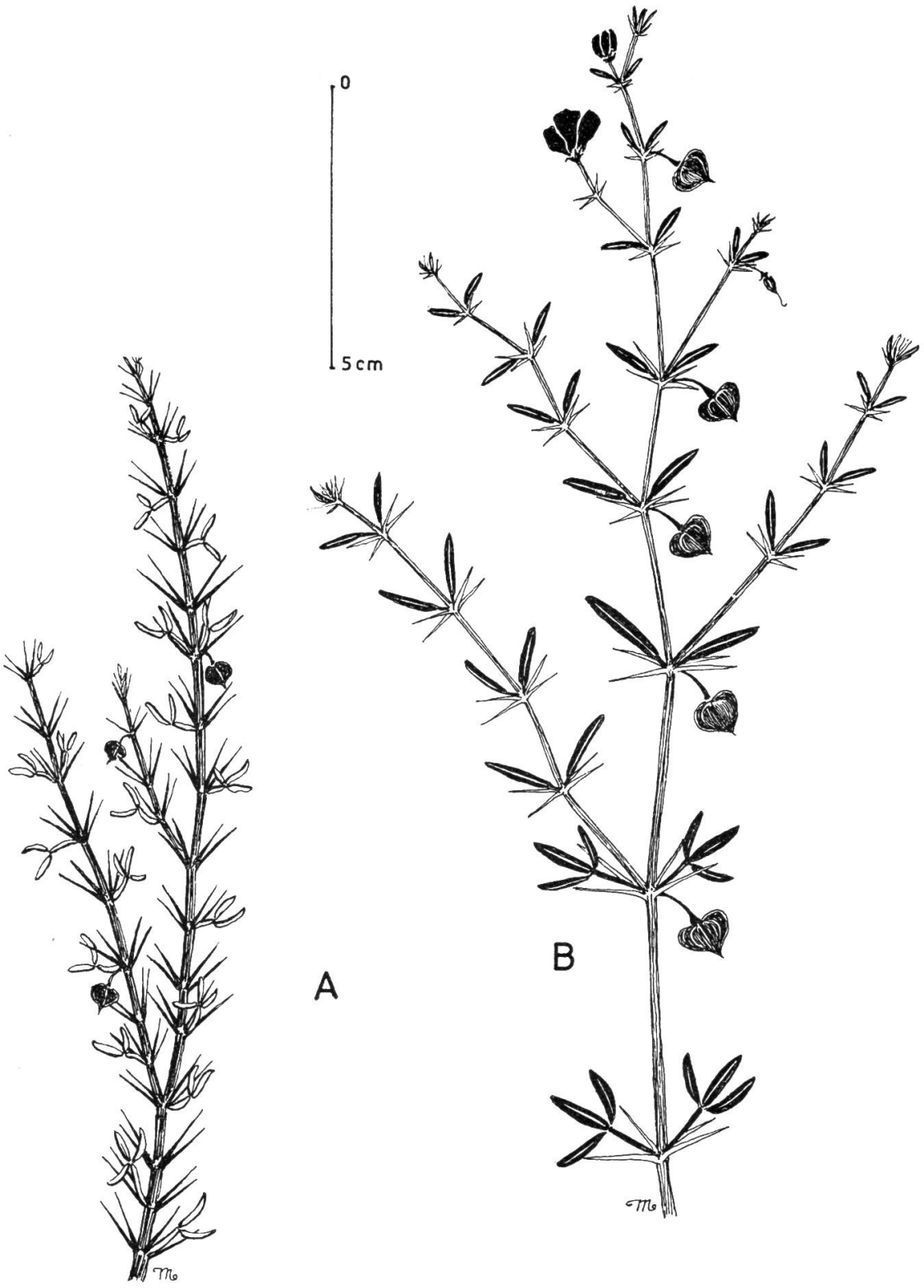

FIG. 5. — A: *Fagonia thebaica* Boiss. – B: *F. boulosii* Hadidi.

Annual with somewhat frutescent, erect or procumbent, glabrous, angular and sulcate branches. *Internodes* long. *Spines* shorter than leaves, spreading or recurved. *Leaves* long-petioled, petiole at least twice as long as the central leaflet; leaflets 3, shortly stalked, linear to narrowly ovate, the central one up to 25 mm long, the lateral shorter. *Flowers* up to 10 mm across, on a slender, 5 mm long peduncle. *Sepals* almost glabrous, 3×1.5 mm. *Petals* rose-coloured, 5×3 mm. *Filaments* short, up to 5 mm long, anthers 0.6×0.3 mm. *Pollen grains* 3-colpate, prolate (30×21 μ), sexine finely reticulate (fig. 14 B). *Fruit peduncle* slender, as long as or longer than capsule, reflexed and pubescent. *Capsule* 3-4 mm broad, 4 mm long, covered with short hairs; style about 3 mm long; fruit calyx persistent (fig. 4).

DISTRIBUTION (map 2): endemic. **Da** mer.: Gebl and Wadi El-Faraied. **GE**-region: Wadi Haitem, Wadi Oolak, Wadi Aak, north-western slopes of Gebl Asoteriba (all CAI).

OBSERVATION: OZENDA & QUÉZEL described as *F. bruguieri* var. *purpurascens* Maire a taxon with similar leaf characters. I have not seen MAIRE's original diagnosis, but I suppose that the variety must be purple-coloured in one way or another, which is not the case with our plant. An interesting statement is that var. *purpurascens* is endemic on the Ahaggar plateau, at the same latitude as *F. kassasii* in Egypt.

5. **F. thebaica** Boiss., Diagn. ser. 1, 8 : 121. 1849.

TYPE: Biban el Molouk near Thebes, *Boissier* (G).

Perennial glabrous green *shrublet* with erect, terete and striate branches. *Internodes* short. *Spines* as long as the internodes, ascending, resembling those of *Alhagi maurorum*. *Leaves* petioled, petioles up to 10 mm long; lower leaves trifoliolate, upper unifoliolate; leaflets distinctly cylindrical. *Flowers* shortly peduncled, up to 15 mm across. *Sepals* oblong-lanceolate, glandular, 3.5×1.5 mm. *Petals* rose-coloured, 7×2.5 mm. *Filaments* 8 mm long, anthers 0.8×0.5 mm. *Pollen grains* 3-colporate, prolate, spheroidal (24×22 μ), sexine finely reticulate. *Fruit peduncle* short, reflexed, glabrous. *Capsule* 5 mm broad, 3-5 mm long, tomentose; calyx deciduous (fig. 5 A).

DISTRIBUTION (map 1): endemic. **Da** sept.: Ain Sokhna, Wadi Seyal, Wadi Qusseib, Abu Darag (all CAI). **Da** mer.: near Luxor (CAIM) and **S**: Wadi Feiran (CAIH); in the last two places very rare.

F. thebaica var. **violacea** Boulos, Yale Peab. Mus. Nat. Hist. Postilla 100 : 20. 1966.

TYPE: affluent of Wadi Kurkur, 3 km S of the wells, 1964, *L. Boulos* (CAI).

Flowers intensely violet, capsule larger than in type. Pollen grains 3-colpoidorate, prolate, larger than in type (28×22 μ), sexine more distinctly reticulate.

DISTRIBUTION (map 1): endemic in the area between Dungul and Kurkur Oases (Boulos 1966).

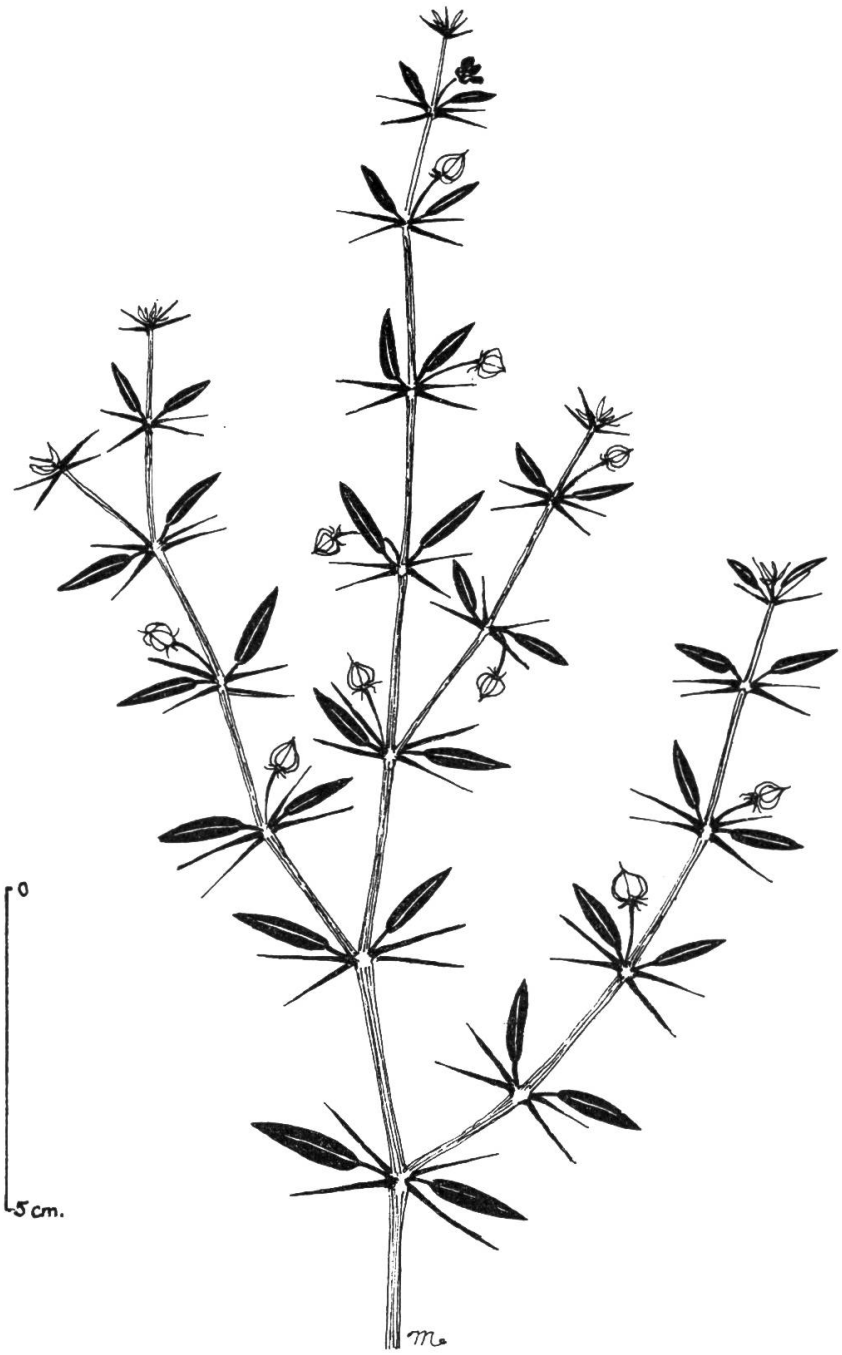

FIG. 6. — *Fagonia indica* Burm. fil.

6. **F. boulosii** Hadidi, spec. nova [1].

TYPE: **Da** sept., Wadi Abu Seyal, 1964, *L. Boulos* (CAI).

Suffrutex pallide virens, ramis erectis, teretiusculis, striatis; tota planta breviter glandulosa. *Internodia* longa. *Spinae* breves patentes, foliis breviores. *Folia* petiolata, petiolis ad 10 mm longis, inferiora trifoliolata, superiora unifoliolata; foliola oblongo-ovata, c. 15 mm longa. *Flores* breviter pedunculati, magni, diametro 15 mm excedentes. *Sepala* ovata, sparse glandulosa, 4.5×2.5 mm. *Petala* rosea, 8×4 mm. *Filamenta* ad 10 mm longa, antherae 1×0.5 mm. *Grana pollinis* 3-colpoidorata, prolata (28×22 μ), sexine minute reticulata. *Pedunculus fructifer* recurvus capsulâ aequilongus vel longior, sparse pilosus. *Capsula* 6 mm lata, 4 mm longa, tomentosa; calyx deciduus.

Perennial *shrublet* of pale green colour with erect, terete and striate branches, entirely covered with short, viscid glands. *Internodes* long. *Spines* short, patent, not exceeding the leaves. *Leaves* petioled, petiole up to 10 mm long; lower leaves trifoliolate, upper unifoliolate, the latter more frequent; leaflets oblong-ovate, mucronate, about 15 mm long. *Flowers* short-peduncled, large, over 15 mm across. *Sepals* ovate with a few glandular hairs, 4.5×2.5 mm. *Petals* rose-coloured, 8×4 mm. *Filaments* up to 10 mm long, anthers 1×0.5 mm. *Pollen grains* 3-colpoidorate, prolate (28×22 μ), sexine finely reticulate. *Fruit peduncle* as long as or longer than capsule, reflexed, slightly hairy. *Capsule* 6 mm broad, 4 mm long, tomentose; calyx deciduous (fig. 5 B).

DISTRIBUTION (map 1): endemic. **Da** sept.: the coastal plain of Red Sea, 60 km South of Suez and further southwards: Wadi Abu Seyal, Wadi Qusseib, North of Wadi Doum, Wadi Amloug (all CAI). In Wadi Qusseib rather common.

7. **F. indica** Burm. fil., Fl. Ind.: 102, tab. 34, fig. 1. 1768 = *F. persica* DC., Prodr. 1: 704. 1824, nom. illeg. = *F. parviflora* Boiss., Diagn. ser. 1, 8: 124. 1849, var. *brevispina* Schweinf., Bull. Herb. Boiss. 7, app. 2: 274. 1899 (typical *F. parviflora* is lacking in Egypt).

TYPE: Iran, *Garcin* (G, herb. Burman).

