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Autecology of common Egyptian *Fagonia* species

By

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With 7 Figures

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1. Introduction

The family *Zygophyllaceae* is represented by 8 genera and 28 species in Egypt (TÄCKHOLM 1956). One of the important genera belonging to this family is *Fagonia*. The genus comprises numerous species growing in different phytogeographical regions in Egypt. Regarding the habitats in which these species grow, they have widely different environmental conditions. The autecology of some common species is studied in the present investigation.

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2. The genus *Fagonia*

The genus *Fagonia* comprises about 40 species which are recorded in the Mediterranean and Saharo-sindian regions, subtropical regions of North and South America and South Africa. PORTER 1963 states that *Fagonia* is a genus known from the warm arid regions of all continents except Australia. North Africa may be considered the centre of distribution of the genus in the Old World. OLIVER 1868 recorded its presence in different localities in Algeria, Tunisia, Tripolitania, Palestine, Syria, Arabia petraea, Mesopotomia and Persia. BLATTER 1914 found that *F. parviflora* is present in Aden, Nubia, Upper Egypt, Abyssinia, S. Arabia and S. Persia. POST

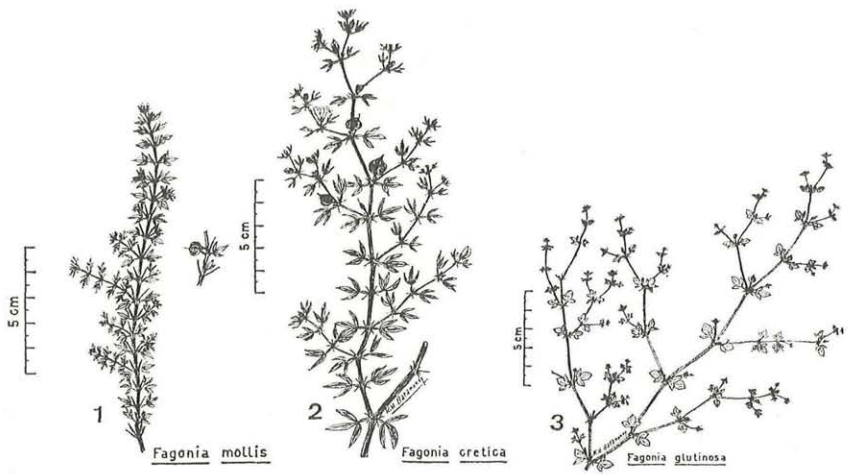

Fig. 1—3. Drawings of *Fagonia mollis* (1), *F. cretica* (2) and *F. glutinosa* (3)

1932 recorded *Fagonia* spp. in Syria, Palestine and Sinai. KOIE & RECHINGER 1963 recorded *F. bruguieri* and *F. parviflora* in Afghanistan. RECHINGER 1964 & AL RAWI 1964 recorded *F. glutinosa*, *F. bruguieri*, *F. myriacantha*, *F. olivieri* and *F. parviflora* in Iraq. OZENDA & QUÉZEL 1956 studied the *Zygophyllaceae* of the North African Sahara and classified the different *Fagonia* species growing there into three natural groups. A plan which is followed by EL HADIDY 1966 for the Egyptian species.

In Egypt, MUSCHLER 1912, RAMIS 1929, POST 1932 and MONTASIR & HASSIB 1956 recorded 10 species of *Fagonia*. TÄCKHOLM 1956 described 12 species, while EL HADIDY 1966 described 18 species of *Fagonia* and constructed an artificial key for their identification. The latter author classified the *Fagonia* species in Egypt into three groups. These groups are:

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

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

3. The *sinica* group, including *F. sinica*, *F. cretica* and *F. bisharorum*.

3. The studied species

In the present study, selected species representing the above mentioned three groups are taken into consideration. The studied species are: *F. mollis*, *F. cretica*, *F. glutinosa*, *F. bruguieri*, *F. parviflora* and *F. arabica*. These species inhabit different habitats with widely different environmental conditions. A concise description is given for each species as follows:

1. *Fagonia mollis* Delile (= *F. grandiflora* Boiss.) (Fig. 1).