Perennial pale green *shrublet* with procumbent or erect cylindrical striate branches, in a juvenile stage frequently pruinose and glandular (fig. 13 H), later almost glabrous. *Internodes* long, nodes slightly swollen and whitish green. *Spines* slender, needle-like, as long as, or shorter, than the leaves. *Leaves* short-petioled, unifoliolate, with a distinct joint between petiole and blade; leaflet ovate-lanceolate, mucronate, ranging from 12 to 16 mm in length. *Flowers* up to 12 mm across, on a slender short peduncle. *Sepals* ovate, glandular, 3×1.5 mm. *Petals* rose-coloured, 6×3 mm. *Filaments* short, about 6 mm long, anthers 0.9×0.5 mm. *Pollen grains* 3-colpoidate, subprolate (27×21 μ), sexine finely reticulate. *Fruit peduncle* slender, longer than capsule, reflexed, sparingly hairy. *Capsule* 4×4 mm, with short style and persistent calyx (fig. 6).

DISTRIBUTION (map 2): rather common in the wadis of **Da** mer., rare in **Da** sept. (along Qena-Safaga road and near Ras Gharib), common in **GE**-region, rare in **Dl** (Kurkur-Dungul road) and **O** (Kharga at Baris).

[1] Named after Dr. Loutfy BOULOS, Egyptian botanist, who collected the species for the first time.

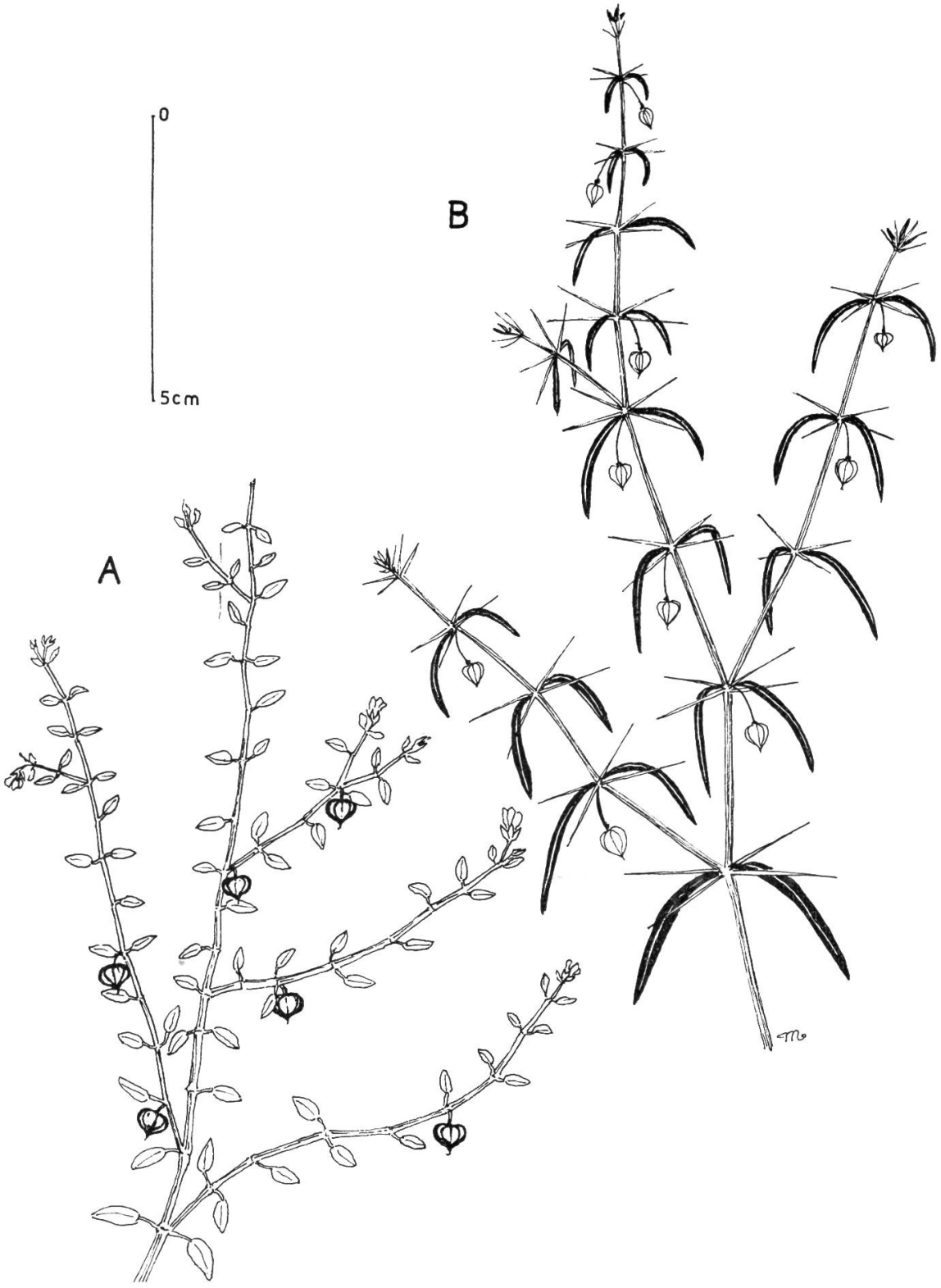

FIG. 7. — A: *Fagonia taeckholmiana* Hadidi – B: *F. elba* Hadidi.

Outside Egypt: rather common in the Sahara where it is recorded (Ozenda & Quézel: 43) under the name *F. olivieri* Boiss. f. *jolyi* Batt. It is more common in the South and Central Sahara than in the North. North and Central Sudan (Andrews : 124, fig. 75, as *F. cretica*), British and Italian Somaliland (Glover, Schwartz), Ethiopia (Blatter, Cufodontis), Arabia including Saudi-Arabia, Aden, Hadramaut (Krause, Blatter, Schwartz; also material in CAI), South Iran (Parsa), East Afghanistan (Patzak).

8. **F. taeckholmiana** Hadidi, spec. nova [1].

TYPE: **Da** sept., Heliopolis desert near Cairo, 1952, *N. El Hadidi* (CAI).

Planta perennis suffrutescens, pallide virens, ramis procumbentibus vel ascendentibus; partes juniores sparse pubescentes vel subglabrae, adultae suffruticosae. *Internodia* elongata, teretiuscula, striata, nodi incrassati. *Spinae* deficientes, raro, cum adsint, minutissimae, oculo nudo vix obviae. *Folia* parva, omnia unifoliolata, inter laminam et petiolum distincte articulata; petioli breves, ad 3 mm longi, foliolo lanceolato mucronato ad 6 mm longo. *Flores* ad 12 mm diam. *Sepala* ovata glandulosa, 3.5×1.5 mm. *Petala* rosea, 6×3 mm. *Filamenta* c. 8 mm longa, antherae 0.6×0.3 mm. *Grana pollinis* 3-colpoidata, subprolata (24×20 μ), sexine minutissime reticulata, colpa indistincta. *Pedunculus fructifer* crassus recurvus pubescens, capsulâ brevior. *Capsula* tomentosa 8 mm lata, 4 mm longa; stylus brevis; calyx deciduus.

Perennial pale green *shrublet* with procumbent or ascending, terete and striate, later frutescent branches; juvenile parts sparingly pubescent or almost glabrous. *Internodes* long, nodes slightly swollen. *Spines* absent, exceptionally present but then minute, hardly recognizable. *Leaves* short-petioled, petioles up to 3 mm long, unifoliolate with a distinct joint between petiole and blade; blade small, lanceolate, up to 6 mm long, mucronate. *Flower* up to 12 mm across, short-peduncled. *Sepals* ovate, 3.5×1.5 mm, glandular. *Petals* 6×3 mm, rose-coloured. *Filaments* about 8 mm long, anthers 0.6×0.3 mm. *Pollen grains* 3-colpoidate, subprolate (24×20 μ), sexine finely reticulate, colpa indistinct. *Fruit peduncle* thick, shorter than capsule, reflexed, pubescent. *Capsule* 5 mm broad, 4 mm long, with a short style, tomentose; calyx deciduous (fig. 7 A).

DISTRIBUTION (map 2): endemic. Type locality.

9. **F. elba** Hadidi, spec. nova [2].

TYPE: **GE**-region at Gebl Alafoot, 1962, *V. Täckholm et al.* (CAI).

Planta annua, glabra, pallide virens, ramis procumbentibus vel ascendentibus, suffrutescentibus, teretibus vel subangulatis, striatis. *Internodia* longa. *Spinae* tenues, folia aequantes vel superantes. *Folia* sessilia unifoliolata, linearia, ad 40 mm longa, 3 mm lata, mucronata. *Flores* breviter pedunculati, parvi, ad 10 mm diam. *Sepala* subglabra, lanceolata, 2.5×1.5 mm. *Petala* rosea, 5×2 mm. *Filamenta* c. 8 mm longa, antherae 0.9×0.5 mm. *Grana pollinis* 3-colporoidata, subprolata (30×25 μ), sexine minute reticulata. *Pedunculus fructifer* recurvus glaber, capsulâ duplo longior. *Capsula* 5×5 mm; stylus brevis; calyx deciduus.

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[1] Named after Professor Vivi TÄCKHOLM, Swedish botanist, working at Cairo University.

[2] Named after the Elba mountains where it was first collected.

Fig. 8. — *Fagonia glutinosa* Delile.

Pale green glabrous *annual*; branches procumbent or ascending, somewhat frutescent, terete or slightly angular, striate. *Internodes* long. *Spines* needle-like, as long as or longer than the leaves. *Leaves* sessile, unifoliolate, linear, up to 40 mm long, 3 mm broad, mucronate. *Flowers* short-peduncled, small, not over 10 mm across. *Sepals* subglabrous, lanceolate, 2.5× 1.5 mm. *Petals* pink, 5× 2 mm. *Filaments* about 8 mm long, anthers 0.9× 0.5 mm. *Pollen grains* 3-colporoidate, subprolate (30× 25 μ), sexine finely reticulate. *Fruit peduncle* twice as long as the capsule, reflexed, glabrous. *Capsule* 5 × 5 mm, with a short style; calyx deciduous. (fig. 7 B).

DISTRIBUTION (map 2): endemic in the Gebl Elba-region. Gebl Karam Elba, Wadi Laseitit, entrance of Wadi Todhi, Gebl Alafoot, Suakin El-Qadim (all CAI).

II. The glutinosa group

10. **F. glutinosa** Delile, Fl. Egypte, Expl. Pl. : 86. 1813.

TYPE: Cairo desert, *Delile* (probably MPU, not seen).

Annual or *perennial*, pale green, with prostrate, terete and striate branches; plant entirely covered with stalked viscid glands (fig. 13 A), with adherent sand. *Internodes* long, slender. *Spines* short, not exceeding the petioles in length. *Leaves* short-petioled, always trifoliolate; leaflets ovate-rhombical, mucronate, the central one usually twice as large as the lateral ones. *Flowers* short-peduncled, small, about 8 mm across. *Sepals* ovate-oblong, 2.5× 1 mm, glandular. *Petals* 4× 1.5 mm, rose-coloured or at least pink-flushed. *Filaments* up to 6 mm long, anthers 0.5-0.3 mm. *Pollen grains* 3-colpoidorate, subprolate (24× 20 μ), sexine tegillate. *Fruit peduncle* shorter than the capsule, reflexed, hairy. *Capsule* 5× 5 mm, densely covered with hairs; calyx persistent in the fruit (fig. 8).

DISTRIBUTION (map 3): **Da** sept.: common, especially along Cairo-Suez road; **Di**: around Ismailla and Bir Lehfen; **Dl**: along Cairo-Faiyum and Cairo-Alexandria desert roads; **Mma**: rare, e.g. Burg el Arab.

Outside Egypt: rather common in West, Central and North Sahara (Ozenda & Quézel), Mauritania (Monod), Tunisia and Tripolitania (Blatter, Eig), Palestine and Jordan (Oppenheimer 1930, Rechinger 1952, Blatter), Iraq (CAI), Arabia, on the East tropical side (Blatter), near Riyadh (CAI) and Kuweit (Burtt & Lewis).

F. glutinosa var. **grandiflora** Boiss., Fl. Or. 1 : 905. 1867.

TYPE: Arabia Petraea, Sinai border, *Boissier* (G).

Densely woolly. Flowers large, sepals as in type but petals 8× 3 mm, pink. Pollen grains 3-colpoidorate, subprolate as in the type, but larger (28× 24 μ). Capsule larger. May deserve specific rank.

DISTRIBUTION (map 3): Sinai, endemic. Mitla pass (CAI, CAIM), Wadi Heridin S of El Arish (CAIM); cp. POST-DINSMORE : 267 for other places in Sinai.