A small shrublet, nearly mat-shaped with quadrangular branches. Internodes longer than the short-petioled trifoliate leaves. Spines densely crowded, and as long as the internodes. Capsules 5 mm broad, 5 mm long with deciduous calyx.

2. *Fagonia cretica* L. (Fig. 2).

A perennial, dark-green, glabrous plant with prostrate quadrangular branches. Leaves trifoliate on short petioles. Spines shorter than petioles. Fruit 10 mm broad, 7 mm long on short, thick, reflexed peduncles, with deciduous calyx.

3. *Fagonia glutinosa* Delile (Fig. 3).

A perennial, prostrate, pubescent, pale-green plant with long internodes, usually covered with adherent sand. Leaves trifoliate, the central one twice as large as the lateral ones. Spines short, as long as petioles. Capsule 5 mm broad, 5 mm long covered with hairs and carried on short hairy reflexed peduncles, with persistent calyx.

4. *Fagonia bruguieri* DC. (= *F. echinella* Boiss.) (Fig. 4).

A small perennial, procumbent, pale-green plant, attaining a height of 20 cm, with quadrangular stems and short internodes. Leaves trifoliate. Spines as long as leaves or longer, slightly recurved. Capsules 3—4 mm broad, 4 mm long on reflexed peduncles nearly as long as the capsule. Fruit-calyx persistent.

5. *Fagonia parviflora* Boiss. (= *F. indica* Burm. = *F. persica* DC.) (Fig. 5).

A small pale-green shrublet with erect branches and elongated internodes. Leaves short-petioled, unifoliate. Spines slender as long as the leaves. Capsule 4 mm broad, 4 mm long on reflexed, slender peduncles, twice as long as the capsule. Fruit-calyx persistent.

6. *Fagonia arabica* L. (Fig. 6).

A small erect shrublet attaining a height of 30—50 cm. The plant is glandular, pubescent with trifoliate leaves below and unifoliate above. Spiny stipules longer than the leaves, nearly as long as the internodes. Capsule 5—7 mm broad, 3—5 mm long, carried on reflexed peduncles nearly as long as the capsules. Fruit calyx deciduous.

4. Distribution of the studied species in Egypt

The distribution of the six studied species in Egypt is interesting. If one eleminates the localities in which a species is rare and considers only the localities with prosperous growth of the studied species, one may infer the

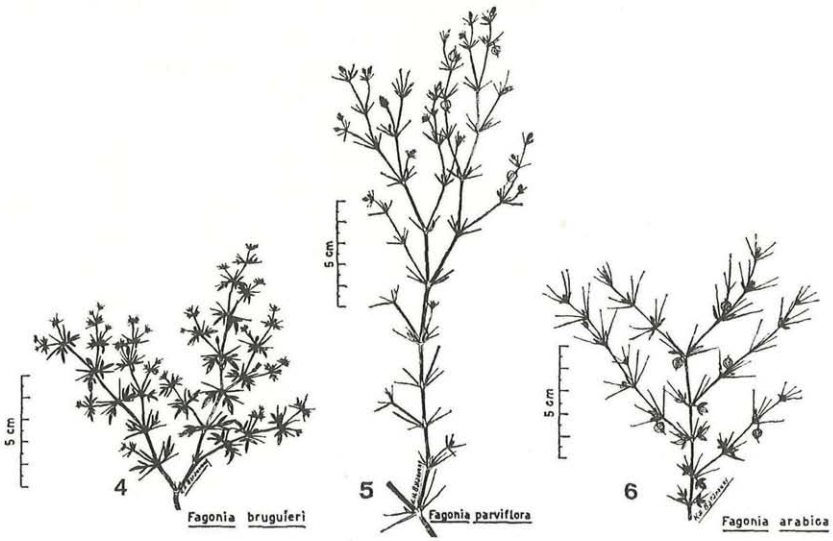

Fig. 4—6. Drawings of *Fagonia bruguieri* (4), *F. parviflora* (5) and *F. arabica* (6)

following: 1. *Fagonia mollis* is common in the limestone wadis of the northern Arabian desert, north of wadi Qena and southern Sinai. — 2. *Fagonia cretica* is restricted to the Mediterranean coastal region. — 3. *Fagonia glutinosa* grows in the gravelly and sandy areas of the northern Arabian desert, particularly along Cairo-Suez road, and some parts of the Lybian desert. — 4. *Fagonia bruguieri* grows in the sandy areas of the northern and southern Arabian desert. — 5. *Fagonia parviflora* is common in the southern Arabian desert south of wadi Qena. — 6. *Fagonia arabica* grows in the habitats of *F. glutinosa* and also in the Isthmic desert and the Oasis.