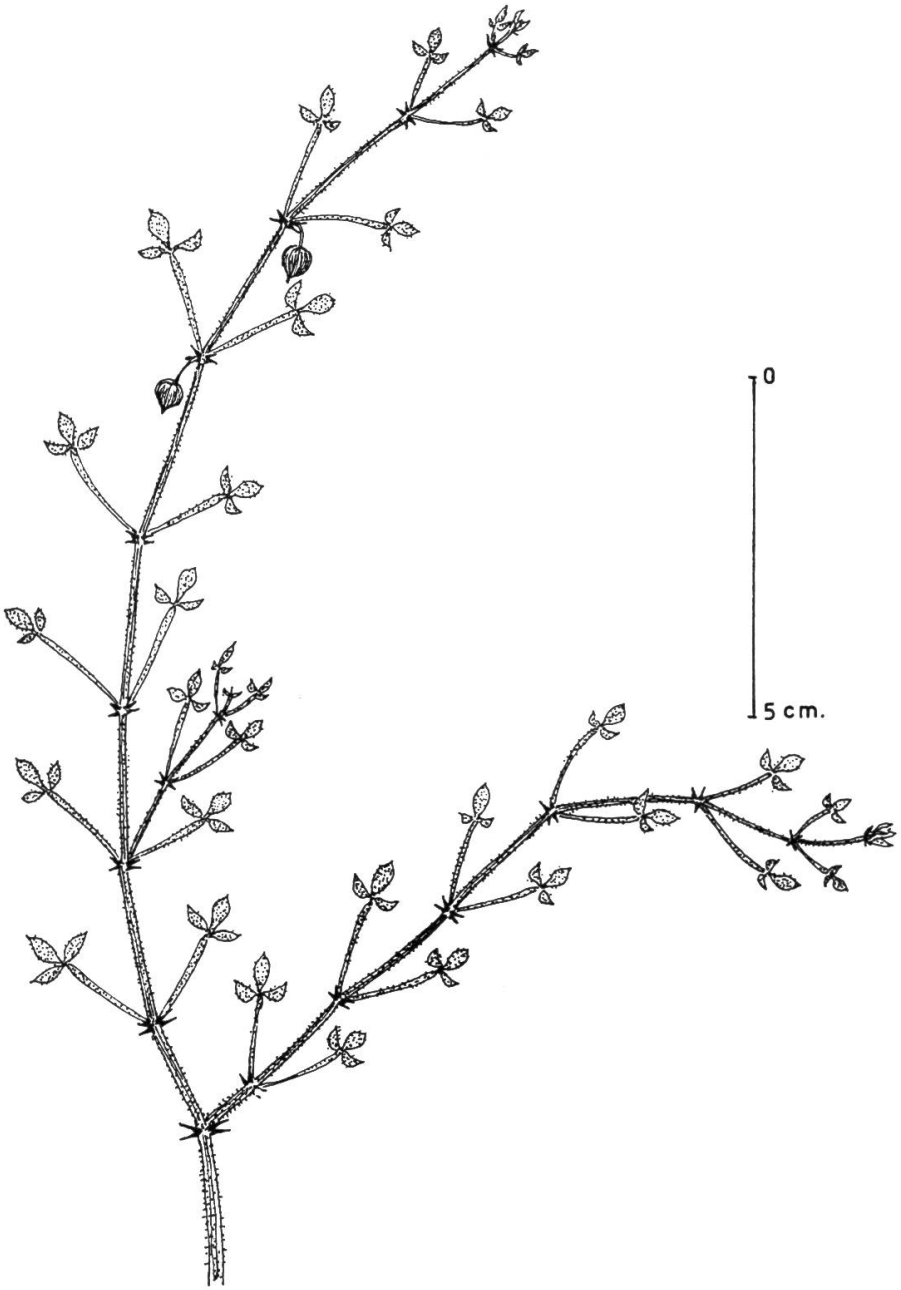


FIG. 9. — *Fagonia microphylla* Pomel.

F. glutinosa var. **nuda** Hadidi, var. nova.

TYPE: **Da** sept., Wadi Liblab near Cairo, 1952, *M. Imam* (CAI).

A typo differt pilis glandulosis stipitatis arenam minime adglutinantibus; granis pollinis minoribus (22×18 μ); capsulâ minore, 3 mm latâ, 4 mm longâ.

Less glandular, without adherent sand. Pollen grains 3-colpoidorate, subprolate as in the type, but smaller (22× 18 μ). Capsule smaller, 3 mm broad, 4 mm long.

DISTRIBUTION: **Da** sept.: Wadi Liblab near Cairo (CAI), Cairo-Suez road (CAI, CAIM).

Outside Egypt: Kuweit (*Dickson 223 A*, sec. Burtt & Lewis: 395). Probably more widespread, but overlooked.

11. **F. microphylla** Pomel, Nouv. Mat. Fl. Atl.: 338. 1875.

TYPE: South Algeria, *Pomel* (not seen).

Perennial pale green *shrublet* with procumbent or ascending, terete or angled branches, entirely covered with stalked viscid glands, often with adherent sand. *Internodes* as long as the leaves. *Spines* short, not exceeding 8 mm in length. *Leaves* long-petioled, petiole up to 30 mm long, flattened, always trifoliolate; leaflets ovate, the central one larger than the lateral ones. *Flowers* short-peduncled, typically 10-12 mm across. *Sepals* lanceolate, 4× 2.5 mm, glandular. *Petals* 8× 4 mm, rose-coloured. *Filaments* up to 8 mm long, anthers 0.6-0.3 mm. *Pollen grains* 3-colpoidorate, subprolate (22× 19 μ), sexine tegillate. *Fruit peduncle* shorter than capsule, reflexed, hairy. Capsule 5 mm broad, 4 mm long, covered with stalked glands and long unicellular hairs. *Calyx* deciduous (fig. 9).

DISTRIBUTION (map 3): **Di**: Sadd El Rauwafah, rare (CAIH).

Outside Egypt: from South Morocco eastwards to Tunisia (Ozenda & Quézel). Its discovery in the Isthmic desert of Egypt may support OZENDA & QUÉZEL's idea (p. 58) that it is endemic in the North part of African Sahara.

12. **F. tristis** Sickenb., Mém. Inst. Egypt. 4 : 201. 1901, var. **boveana** Hadidi, var. nova[1] = *F. cistoides* Delile in Bové, Pl. Exs., nom. nudum; *F. mollis* auct. non Delile 1813: Boiss., Fl. Or. 1 : 907, and others.

TYPE: Sinai desert, *Bové* (G).

The description given by BOISSIER, Fl. Or. 1: 907, under "*F. mollis*" will serve as latin diagnosis for the new taxon.

Perennial hispid *shrublet* with erect, terete and striped branches; plant entirely covered with yellowish glands and hairs (fig. 13 E). *Internodes* generally short. *Spines* hispid, as long as the leaves, patent or ascending. *Leaves* short-petioled, often trifoliolate; leaflets ovate, obtuse, fleshy, mucronate, about 10 mm in length. *Flowers* short-peduncled, large, about 12 mm across. *Sepals* ovate, 4× 1.5 mm, glandular-hairy, hairs about 320 μ long. *Petals* 7× 3 mm, pink. *Filaments* about

[1] Named after its collector.

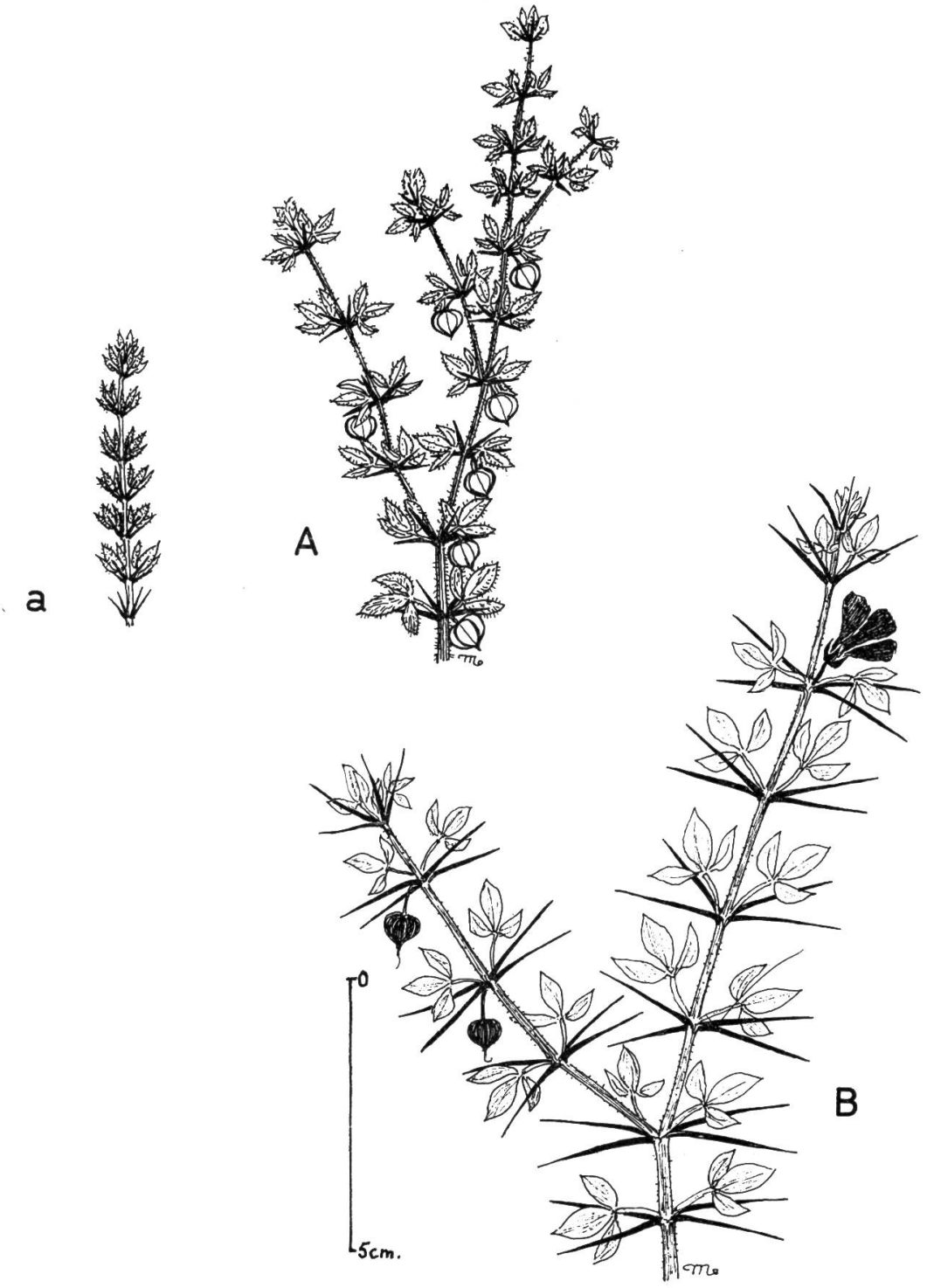


FIG. 10. — A: *Fagonia tristis* var. *boveana* Hadidi – a: *F. tristis* Sickenb. – B: *F. mollis* Delile.

10 mm long, anthers 0.9× 0.5 mm. *Pollen grains* 3-colporate, subprolate (24× 20 μ), sexine finely reticulate. *Fruit peduncle* as long as or shorter than capsule, reflexed, hairy. *Capsule* 5 mm broad, 6 mm long, with a short style, covered with spreading hairs; calyx deciduous (fig. 10 A).

DISTRIBUTION (map 1): **Da** sept.: Cairo-Suez road 116 km from Cairo, around Suez, Gebl Ataqa (especially in Wadi Aber) Wadi Qusseib; common in all these places. **Di**: rare in Gebl El Maghara. **S**: common in the mountain region around St. Catherine Monastery.

Outside Egypt: in Southern Palestine (Blatter, Post-Dinsmore, Oppenheimer & Evenari).

F. tristis var. **tristis**.

TYPE: between Mokattam and Gebl Ahmar near Cairo, 1880, *E. Sickenberger*.

Pubescent. Internodes and spines shorter than in var. *boveana*, about 10 mm long. Spines and leaves densely crowded, about equal in length. Leaflets always 3, cylindrical, mucronate (fig. 10 a).

DISTRIBUTION: endemic. Common in **Da** sept., particularly westwards of Cairo at Wadi Hof, Wadi Liblab, Gebl Ahmar, etc. From Suez to Hurghada along the Red Sea coast, here more common than var. *boveana*. **Di**: northwards to Wadi El Arish, also more common than var. *boveana*.

13. **F. mollis** Delile, Fl. Egypte, Expl. Pl.: 76. 1813 = *F. grandiflora* Boiss., Diagn. ser. 1, 8 : 121. 1849.

TYPE: Cairo desert, *A. R. Delile* (MPU).

Perennial *shrublet*, glabrous or sparingly hairy (fig. 13 D), with prostrate or procumbent, 4-angled and sulcate branches. *Internodes* longer than the leaves. *Spines* patent, as long as the internodes. *Leaves* short-petioled, most often trifoliolate with ovate, obtuse, mucronate leaflets about 10 mm in length. *Flowers* short-peduncled, large, over 15 mm across. *Sepals* ovate, 3× 1.5 mm, with few hairs (80-160 μ). *Petals* pink, 8× 4 mm. *Filaments* about 10 mm, anthers 1.1× 0.6 mm. *Pollen grains* 3-colpoidorate, prolate (30× 22 μ), sexine finely reticulate. *Fruit peduncle* as long as the capsule, reflexed, slightly hairy. *Capsule* 5× 5 mm, slightly hairy to tomentose; calyx deciduous (fig. 10 B).

DISTRIBUTION (map 1): **Da** sept.: around Cairo, particularly Wadi Hof, along Cairo-Suez road, Gebl Ataqa. **Di**: rare, El Maghara, Ain El Gedirat.

Outside Egypt: Southern Palestine, Jordan (Post-Dinsmore, Oppenheimer, Oppenheimer & Evenari, Rechinger 1952).

14. **F. latifolia** Delile, Fl. Egypte, Expl. Pl. : 86. 1813.

TYPE: Cairo desert, *A. R. Delile* (MPU).

Annual (rarely perennial) slender *herb* with rosetted broad leaves at the base and erect 4-angled and sulcate branches; plant entirely covered with brownish patent

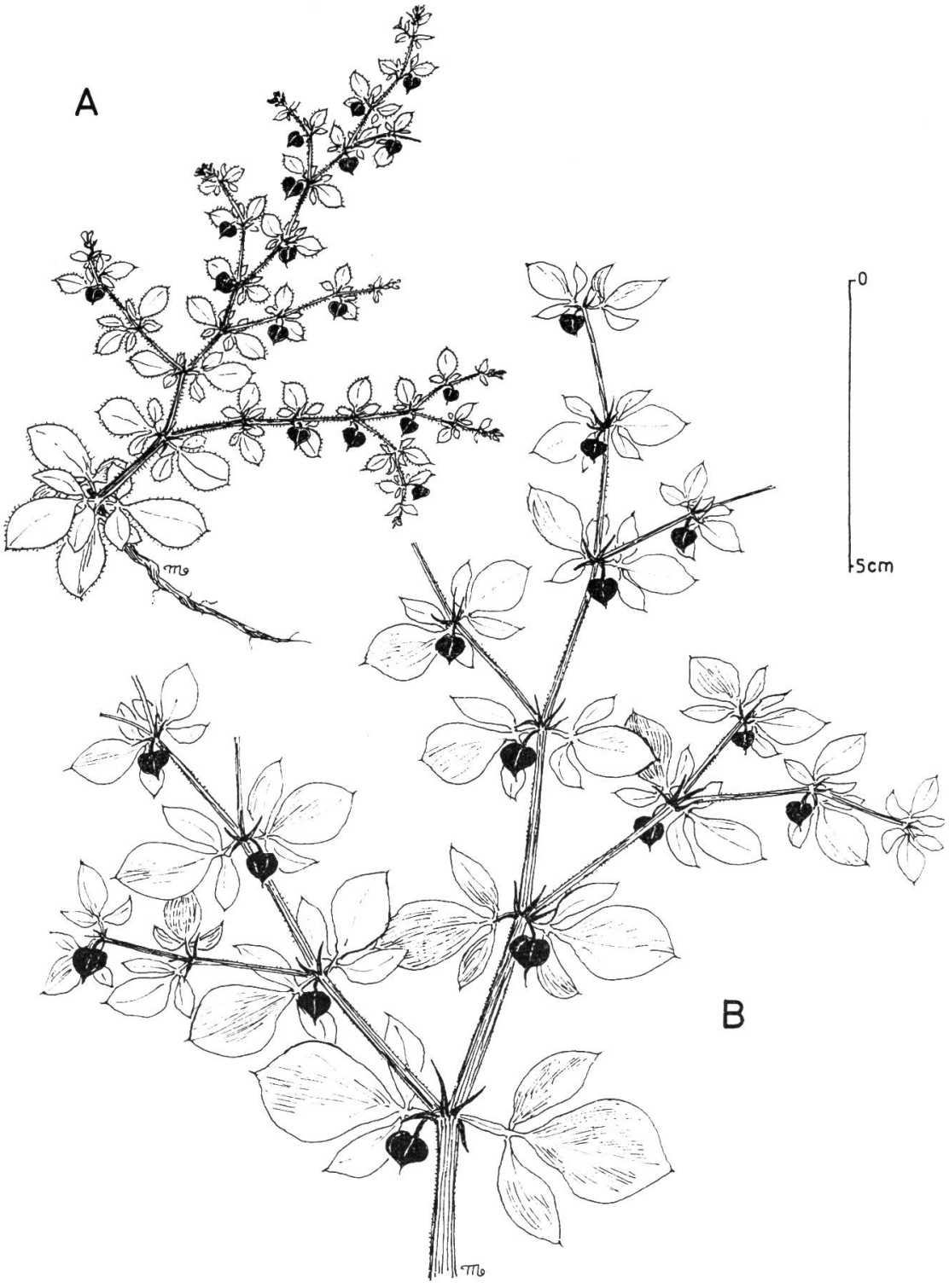


FIG. 11. — A: *Fagonia latifolia* Delile – B: *F. isotricha* Murb.

hairs (fig. 13 B). *Internodes* short. *Spines* very short, not over 5 mm long. *Leaves* short-petioled, mostly trifoliolate; leaflets ovate-rhombical, the central one distinctly mucronate, larger than the lateral ones, up to 15 mm long. *Flowers* short-peduncled, small, up to 8 mm across. *Sepals* ovate-oblong, 2×1 mm, glandular. *Petals* 3.5×2 mm, pale rose. *Filaments* up to 5 mm long, anthers 0.5×0.3 mm. *Pollen grains* 3-colpoidorate, subprolate (24×21 μ), sexine tegillate. *Fruit peduncle* shorter than the capsule, reflexed, spreadingly hairy. *Capsule* 4 mm broad, 3 mm long, spreadingly hairy; style short, not over 2 mm; calyx deciduous (fig. 11 A).

DISTRIBUTION (map 3): **Da** sept., rare, here particularly around Cairo at Gebl Ahmar and along Cairo-Suez road. Appears as an annual in the spring only after a winter with good rain.

Outside Egypt: in North and Central Sahara (Ozenda & Quézel, as *F. latifolia* subsp. *eu-latifolia*), Tunisia (Bonnet & Barratte).

15. **F. isotricha** Murb., Acta Reg. Soc. Physiogr. Lund 8 : 54. 1897 = *F. soturbensis* Schweinf., Bull. Herb. Boiss. 7, app. 2: 276. 1899.

TYPE: Algeria (Biskra), 1853, *Balansa* (LD).

Perennial robust viscid *shrublet* with erect, angled or terete, striate branches. *Internodes* long. *Spines* short, about 10 mm in length. *Leaves* short-petioled, lower ones tri-, upper unifoliolate; central leaflet broad, rhomboidal, up to 2 cm long, 1 cm broad, covered with an indumentum of stalked glands (fig. 13 C). *Flowers* short-peduncled, small, less than 10 mm across. *Sepals* ovate, 2.5×1.5 mm, glandular. *Petals* 4.5×2.5 mm, rose-coloured. *Filaments* up to 6 mm long, anthers 0.8×0.5 mm. *Pollen grains* 3-colpoidorate, prolate, spheroidal (30×28 μ), sexine tegillate (fig. 14 A). *Fruit peduncle* as long as, or longer than the capsule, reflexed, sparingly hairy. *Capsule* 5 mm broad, 4 mm long, tomentose; style up to 2 mm long; calyx deciduous (fig. 11 B).

DISTRIBUTION (map 3): **Da** mer.: rare at Gebl Hamata, Wadi Holuz and Gebl Samiuki; plants from these localities are less hairy than the type. **GE**-region, rare: in Wadi Aak, Wadi Mawaw, NW an W slopes of Gebl Asoteriba (Soturba) (all CAI).

Outside Egypt: very common in North Africa, especially in the Western Sahara, including Mauritania, and in the South Sahara: Tibesti plateau, Adrar, etc. (Ozenda & Quézel, as *F. latifolia* subsp. *isotricha*). It is interesting to observe that the localities in Egypt are on the same latitude as those of the South Sahara.

III. The sinaica group

16. **F. sinaica** Boiss., Diagn. ser. 1, 1: 61. 1842, var. **kahirina** (Boiss., Diagn. ser. 1, 8: 122. 1849, pro spec.).

TYPE: Cairo desert, 1846, *Boissier* (G).

Perennial dark green *shrublet* with prostrate, dichotomous, 4-angled and sulcate, sparingly glandular branches. *Internodes* long. *Spines* short, not exceeding 10 mm in length. *Leaves* short-petioled, lower ones tri-, upper ones unifoliolate; leaflets

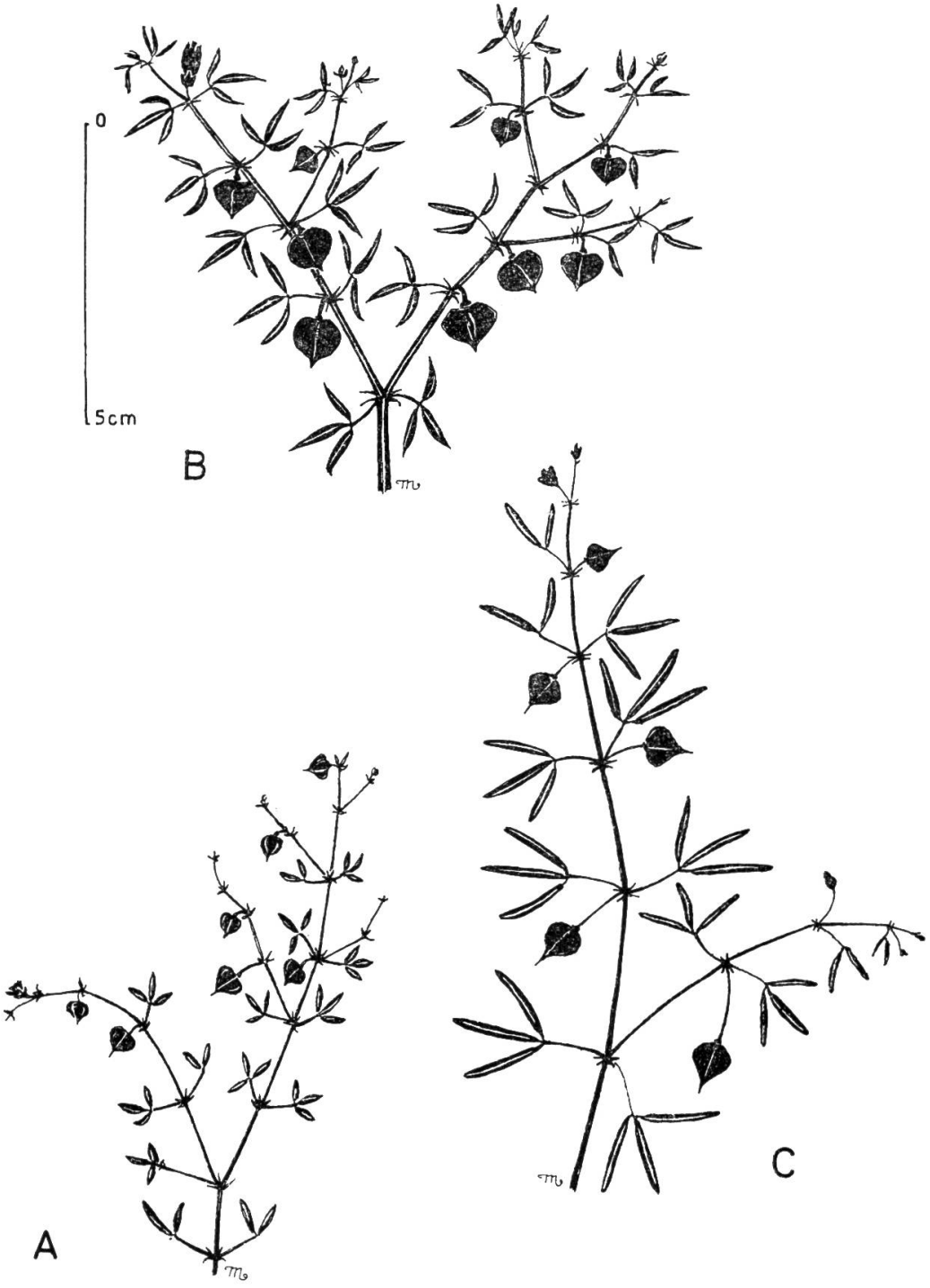


FIG. 12. — A: *Fagonia sinaica* Boiss. var. *kahirina* (Boiss.) – B: *F. cretica* L. – C: *F. bischarorum* Schweinf.

lanceolate or ovate-oblong, about 10 mm in length. *Flowers* short-peduncled, large, about 15 mm across. *Sepals* ovate, 3× 1.5 mm, sparingly glandular with few capitate hairs. *Petals* 7× 2.5 mm, pink. *Filaments* up to 3 mm long, anthers 0.6× 0.3 mm. *Pollen grains* 3-colporoidate, prolate (28.5× 19 μ), sexine tegillate. *Fruit peduncle* as long as or shorter than the capsule, reflexed, sparingly hairy. *Capsule* 4 mm broad, 3 mm long, covered with spreading hairs; style up to 3 mm long; calyx deciduous (fig. 12 A).

DISTRIBUTION (map 3): **Da** sept.: common on rocky slopes, especially in Wadi Hof and along the Cairo-Suez road, Wadi Aber of Gebl Ataqa, Wadi Qusseib (CAI); **Dl**: along the Cairo-Alexandria road; **Di**: Maghara (CAI), Mitla Pass (CAIM); **Mma**: Burg El Arab, rare.

Outside Egypt: common on the high plateaux of the Atlas, the north Sahara and central Tunisia, more rare southwards through the central Sahara (Ozenda & Quézel as *F. kahirina* var. *typica*). Its occurrence in Morocco is uncertain. East of Egypt, in Palestine (Post-Dinsmore) and Syria (Blatter, Eig).

F. sinaica var. **sinaica** = *F. kahirina* var. *sinaica* (Boiss.) Boiss., Fl. Or. 1: 905. 1867.

TYPE: Sinai, *Aucher-Eloy 800* (G).

More glandular and greyish-green than var. *kahirina*. Petioles longer, up to 10 mm. Flowers smaller. Peduncles up to 10 mm long (in var. *kahirina* shorter).

DISTRIBUTION: **Di**: Maghara; **S**: Wadi Feiran; **Da** sept.: Wadi Qusseib.

Outside Egypt: Palestine (Post-Dinsmore), probably also south of Tunisia, Algeria and Oran (Ozenda & Quézel: 54, as *F. kahirina* var. *longipes*; the authors claim that this variety is identical with BOISSIER's *sinaica*, also their description of the variety supports this view). BONNET & BARRATTE (p. 89 and 506) recorded the var. *sinaica* from Tunisia and Tripolitania (Libya).

17. **F. cretica** L., Sp. Pl. : 386. 1753.

TYPE: grown in Uppsala Botanical Garden, *Linné*.