In addition to the above mentioned localities, these species may grow elsewhere, but with lower density and negligible cover. The geographical distribution of these species is illustrated in Fig. 7.

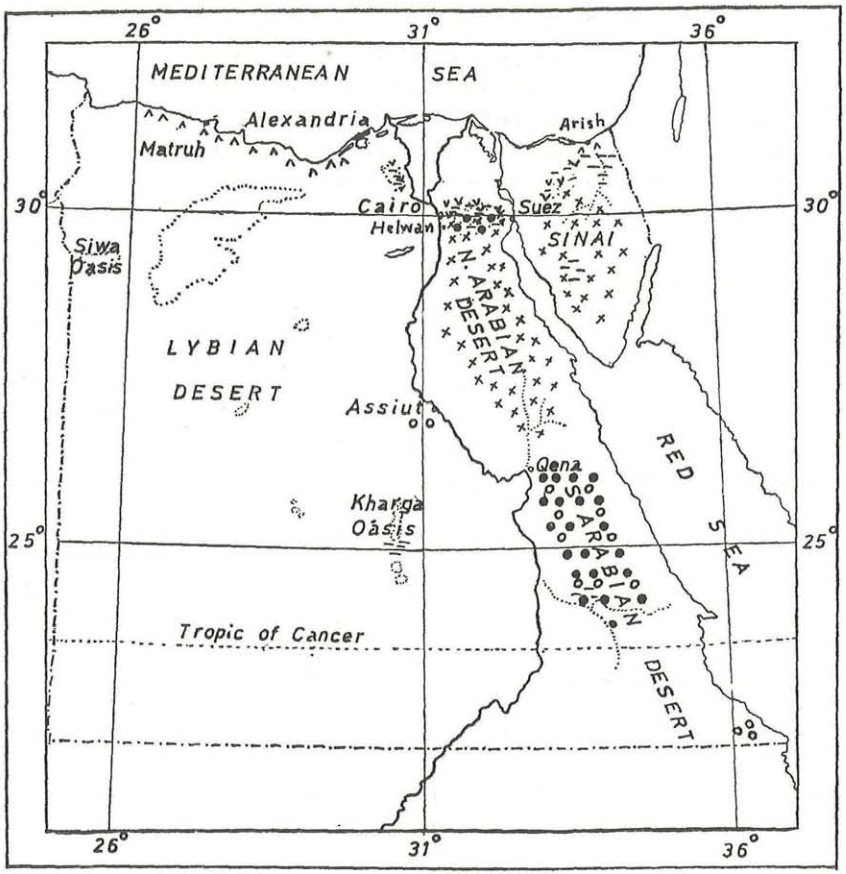

Fig. 7. Map showing the distribution of the studied *Fagonia* species in Egypt. — *F. mollis*: × ; *F. cretica*: ∧ ; *F. bruguieri*: ● ; *F. parviflora*: ○ ; *F. glutinosa*: ∨ ; *F. arabica*: —

5. Habitat and communities

5.1. *Fagonia mollis*

This species is common in the wadis of the northern Arabian desert in the limestone country. It is not met with in the gravel deserts and Nubian sandstone territories in the southern part of the same desert. It is a chasmophyte of genuine affinity to the rocky habitat. The wadis crossing the limestone plateau in the northern Arabian desert represent favourable home for *F. mollis*. The wadi habitat is distinguished into numerous micro-habitats (Abdel Rahman & Batanouny 1966). *F. mollis* is common in the affluent runnels leading to the main wadi, a habitat characterised by

the presence of blocks and boulders, with shallow soil and limited water resources. This species may grow in the pockets of barren rocks.

F. mollis grows in soils with high carbonate content ranging from 15.22 to 23.3% (Table 1). Soils supporting this species have higher salt content than soils supporting other studied *Fagonia* species. The total soluble salts content ranges from 0.40 to 0.72% (Table 1).

Table 1

Analysis of soils supporting the studied *Fagonia* spp. in different localities. (Samples collected from the root zone, approximately from 25—50 cm)

Species	Locality	Total soluble salts (%)	Chlorides (%)	Calcium carbonate (%)
F. mollis	Wadi Hoff (Helwan)	0,72	0,230	23,2
	Wadi Aber (Suez)	0,60	0,210	18,3
	Cairo-Suez road	0,40	0,080	15,2
F. glutinosa	Cairo-Suez road	0,07	0,011	3,8
	Lybian desert	0,06	0,010	1,5
F. arabica	Cairo-Suez road	0,20	0,092	5,6
	Cairo-Suez road	0,10	0,037	1,3
	Wadi El Arish	0,40	0,101	2,6
F. bruguieri	Cairo-Suez road	0,12	0,180	5,7
	Cairo-Suez road	0,42	0,093	8,2
	Wadi El Kharit (S. Arabian desert)	0,05	0,003	1,2
F. parviflora	Wadi El Shait (S. Arabian desert)	0,05	0,002	2,3
	Wadi El Natash (S. Arabian desert)	0,04	0,001	2,0
F. cretica	Ras El Hikma	0,08	0,013	25,1
	Burg El Arab (Mediterranean region)	0,09	0,002	17,7

The meteorological data from Helwan and Suez stations represent those prevailing in areas inhabited by *F. mollis*. Such data, given in Table 2, show drastic desert conditions of drought and high evaporation rates. Runoff may contribute to the water resources of habitats inhabited by *F. mollis*, but it is noteworthy that this species may grow on stepped cliffs in wadis, a habitat with limited water resources.

The phytosociological studies of stands with *F. mollis*, shown in Table 3, reveal that among the associates of this species there are 13 species that do not grow in habitats supporting other studied *Fagonia* species. The most important of these special associates are: *Erodium glaucophyllum*, *Diplotaxis harra*, *Reaumuria hirtella*, *Helianthemum kahiricum*, *Iphiona mucronata* and *Achillea fragrantissima*.

Table 2

Comparison of Meteorological data of different stations in various localities in which the studied *Fagonia* species grow (Data obtained from the Meteorological Department, Egypt)

Factor		Mersa Matruh	Arish	Almaza (near Cairo)	Suez (Port Tewfik)	Helwan	Qena
Rainfall	Annual mean (mm)	158	97	27	26.5	31	4
	No. of rainy days with at least 1 mm/year	21.7	17.1	5.6	4.5	6.4	1.1
Temperature (°C)	Mean of January	12.4	12.0	12.8	13.8	12.3	13.2
	Mean of July	24.7	25.4	27.9	28.4	27.5	32.0
	Annual mean	19.1	19.5	21.1	21.7	20.8	24.0
Relative Humidity (%)	Mean of January	76	75	61	68	61	63
	Mean of July	81	76	59	62	51	31
	Annual mean	76	74	59	64	54	44
Evaporation (mm/day)	Mean of January	6.4	3.4	7.1	5.1	5.2	3.3
	Mean of July	6.9	5.1	12.5	13.2	15.3	11.8
	Annual mean	7.2	4.6	9.8	9.3	10.8	7.7

Kassas et al. 1962, 1964 & 1965 recorded *Fagonia mollis* in 6 community types in the eastern part of Cairo-Suez road, 7 types in the wadis east of the Nile and north of wadi Qena, all inhabiting limestone territories.

5.2. *Fagonia cretica*

This species is restricted to the Western Mediterranean littoral zone of Egypt. It is not found in the inland deserts. Oliver 1945—6 stated: "Its distribution is peculiar and is best described by the statement that it occurs in the most unexpected places including ridges, hill sides, lake bed, desert plateaus and even dune areas". He considered in some detail the means of seed dispersal in this plant.

F. cretica grows in habitats with fine-textured, compact soils: barley fields, beside hedges and walls. Wherever it occurs, it usually grows showing considerable gregariousness. This may be attributed to high seed productivity and accumulation of ejaculated seeds beside the walls and hedges.