Perennial, dark to bright green *plant* with frutescent base; branches numerous, prostrate, 4-angled and sulcate, glabrous. *Internodes* longer than leaves. *Spines* short, not exceeding 10 mm in length. *Leaves* short-petioled, always trifoliolate; leaflets lanceolate, mucronate, up to 20 mm long, glabrous with a few marginal glands. *Flowers* short-peduncled, large, up to 20 mm across. *Sepals* lanceolate, 5× 2 mm, glabrous. *Petals* 9× 5 mm, purple. *Filaments* up to 10 mm long, anthers 1.2× 0.6 mm. *Pollen grains* 3-colpoidate, prolate, spheroidal (30× 27 μ), sexine tegillate. *Fruit peduncle* shorter than the capsule, thick, reflexed, covered with capitate glands. *Capsule* large, 10 mm broad, 7 mm long, glabrous or sparingly hairy on the angles; style short, up to 2 mm; calyx deciduous (fig. 12 B).

DISTRIBUTION (map 3): along the Eastern Mediterranean coast, **Mma**, from Sollum to Alexandria. No records from the Eastern Mediterranean strip in **Mp**: the plant seems to be restricted to the calcareous rocky plateaux; in **Mp** the ground is sandy.

Outside Egypt: Canary Islands, Spain, Portugal, Malta, North Africa, Crete and Cyprus (Ozenda & Quézel), Italy and Greece (Eig). Other records, e.g. Aden (Krause), Lahag (Blatter), Somali (Glover), Tropical Africa (Oliver), etc., are probably all erroneous and should be referred to other species.

18. **F. bischarorum** Schweinf., Bull. Herb. Boiss. 7, app. 2 : 276. 1899 = ?*F. flamandi* Batt., Bull. Soc. Bot. Fr. 47 : 249. 1900.

TYPE: from "Soturba" (Asoteriba) mountains, *G. Schweinfurth 2208.*

Perennial, olive-green *shrublet* with numerous erect, terete and striped, glabrous branches. *Internodes* long, the nodes slightly swollen, white. *Spines* very short, 2-5 mm. *Leaves* glabrous, trifoliolate, petioles 10-15 mm in length; leaflets linear, the central one 10-15 mm long, 2 mm broad, the lateral ones shorter. *Flowers* large, up to 15 mm across, on a peduncle up to 10 mm long. *Sepals* ovate, 3.5× 1.5 mm, glabrous. *Petals* 7× 3 mm, rose-coloured. *Filaments* up to 8 mm, anthers 1× 0.6 mm. *Pollen grains* 3-colpoidate, prolate (30× 21 μ), sexine tegillate. *Fruit peduncle* longer than capsule, up to 20 mm, slender, reflexed, glabrous. *Capsule* 5× 5 mm, covered with short hairs; style up to 3 mm long; calyx deciduous (fig. 12 C).

DISTRIBUTION (map 3): endemic. **Da** mer.: around Gebl Hamata.

OBSERVATION: OZENDA & QUÉZEL described *F. flamandi* Batt. as an endemic species in the Central Sahara, Ahaggar, Tibesti, etc. This species may be identical with our *F. bischarorum.* Geographically, they grow on the same latitude.

Discussion

I. The systematic value and significance of the various characters

So far as this investigation is concerned, the revision of the Egyptian material of *Fagonia* has revealed the occurrence of 18 species, whereas recent floristic works, e.g. TÄCKHOLM (1956), only recorded 12 species. The criteria previously used for distinguishing between the different *Fagonia* species, e.g. by BOISSIER, OZENDA & QUÉZEL, PORTER and others, are merely morphological. Microscopical criteria have been tried here probably for the first time. Such criteria are nowadays very important features in systematic research. Furthermore, geographical distribution is so highly significant that OZENDA & QUÉZEL in their systematic treatment of *Zygophyllaceae* in African Sahara pointed out (p. 27) that, in future, endemic species will merit a special study.

The application of the different criteria have shown clearly that the *Fagonia* species in Egypt belong to three more or less natural groups. The characters involved will be discussed briefly as follows:

A. MORPHOLOGY.

Morphological criteria in *Fagonia* still remain the base of the specific character and are useful for constructing artificial keys for identification purposes.

Stem. Perennial species with woody stem usually belong to the *arabica-bruguieri* group, whereas herbaceous forms come within the *glutinosa* and *sinaica* groups. It will be shown later that the latter two groups are closely allied. Probably, they originated in the African desert and did not expand much outside this area. The *arabica-bruguieri* group, on the other hand, includes the most common and most widespread species within the Saharo-Sindian belt.

Leaves. The leaves in the *glutinosa* and *sinaica* groups are both distinctly trifoliolate, but the leaflets of the first group are rhombic-ovate whereas they are ovate-lanceolate in the second. The *arabica-bruguieri* group includes species with the lower leaves trifoliolate, the upper ones unifoliolate, e.g. *F. arabica*, *F. bruguieri*. Through reduction, a more advanced group of species with unifoliolate leaves originated, viz. *F. indica*, *F. elba* and *F. taeckholmiana*.

Spiny stipules. This character had already been taken into consideration at an early date by BOISSIER, and up to the present by OZENDA & QUÉZEL and PORTER. These authors distinguished between different taxa according to the length of the spines, whether they were shorter or longer than the corresponding leaves. In the *glutinosa* and *sinaica* groups the spines as a rule are shorter than, or mostly equal to the leaves, in the *arabica-bruguieri* group they are longer. Only highly advanced species show a deviation from the rule. Thus in *F. taeckholmiana* the spines are completely absent. In *F. kassasii* the petiole is much elongated and thus makes the leaf longer than the spines. In *F. elba*, it is the leaflets that are much elongated and exceed the spines, which is not the case with *F. parviflora*, from which it is probably derived. The most wide-spread taxon in the African Sahara, *F. indica*, differs from other members of the group in its much reduced spines, hardly exceeding, or usually shorter than, the leaves. There is reason to believe that a further reduction of the spines and a migration from the south, where *F. indica* occurs, towards the north, led to the formation of *F. taeckholmiana*. The occurrence of intermediate forms between the two in the Egyptian **Da** sept. is in favour of such a theory.

Pubescence. STANDLEY, OZENDA & QUÉZEL and PORTER have shown that pubescence sometimes may be of systematic value. A microscopical study of the hairs (fig. 13) of the Egyptian Fagonias has proved that all species belonging to *arabica-bruguieri* and *sinaica* groups have simple capitate hairs or glands which are merely outgrowths of the epidermal cells. The species of the *glutinosa* group, on the other hand, in addition to simple hairs and glands, also have compound hairs, trichomes. Primitive species, such as *F. latifolia* and *F. tristis*, have much more elaborate trichomes than the advanced species, such as *F. isotricha* and *F. mollis*, which are probably derived from the other two. Fig. 13 shows that the trichomes of the latter two species are merely reduced forms of the trichomes of the first two. OZENDA & QUÉZEL considered both *F. latifolia* and *F. isotricha* as two subspecies of their *F. latifolia* sensu lato. But the great difference in hair structure would rather support the idea that the two of them represent different species. Already MURBECK

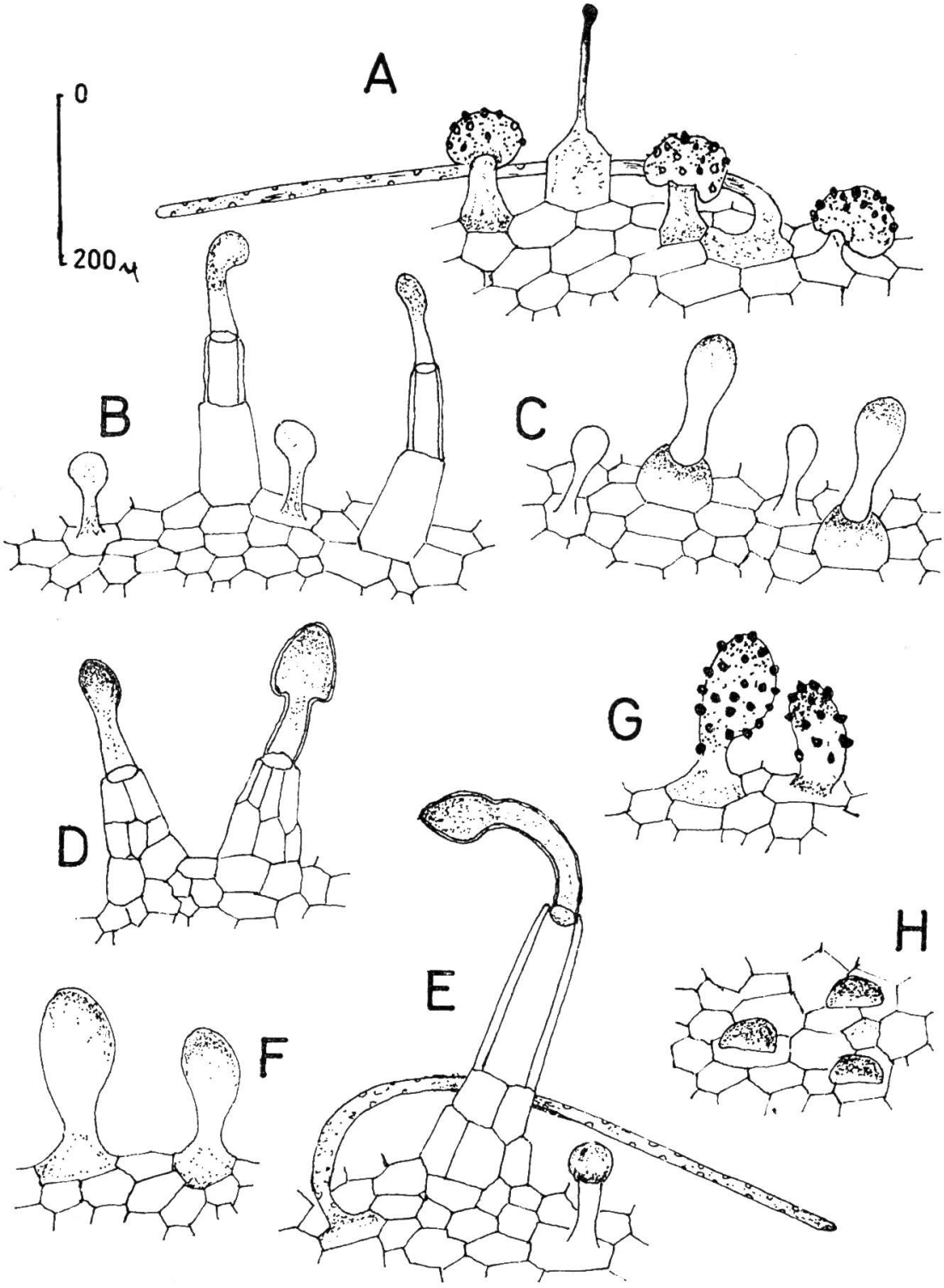


FIG. 13. — Hairs of different species of *Fagonia*.

A: *Fagonia glutinosa* Delile – B: *F. latifolia* Delile – C: *F. isotricha* Murb. – D: *F. mollis* Delile – E: *F. tristis* Sickenb. var. *boveana* Hadidi – F: *F. arabica* L. – G: *F. arabica* var. *viscidissima* Maire – H: *F. indica* Burm. fil.

in his diagnosis of *F. isotricha* laid stress on its particular type of hairs: " glandulis stipitatis sparse obsita ".

Capsule. Pubescence of the capsule, length of the peduncle and the " beak " (persistent style) have been used by BOISSIER and others in their differentiation between the species. OZENDA & QUÉZEL laid much stress on the characteristics of the capsule, particularly its size and the persistence of the fruit calyx. In the present investigation, these characters have proved to be very useful. Thus species with persistent fruit calyx, viz. *F. bruguieri*, *F. indica* and *F. glutinosa*, are the most widespread and occur throughout the Saharo-Sindian belt. These species constitute within their natural groups (compare fig. 1) the key species, from which other species have originated. Through evolution and specialization the calyx gets lost. Thus the majority of taxa derived from species with persistent calyx have deciduous calyx. Only the two advanced taxa *F. myriacantha* and *F. kassasii* have a persistent fruit calyx like the closely related *F. bruguieri*, from which they are apparently derived. These three taxa have been considered by several authors as one collective species, viz. *F. bruguieri*.

OZENDA & QUÉZEL distinguished between two categories of capsular size: one with the capsule up to 4 mm across, and another with the capsule 5 mm or more. As a rule the capsule size is nearly constant within each natural group of species. This is the case e.g. in the *sinaica*-group, in *F. bruguieri* and its allied species *F. myriacantha* and *F. kassasii*, in *F. arabica* and its related species *F. thebaica* and *F. boulosii*. OZENDA & QUÉZEL divide *F. latifolia* into two subspecies: *eu-latifolia* and *isotricha*, each with different capsule size. As most species in *Fagonia* have only one capsule size, it is evident that the two taxa should be treated not as subspecies but as species.

B. PALYNOLOGY.

Palynological studies of the different Egyptian species showed that all species of the *arabica-bruguieri* group have reticulate sexine, while the *sinaica* and *glutinosa* groups have tegillate sexine. It is also striking that species like *F. arabica*, *F. sinaica*, *F. tristis* and *F. latifolia* have smaller pollen grains as compared with other species, and may have been derived from them. E.g. *F. thebaica* var. *violacea* and *F. boulosii* have larger pollen grains than *F. arabica*; *F. cretica* and *F. isotricha* have larger pollen than *F. sinaica* and *F. latifolia*, etc.

C. ANATOMY.

The anatomy of the young shoots of the Egyptian species has been studied in relation to BOISSIER's old concept of grouping the species according to quadrangular or terete stems. Certain authors, like OZENDA & QUÉZEL, claimed that this character had little systematic value, since it was not always clear in a specimen whether the stem was terete or quadrangular, especially in the adult stage.