Sharkawy 1960 recorded *F. cretica* as on of the companions of the associations belonging to the alliance Thymelaeion hirsutae at Ras El Hikma in the Mediterranean region.

Analysis of soil samples from the root zone of this species shows that the soils supporting it have high content of carbonates ranging from 17.7 to 25.1% (Table 1) and low soluble salts content amounting to 0.09%. This means that *F. cretica* and *F. mollis* are the two species supported by soils with high carbonate content, but the latter inhabits soils with higher salinity.

The meteorological data collected from Mersa Matruh station represent those prevailing in the habitat of *F. cretica*. This shows (Table 2) that *F. cretica* grows under mild climatic conditions with higher rainfall than the inland desert. The geographical restriction of this species may be attributed to the severe drought in inland deserts. Decrease of rainfall towards inland deserts is associated with the disappearance of *F. cretica*.

The phytosociological data shown in Table 4 show that there are 38 species growing with *F. cretica* in the four stands studied. Eight species of these associates show presence values higher than 50%. These species are: *Koeleria phleoides*, *Centaurea glomerata*, *Chrysanthemum coronarium*, *Echium serecium*, *Carrechtera annua*, *Moricandia nitens*, *Salvia lanigera*, *Filago spathulata*, *Pithyranthus tortuosus*, and *Atriplex halimus*. All except the latter three species grow mainly in the Mediterranean region.

5.3. *Fagonia glutinosa*

This species is more favoured in sand formations in the northern Arabian desert, and is rarely found in the Lybian and Isthmic deserts. It may grow in some wadis of the northern Arabian desert, but in localities with sandy accumulations. *F. glutinosa* is not recorded in the southern part of the Arabian desert. Though it may grow in soils of limestone origin, but it seems to prefer soils of sandstone origin. The gravel deserts along Cairo-Suez road represent favourable habitat for *F. glutinosa*. This species may grow *associated* with *F. arabica*, but usually in shallower soils.

Analysis of soils supporting *F. glutinosa* (Table 1) shows that carbonate and salt contents are lower than in soils supporting other *Fagonia* species. It grows under the same climatological conditions of *F. arabica*. The latter is of wider geographical distribution. This may be attributed to the tolerance of *F. arabica* to wider ranges of carbonate and soluble salts contents.

The meteorological data collected from Almaza and Suez stations represent climatic conditions under which *F. glutinosa* thrives. Such data

Table 3 : Species lists showing the composition of the vegetation in the different habitats inhabited by the studied Fagonia species
Each species is given a figure representing the combined abundance-dominance scale (Braun-Blanquet 1964)

Species	Fagonia mollis							Fagonia glutinosa						Fagonia arabica						Fagonia bruguieri						F. parviflora		
	Wadis of the northern Arabian desert					Red Sea wadis		Gravel desert Cairo-Suez road			Lybian Cairo-Alex road			desert Alexandria	Gravel desert Cairo-Suez road		Wadi El Arish			Gravel desert Cairo-Suez road	Wadis of north. Arabian desert		Wadis of the southern Arabian desert					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Fagonia mollis Del.	1	1	1	2	2	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fagonia glutinosa Del.	+	.	.	.	.	.	.	+	1	1	1	2	1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Fagonia arabica L.	.	.	.	.	.	.	.	.	+	+	+	.	.	2	1	1	1	1	1	.	.	.	.	.	.	.	.	.
Fagonia bruguieri DC.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	2	+	.	.
Fagonia parviflora Boiss.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	1
Zilla spinosa Prantl.	1	2	.	.	.	+	+	1	1	+	+	.	+	.	.	1	+	.	.	1	1	2	1	1	.	2	+	1
Zygophyllum coccineum L.	2	1	1	.	+	+	.	.	+	1	2	.	.	.	.	1	+	.	.	.	.	1	.	.	.	+	.	+
Zygophyllum simplex L.	.	.	.	+	.	.	.	+	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	+	+	.	+
Schismus barbatus Thell.	.	+	.	.	.	.	.	+	.	.	.	+	+	+	+	+	.	.	.	+	+	.	.	.	.	.	.	.
Plantago ovata L.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.
Cotula cinerea Del.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	+	.	+
Aristida plumosa L.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	+	.	.	.	+	.	.	.	.	+	.	+	.	.
Panicum turgidum Forsk.	.	.	.	.	.	.	.	1	1	1	1	.	+	.	2	1	+	1	1	.	.	.	.	.	.	.	.	.
Iflega spicata Sch.Bip.	.	.	.	.	.	.	.	+	.	.	.	+	1	+	.	+	.	.	.	.	.	.	+	.	.	.	.	.
Polycarpea repens Asch.&Schweinf.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.
Filago spathulata Perol.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.
Halexylon salicornicum Boiss.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	2	.	.	.	.	+	.	.	+	.	.	.	.
Parenychia desertorum Boiss.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.
Farsetia aegyptiaca Turra.	.	.	.	1	.	+	.	+	+	+	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Trigonella stellata Forsk.	.	+	.	+	.	.	.	+	.	+	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.
Pithyranthus tortuosus Benth.&Hook.	.	.	.	.	.	.	1	.	.	.	.	+	1	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.
Erodium glaucophyllum L'Her.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diplotaxis harra Boiss.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Reaumuria hirtella Jaub.&Spa	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Helianthemum kahiricum Del.	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Iphiona mucronata Asch.&Schweinf.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Achillea fragrantissima Sch.Bip.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Launaea spinosa Sch.Bip.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leptadenia pyrotechnica Decne.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Fagonia kahirina Boiss.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trichedesma africanum R.Br.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex vesicarius L.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ochradenus baccatus Del.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Diplotaxis acris	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zygophyllum decumbens Del.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Asteriscus graveolens Less.	.	+	2	+	+	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Centaurea aegyptiaca L.	.	+	.	1	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pergularia tomentosa L.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Retama raetam Forsk.	.	.	.	.	.	.	+	.	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia kahirensis Reauch.	.	.	.	.	.	.	.	+	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Linaria aegyptiaca Dum.Cours.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.
Salvia aegyptiaca L.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Astragalus bombycinus Boiss.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Atractylis flava Desf.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Launaea nudicaulis Hook.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Erodium bryoniifolium Boiss.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Echinops spinosissimus Turra.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Launaea cassiniana Ktze.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Zygophyllum album L.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Neurada procumbens L.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Haplophyllum tuberculatum A.Juss.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Astragalus spinosus Forsk.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Mesembryanthemum forskalei Hockst.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.
Convolvulus lanatus Vahl.	.	.	.	.	.	.	.	.	.	+	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia monosperma Del.	.	.	.	.	.	.	.	.	.	.	.	+	1	+	1	.	1	.	.	.	.	.	.	.	.	.	.	.
Hyoscyamus muticus L.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Meltkea callosa Wettst.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.
Astenstherum forskalei Nevski.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.
Eremobium lineare Asch.&Schweinf.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Cleome arabica Jasl.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Lasiurus hirsutus Boiss.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.
Plantago albicans L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
Pancratium sickenbergeri Asch.&Sch.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Cyperus conglomeratus Rottb.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Convolvulus elarishensis Boulos	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Pithyranthus triradiatus Asch.&Sch.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Cornulaca monacantha Del.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.
Artemisia judaica L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.
Matthiola livida DC.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.
Colocynthis vulgaris Scherd.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	1	+	+	.	.	.
Aerva persica Meril.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	+	1	.	+
Astragalus vegeli Bornm.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.
Acacia flava Schweinf.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	2
Acacia raddiana Savi	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+
Astragalus eremophilus Boiss.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	+
Morettia philaena DC.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+
Schouwia thebaica Webb.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.
Tribulus longipetalus Viv.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Cassia alexandrina Thell	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Lotonesis platycarpa Viv.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.

(Table 2) show that this species lives under dry conditions of low rainfall (about 27 mm annually), high evaporation rate amounting to 13.2 mm/day in July in Suez station, and high temperatures particularly during summer months. The prostrate body of this plant is close to the soil surface where temperature is high during summer months. SHALABY 1958 found that the soil surface may attain a temperature reaching 57° C in summer along the Cairo—Suez road in localities occupied by *F. glutinosa*.