A detailed description of the anatomical features in *Fagonia* is not within the scope of this paper. It will be published later separately. It may only be mentioned here that stems which are considered not distinctly quadrangular at least have their first secondary-growth rings angular in outline, and their subepidermal patches of mechanical tissue, if present, are usually four. Terete species have circular secondary-growth rings, and the mechanical patches are otherwise arranged.

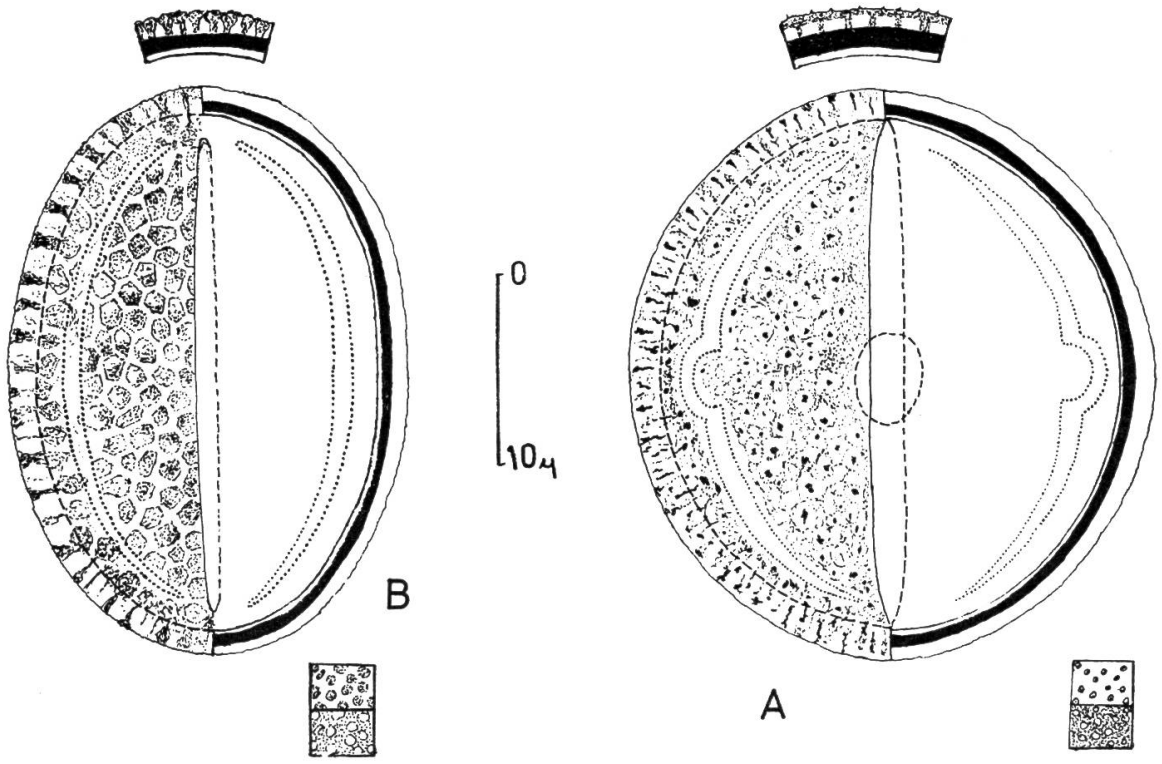


FIG. 14. — A: Tegillate sexine in *F. isotricha* Murb. – B: Reticulate sexine in *F. kassasii* Hadidi.

D. CYTOLOGY.

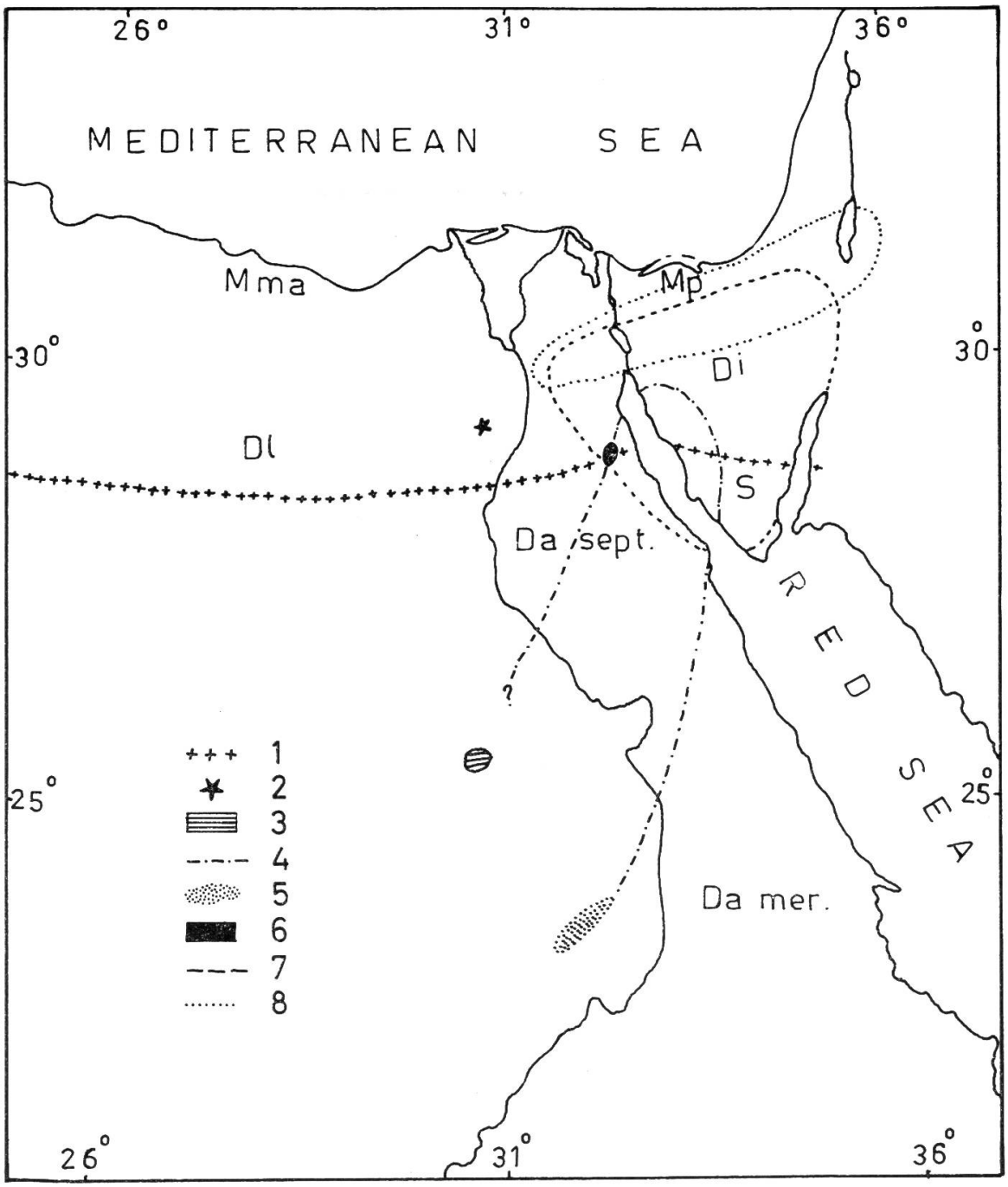
The *Zygophyllaceae* are known as a difficult family for cytological investigations. The flowers of one and the same plant may have different structures. The presence of many intermediate forms complicates research. In addition, the chromosomes are minute. This may explain the difficulties which have faced investigators, and why only two records of chromosome counts in the genus *Fagonia* are known up to the present.

II. Geographical distribution

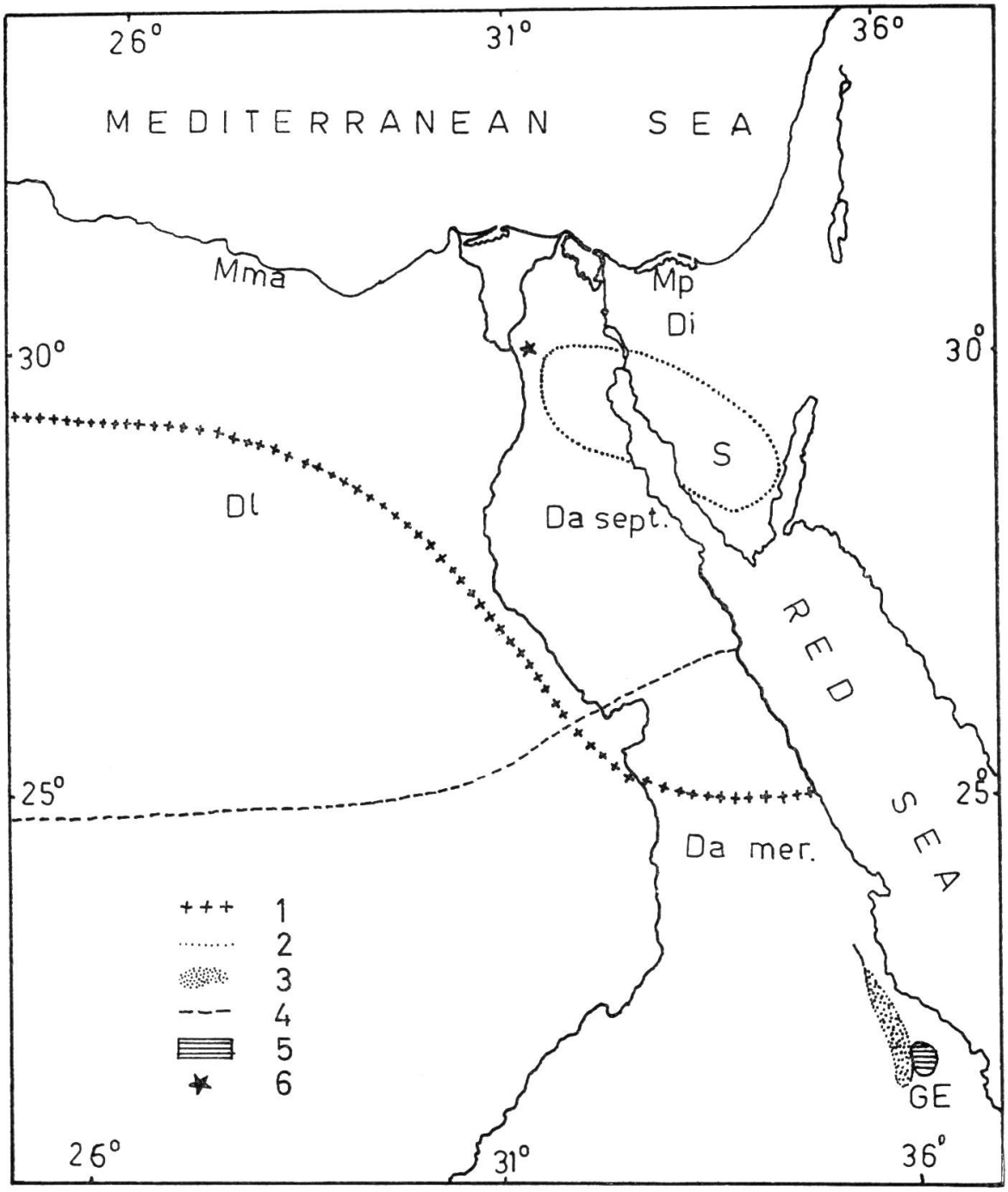
A. WIDESPREAD TAXA.

The species of *Fagonia*, which are of a wide distribution, are actually the key-species of the three natural groups. Thus *F. bruguieri* is the most widespread species within the Saharo-Sindian belt. It penetrates southwards into the Sudano-Deccanian region. Also, *F. indica* is known to occur all over the southern part of the Saharo-Sindian belt and in the Sudano-Deccanian region. Similarly, both *F. sinaica* and *F. glutinosa* are the comparatively most widespread species within their natural groups.

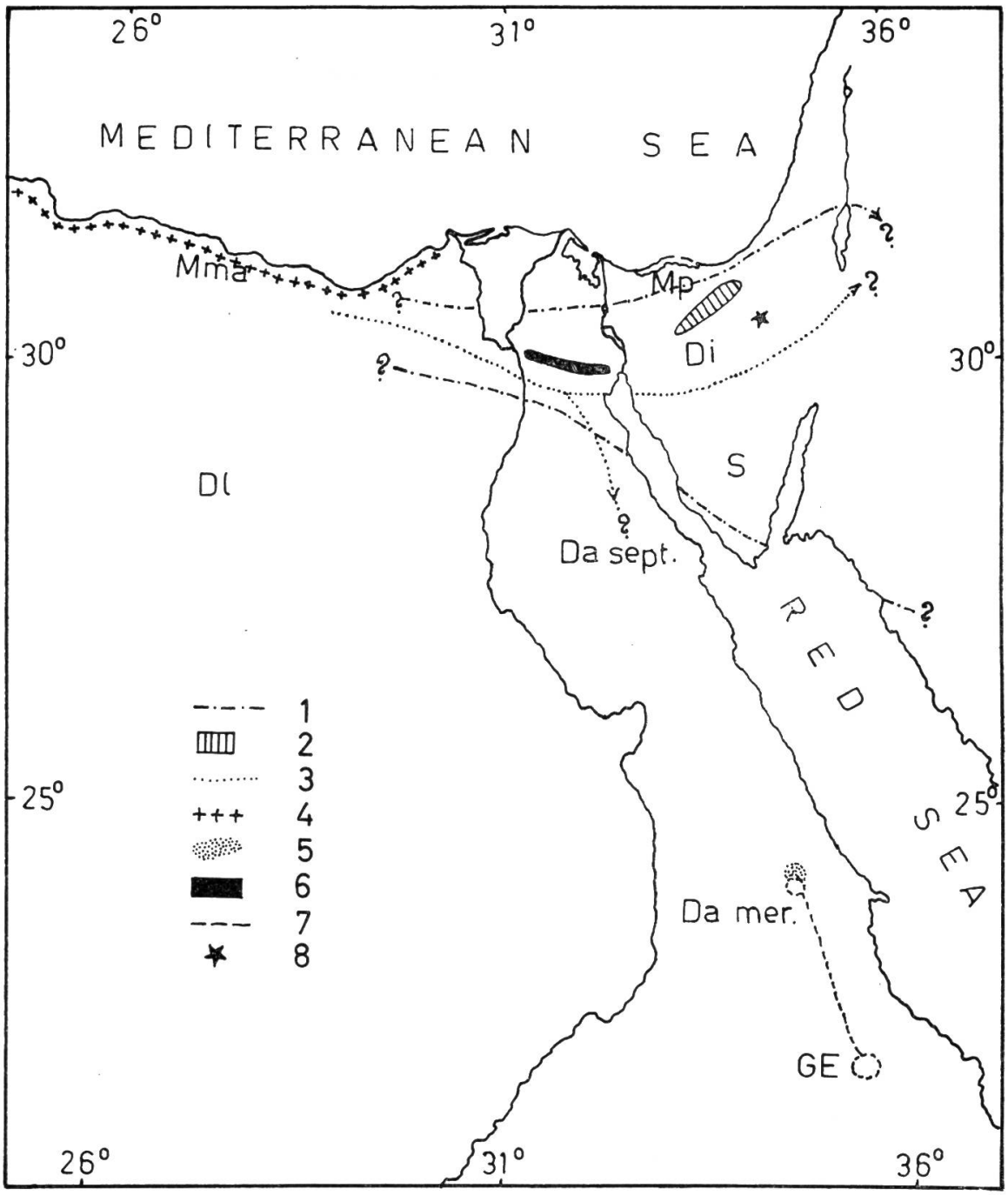
Through specialization and evolution of these common taxa, other taxa have originated which are of limited geographical distribution or even restricted to just



MAP 1. — 1: *Fagonia arabica* – 2: *F. arabica* var. *imamii* – 3: *F. arabica* var. *tilhoana* – 4: *F. thebaica* – 5: *F. thebaica* var. *violacea* – 6: *F. boulosii* – 7: *F. tristis* – 8: *F. mollis*.



MAP 2. — 1: *Fagonia bruguieri* (S limit) – 2: *F. myriacantha* – 3: *F. kassasii* – 4: *F. indica* (N limit) – 5: *F. elba* – 6: *F. taeckholmiana*.



MAP 3. — 1: *Fagonia glutinosa* – 2: *F. glutinosa* var. *grandiflora* – 3: F. *sinaica* (S limit) – 4: *F. cretica* – 5: *F. bischarorum* – 6: *F. latifolia* – 7: *F. isotricha* – 8: *F. microphylla.*

one small area. The majority of species within the three natural groups are of a limited geographical distribution.

According to the literature, *F. arabica* is recorded as a very widespread species. In reality, it is surprisingly rare and only known from the northern parts of the African deserts. It may be considered widespread only through its varieties. Thus var. *viscidissima* is more common in the African deserts than the type itself. In addition, there are several varieties which are endemic in the Sahara, e.g. var. *planii* Maire in the Ougarate region (Ozenda & Quézel : 48), var. *imamii* Hadidi in the Egyptian part of the Libyan desert (**Dl**), and var. *tilhoana* Maire in the Central Sahara including the Kharga Oasis of Egypt. The latter variety was described by MAIRE as a distinct species (compare Ozenda & Quézel : 48). According to these authors, p. 46, *F. arabica* has been replaced on the plateaux of Atlas and Oran by two other closely allied species, *F. malvana* and *F. zilloides*, which probably have sprung from *F. arabica*.

In Egypt *F. arabica* is entirely absent from the southern deserts (see map 1), but is replaced here by two closely allied species, viz. *F. thebaica* and *F. boulosii*. The former penetrates southwards into **Dl** by its variety *violacea*.

B. F. INDICA AND F. OLIVIERI.

BOISSIER, 1867, distinguished between two closely related taxa, viz. *F. olivieri* DC., native of the northern part of the Asiatic region of the Saharo-Sindian belt, and *F. parviflora* Boiss., recorded from Egyptian Nubia and adjacent regions of Africa. According to BOISSIER, the stem in *F. parviflora* is terete and striate, in *F. olivieri* quadrangular and sulcate. In addition the fruit peduncle in the former species is twice as long as in the latter.

OZENDA & QUÉZEL (p. 41), assuming that the *olivieri-parviflora* question is not concerned with North Africa and believing that the two taxa are identical, kept the name *olivieri*, as being the oldest, for the plant growing in the North-African Sahara.

The author has another opinion about this matter, and for the following reasons: *F. olivieri* does not occur in the African deserts. It is a species from Syria, Iraq (Boissier, Bouloumoy, Thiébaut, Zohary, Rechinger 1959) and North Iran (Parsa). *F. parviflora* Boiss. has a different and more southern distribution (see under the description of this species). The author also had the chance to examine a specimen of *F. olivieri*, collected in NE Saudi-Arabia (*A. Khattab*, 1944, CAIM). This specimen is quite different from *F. parviflora*, but agrees well with the photograph of *F. olivieri* published by BOULOUMOY (p. 70, tab. 58).

F. olivieri f. *jolyi* described by OZENDA & QUÉZEL (p. 39), with illustration (p. 42, fig. 3) and geographical distribution, fits very well *F. parviflora* var. *brevispina*, which is the most common taxon in the southern African deserts. This, however, is the same as *F. indica* Burm. fil. from Iran which, being the oldest name, is adopted here.

C. THE GLUTINOSA GROUP.

The species which are included in this group occur in the Egyptian deserts of Sinai, extending westwards into **Da** sept. A careful examination of the Egyptian

material has revealed the occurrence in Egypt of *F. microphylla*, a species known earlier only from the northern deserts, from Morocco to Tunisia.

F. glutinosa, the key species of this natural group, is the most widespread of the species penetrating through the Saharo-Sindian belt. Other species are confined to North Africa. *F. microphylla*, *F. latifolia* and *F. isotricha* penetrate westwards into Sahara, the two former in the northern and the latter in the southern part of the Sahara desert belt. *F. tristis* and *F. mollis*, on the other hand, are confined to the Sinai, south Palestine, and penetrate into **Da** sept., but do not go further westwards.

The latter two species are closely allied but differ in several respects (see description). *F. mollis* was described by DELILE from the desert near Cairo. The name was later applied erroneously by several authors, including BOISSIER, for the taxon which is named here *F. tristis* var. *boveana* because it was collected for the first time from Sinai by BOVÉ. DELILE labelled this specimen *F. cistoides*, but never published the name. DECAISNE in his publication on BOVÉ's plants (p. 280), realised that *F. mollis* Delile and *F. cistoides* Delile were different taxa because the former has much larger flowers. This was realised also by BOISSIER, who gave the name *grandiflora* to the large-flowered plant and used *mollis* for the small-flowered, not aware of the fact that DELILE's *mollis* was the large-flowered one. This has caused great confusion.

Furthermore, SICKENBERGER published a species, *F. tristis*, closely related to *F. mollis* according to his opinion. The present revision has proved that *F. tristis* is merely a form of "*F. cistoides*" which has migrated from the Sinai westwards into **Da** sept. and along the Suez Gulf down to Hurghada. Its western limit is Burg el Arab (**Mma**), from where it has been recorded only once.

F. glutinosa var. *grandiflora* is endemic in **Di** of the Sinai Peninsula. It is a taxon which needs further studies and may merit specific rank.

The fact that the species of the *glutinosa* group are represented in the Sinai, and that we have here several endemic taxa, would suggest that the Sinai and adjacent places is the centre of origin for the species of this group. Here they may have originated from the most primitive and widespread of them, *F. glutinosa*. Some of the species succeeded to invade the African Sahara, e.g. *F. microphylla*, *F. latifolia* and *F. isotricha*, while others remained endemic in the Sinai and adjacent deserts of Egypt and Palestine.

D. THE SINAICA GROUP.

This is represented by three closely allied chasmophyte species, mainly found in North Africa. *F. kahirina* (first described from the Egyptian deserts) represents the mother taxon of this group with the northern Egyptian deserts as the centre of origin. Here it is known to be more common than in any other part of its distribution area. In other parts of North-African Sahara it is rare and represented by a certain endemic taxon, var. *pedunculata*.

The calcareous Mediterranean coasts in Africa and Europe have another closely allied species, *F. cretica*, which may represent a specialization of the mother taxon to the north. *F. bischarorum* represents another specialization of the mother taxon towards the south in the African Sahara. An intermediate form is *F. sinaica*, confined in Egypt to the Sinai and **Da** sept. (outside Egypt it is known from the southern parts of Tunisia and Algeria, as var. *longipes* Maire). This taxon is recorded from

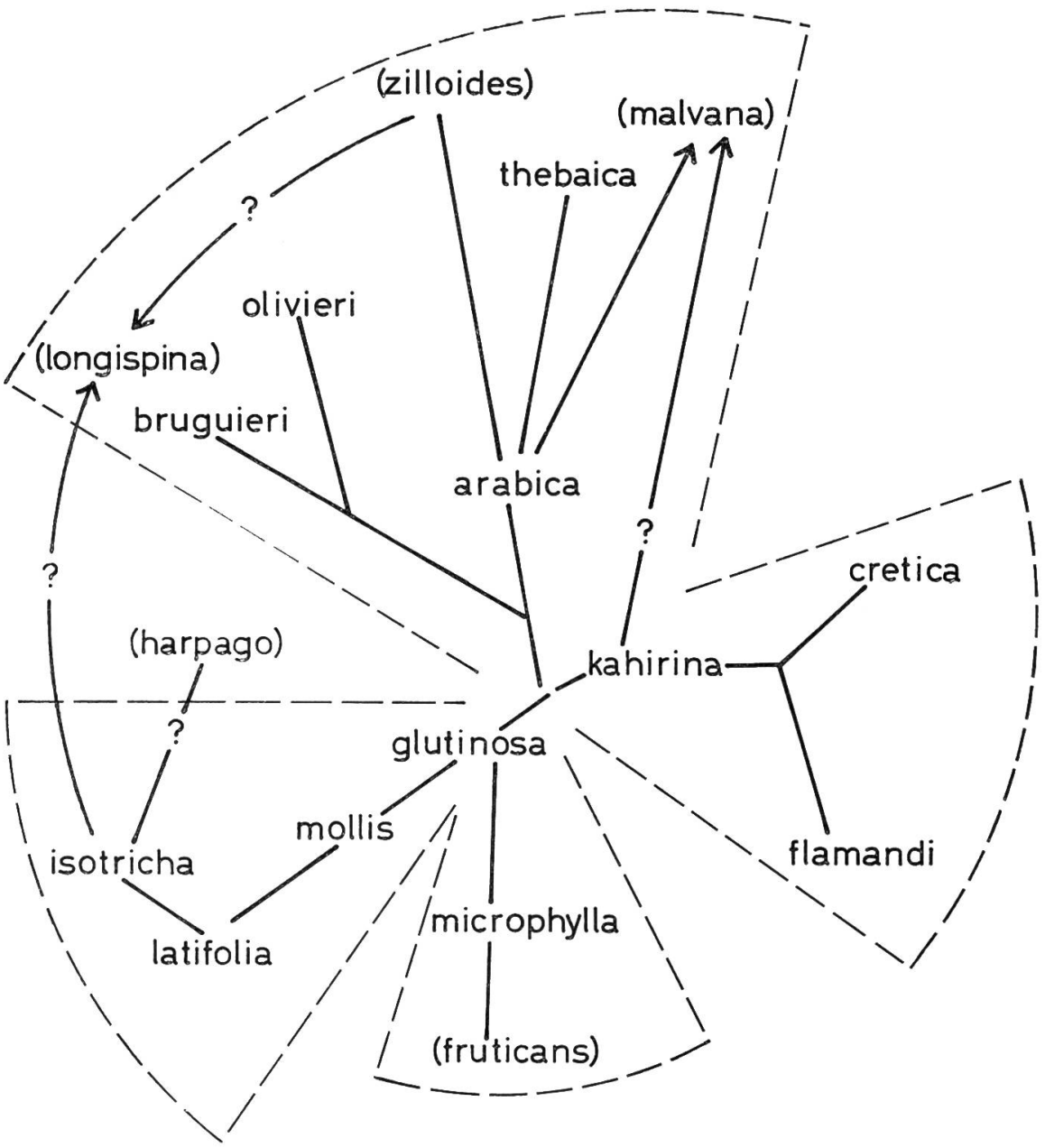


FIG. 15. — Natural groups of *Fagonia* species in North African Sahara, after OZENDA & QUÉZEL 1956 (species between brackets are not represented in Egyptian flora).

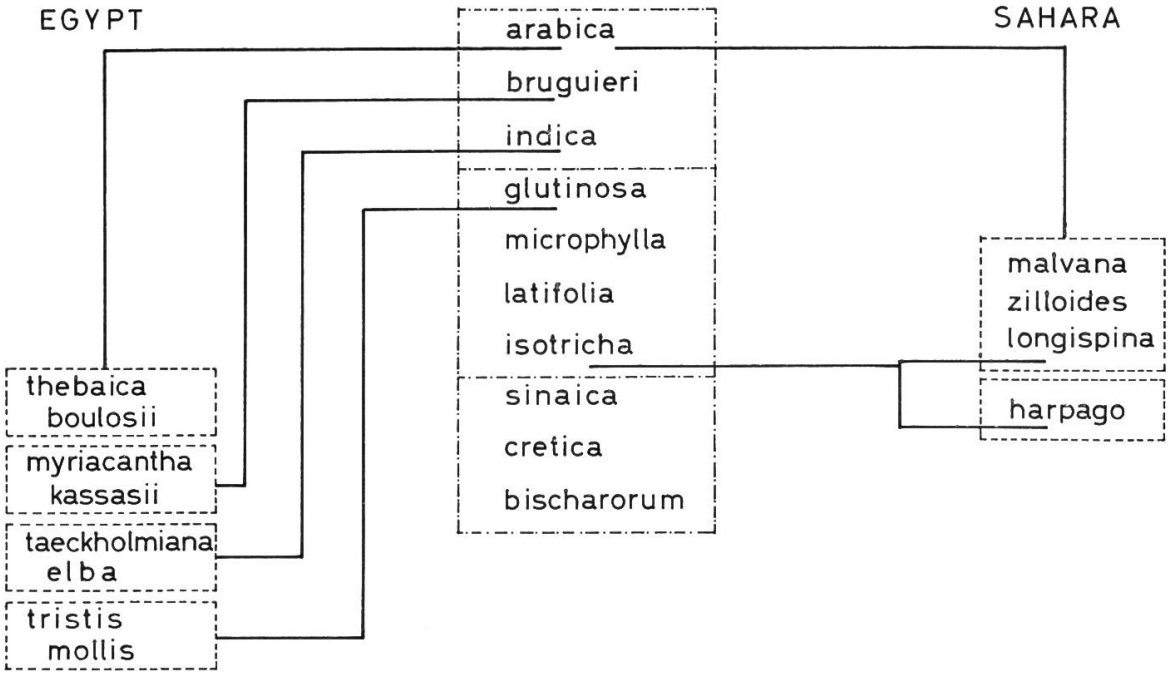


FIG. 16. — Natural groups of *Fagonia* in North Africa; species within - - - lines are endemic in Egypt or Sahara, species within ····· lines are found in the whole North Africa.

the same places as *F. bischarorum* (also known as *F. flamandi*), thus supporting the opinion that it is an intermediate between *F. kahirina* and *bischarorum*. *F. sinaica* and *F. kahirina* are here regarded as conspecific, and the oldest name, *sinaica*, had to be adopted at the specific level.

According to geographical distribution, the *sinaica* as well as the *glutinosa* groups are mainly North African. Nearly all the taxa of the *sinaica* group are represented in Egypt in the same area as that in which the *glutinosa* group has its main centre of origin.

It has already been mentioned that both groups comprise short-spined, trifoliolate species with quadrangular stem; also the pollen type and sexine sculpture are the same. Thus it is possible that both groups may have the same origin. The *sinaica* group specialized in inhabiting rocky places, while the *glutinosa* group became restricted to sandy deserts. *F. glutinosa* is always covered with adherent sand, a relic character still kept.

A close relationship between the two groups is also shown by the presence of an intermediate form, *F. glutinosa* var. *nuda*, restricted in Egypt to **Da** sept. where the mother species of the two groups are frequently met with. This variety is intermediate between *F. sinaica* var. *kahirina* and *F. glutinosa*.

III. The natural groups of Fagonia in North Africa

Figure 15 shows OZENDA & QUÉZEL's plan of the natural groups of *Fagonia* species in the North African Sahara. It will be noticed the great agreement between this and the corresponding plan for the Egyptian species in figure 1.

The *Fagonia* species of North Africa belong to 3 more or less well defined groups. These will be discussed briefly as follows, and their interrelationships shown diagrammatically in figure 16.

A. ARABICA-BRUGUIERI GROUP.

This is represented in North Africa by 12 species of which three are known from North Africa, viz. *F. arabica*, *F. bruguieri* and *F. indica*; three are endemic in the Sahara, viz. *F. malvana*, *F. zilloides* and *F. longispina*; and six are endemic in Egypt, viz. *F. thebaica*, *F. boulosii*, *F. myriacantha*, *F. kassasii*, *F. elba*, and *F. taeckholmiana*.

The three species endemic in the Sahara have probably all sprung from *F. arabica*. *F. arabica* is recorded in literature as a very widespread species found all over the Saharo-Sindian and southwards in the Sudano-Deccanian region. The author is of the opinion that many of these records, especially those from Arabia and Ethiopia and other places in the south, may represent other, closely allied species. This remains to be revised in a future monographic treatment of the genus.

Of the many species of this group endemic in Egypt only two have probably been derived from *F. arabica*, viz. *F. thebaica* and *F. boulosii*. The two endemic species *F. myriacantha* and *F. kassasii* must have sprung from *F. bruguieri*. The records of *F. myriacantha* from outside Egypt may belong to *F. bruguieri* var. *laxa*, which is a very robust plant. The taxon described from the Sahara as *F. bruguieri* var. *purpurascens* needs further study and comparison with the Egyptian *F. kassasii*. Both have similar leaves, and are endemic in the African desert on the same latitude.

The remaining two species of this group, endemic in Egypt, are *F. elba* and *F. taeckholmiana*. The former has certain similarities with the Sahara taxon " *F. olivieri* f. *typica* ", but differs from it in having a persistent fruit calyx. In *F. elba* the fruit calyx is deciduous.

B. GLUTINOSA GROUP.

This group comprises seven North African species, of which four are known all over North Africa, viz. *F. glutinosa*, *F. microphylla*, *F. latifolia* and *F. isotricha*; one is endemic in the Sahara, viz. *F. harpago*; and two are limited to Egypt, viz. *F. tristis* and *F. mollis*.

C. SINAICA GROUP.

This is represented in North Africa by three species. *F. cretica* is found on the coastal rocky plateaux of the Mediterranean region; *F. sinaica* in the northern parts of the Sahara, and *F. bischarorum* (or *F. flamandi*) in the southern parts of the same.

Altogether 22 species of *Fagonia* are known to occur in North Africa. Of these, 10 are of common occurrence, while 8 are limited to Egypt and 4 to the Sahara.

Egypt with its central position within the Saharo-Sindian belt contains the greatest number of species and endemics. This may suggest that Egypt is the centre of origin for most of these taxa.

The author is greatly indebted to Professor Dr. Vivi TÄCKHOLM, Botany Department, Faculty of Science, Cairo University, for her invaluable suggestions and help and also for her kindness in putting the collections and library of the University Herbarium at his disposal.

Also the author wishes to express his deep gratitude to the staff of the Conservatoire botanique in Geneva, especially to its director, Prof. J. MIÈGE, and to Dr. BONNER and Mr. GREUTER, for completing the bibliographical citations and checking the nomenclature, which is a very difficult task unless one has a good library at one's disposal. The artist of the same institute, Miss GUIBENTIF, has kindly redrawn some of the original tables.

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BIBLIOGRAPHY

ANDREWS, F. W. 1950. *The flowering plants of the Anglo-Egyptian Sudan* : 124-125. T. Buncle & Co. Ltd. Arbroath.

ASCHERSON, P. & SCHWEINFURTH, G. 1889. Illustration de la Flore d'Egypte. *Mém. Inst. Egypt.* 2 : 56.

BLATTER, E. 1919. Flora Arabica. *Rec. Bot. Surv. India* 8 : 97.

BOISSIER, E. 1867. *Flora Orientalis* 1 : 906-908. Genève.

BONNET, E. & BARRATTE, G. 1896. *Catalogue raisonné des plantes vasculaires de la Tunisie* : 88-89. Paris.

BORMÜLLER, J. 1939. Aus der Pflanzenwelt von Iranisch-Balutschistan und der angrenzenden Wüste Lut. *Beih. Bot. Centralbl.* sect. B, 59 : 293.

BOULOS, L. 1966. A natural history of Kurkur Oasis, Libyan Desert, Egypt. 4. The Vegetation. *Yale Peab. Mus. Nat. Hist. Postilla* 100: 1-22.

BOULOUMOY, L. 1930. *Flore du Liban et de la Syrie* : 70. Paris.

BURTT, B. L. & LEWIS, P. 1954. On the Flora of Kuweit. III. *Kew Bull.* 1954 : 394-396.

CUFODONTIS, G. 1956. Enumeratio Plantarum Aethiopiae. Spermatophyta. *Bull. Jard. Bot. Etat Bruxelles* 26 : 356-358.

DARLINGTON, C. D. 1955. *Chromosome Atlas of flowering plants*, ed. 2: 82. G. Allen & Unwin Ltd. London.

DECAISNE, J. 1834. Florula Sinaica. Enumération des plantes recueillies par M. Bové dans les deux Arabies, la Palestine, la Syrie et l'Egypte. *Ann. Sci. Nat.* ser. 2, 3 : 280.

DELILE, A. R. 1813. Flore d'Egypte. Explication des planches. *Mémoires botaniques extraits de la " Description de l'Egypte "* 5 : 76, 86-87. Impr. impériale, Paris.

EIG, A. 1932. Les éléments et les groupes phytogéographiques auxiliaires dans la flore palestinienne. *Feddes Rep. Beih.* 63/2 : 68.

ERDTMAN, G. 1952. *Pollen morphology and plant taxonomy*, Angiosperms : 6-9, 12-20. Almqvist & Wiksell. Stockholm.

FORSKÅL, P. 1775. *Flora Aegyptiaco-Arabica* : 88. Havniae (Copenhagen).

GLOVER, P. E. 1947. *A provisional check list of British and Italian Somaliland trees, shrubs and herbs.* Crown agents for the colonies. London.

HART, H. C. 1891. *Some account of the fauna and flora of Sinai, Petra, and Wady Arabah* : 87. London.

JOHNSTON, I. M. 1924. Expedition of the California Academy of Science to the Gulf of California in 1921. The Botany (vascular plants). *Proc. Calif. Acad. Sci.* ser. 4, 4 : 951-1218.

KITAMURA, S. 1960. *Flora of Afghanistan*: 249. Kyoto Univ.

KRAUSE, K. 1905. Beiträge zur Kenntnis der Flora von Aden. *Bot. Jahrb.* 5 : 41, 59.

MONOD, Th. 1952. Contribution à l'étude du peuplement de la Mauritanie. Notes botaniques sur l'Adrar (Sahara occidental). *Bull. Inst. Fr. Afr. Noire* 14 : 433.

MURBECK, S. 1897. Contribution à la connaissance de la Flore du Nord-Ouest de l'Afrique, I. *Acta Reg. Soc. Physiogr. Lund* 10/1 : 55.

NAGÉLÉ, A. 1958. Contributions à l'étude de la flore et des groupements végétaux de la Mauritanie. *Bull. Inst. Fr. Afr. Noire* 20 : 901.

OLIVER, D. 1868. *Flora of Tropical Africa* : 287. L. Reeve & Co. Ltd. Ashford, Kent.

OPPENHEIMER, H. R. 1930. Florula Transiordanica (Reliquiae Aaronsohnianae I). *Bull. Soc. Bot. Genève* 22 : 220.

OPPENHEIMER, H. R. & EVENARI, M. 1940. Florula Cisiordanica (Reliquiae Aaronsohnianae II). *Bull. Soc. Bot. Genève* 31 : 308.

OZENDA, P. & QUÉZEL, P. 1956. Les Zygophyllacées de l'Afrique du Nord et du Sahara, *Trav. Inst. Rech. Sah.* 14 : 23-64.

PARSA, A. 1951. *Flore de l'Iran* 1 : 1478-1481. Danesh, Teheran.

PATZAK, A. 1963. Zygophyllaceae. In KØIE, M. & RECHINGER, K. H. Symbolae Afghanicae V. *Biol. Skr. Dan. Vid. Selsk.* 13/4 : 14.

PORTER, D. M. 1963. The taxonomy and distribution of the Zygophyllaceae of Baja California, Mexico. *Contr. Gray Herb. Harw. Univ.* 192 : 99-125.

POST, G. E. 1932. *Flora of Syria, Palestine and Sinai* ed. 2 (by J. E. DINSMORE), 1 : 266-269. American Press, Beirut.

RAMIS, A. I. 1929. *Bestimmungstabellen zur Flora von Aegypten* : 124-125. Gustav Fischer, Jena.

RECHINGER, K. H. 1952. Zur Flora von Palästina und Transjordanien. *Ark. Bot.* 2 : 380.

— 1959. Zur Flora von Syrien, Libanon und den angrenzenden türkischen Gebieten. *Ark. Bot.* 5 : 278.

SCHWARTZ, O. 1939. Flora des tropischen Arabien. *Mitt. Inst. Allg. Bot. Hamburg* 10 : 119-120.

SCHWEINFURTH, G. 1899. Sammlung arabisch-äthiopischer Pflanzen. *Bull. Herb. Boiss.* 7, app. 2 : 274-277.

SICKENBERGER, E. 1901. Contribution à la Flore d'Egypte. *Mém. Inst. Egypt* 4 : 200-201.

STANDLEY, P. C. 1911. The American species of Fagonia. *Proc. Biol. Soc. Wash.* 24 : 243-250.

TÄCKHOLM, V. et al. 1956. *Students' Flora of Egypt* : 256-258. Anglo-Egyptian Bookshop, Cairo.

THIÉBAUT, J. 1936. Flore Libano-Syrienne I. *Mém. Inst. Egypt.* 31 : 161.

WODEHOUSE, R. P. 1959. *Pollen grains, their structure, identification and significance in science and medicine* : 106-107. Hafner Publ. Co., New York.

ZOHARY, M. 1950. *The flora of Iraq and its phytogeographical subdivisions* : 98. Gov. Press, Baghdad.