Vegetation study (Table 3) shows that there are special associates growing only with *F. glutinosa*. These species are: *Euphorbia kahirensis, Salvia aegyptiaca, Aastrgalus bombycinus, Erodium bryoniifolium, Echinops spinosissimus* and *Launaea cassiniana*. Moreover, there are 10 species associated with both *F. glutinos* and *F. arabica*. This means that these two species are ecologically related.

KASSAS & IMAM 1959 recorded *F. glutinosa* growing with 5 community types out of the thirteen types that they defined in the gravel desert along Cairo-Suez road. They found that it is very common in water runnels across Oligocene and non-marine Miocene gravel showing high presence (P = 100%) in the community dominated by *Lasiurus hirsutus*. KASSAS & EL ABYAD 1962 found that *F. glutinosa* has a presence value of 50% in the community type dominated by *Zygophyllum coccineum* and with values less than 50% in other 11 community types in the eastern limestone country along Cairo—Suez road.

5.4. *Fagonia bruguieri*

This species grows in widely different habitats. It is common in many parts of the gravel desert, limestone wadis and Nubian sandstone wadis. The plants grows with considerable presence values in the affluent runnels crossing the Pliocene gravels as well as in the Eocene limestone. Analysis of soils supporting this species shows that it tolerates a wider range of total soluble salts than other studied species. The carbonate content though lower than in soils supporting both *F. mollis* and *F. cretica* but with wider range than the other studied species ranging from 1.2 to 8.2%.

The meteorological data from Helwan, Almaza, Suez and Qena may represent the climatic conditions under which this species grow. The wide range of rainfall, from 4 mm in Qena to 31 mm in Helwan, shows that this species can thrive under dry conditions with very low rainfall. Under such dry conditions, particularly of the southern Arabian desert, the plant acquires an ephemeral habit (GIRGIS 1965).

The vegetation studies (Table 3) show that there are no species restricted to communities of *F. bruguieri*. On the other hand, there are some species associated with it and other studied *Fagonia* species. This may be explained by the wider ecological range of this species than the others.

This species was recorded in 9 community types along Cairo—Suez road in both sandstone and limestone territories (KASSAS et al. 1959 &

Table 4

Species lists showing the composition of the vegetation in the different stands inhabited by *F. cretica* along the western Mediterranean coastal zone

Species	Burg El Arab		Ras El Hikma	
	1	2	3	4
Fagonia cretica L.	2	1	1	1
Koeleria phleoides PERS.	1	1	+	+
Centaurea glomerata VAHL.	+	+	+	+
Chrysanthemum coronarium L.	1	2	+	–
Moricandia nitens VIV.	–	1	1	+
Echium serecium VAHL	–	+	+	+
Carrechtera annua L.	–	+	+	+
Pithyranthus tortuosus BENTH. & HOOK.	–	+	+	+
Salvia lanigera POIR.	–	+	+	+
Filago spathulata PRESL.	–	+	+	+
Atriplex halimus L.	–	+	+	+
Erucaria microcarpa BOISS.	+	+	–	–
Malva parviflora L.	–	+	+	–
Reseda decursiva FORSK.	+	+	–	–
Enarthrocarpus strangulatus BOISS.	+	+	–	–
Anacyclus alexandrinus WILLD.	+	+	–	–
Vicia cinerea M. BIEB.	+	+	–	–
Launaea nudicaulis L.	–	+	+	–
Carthamus mareoticus DEL.	–	+	+	–
Emex spinosus CAMPD.	–	+	+	–
Calendula micrantha TINEO & GUSS.	–	+	+	–
Picris radicata LESS.	–	–	+	+
Adonis dentata DEL.	–	+	+	–
Matthiola humilis DC.	+	–	–	+
Trigonella maritima DEL.	–	–	+	+
Eryngium creticum LAM.	1	–	–	–
Lolium perenne L.	+	–	–	–
Bromus tectorum L.	–	+	–	–
Teucrium polium L.	–	+	–	–
Parapholius incurva L.	–	–	–	+
Erodium hirtum WILLD.	–	–	–	+
Onopordon alexandrinum BOISS.	–	+	–	–
Thymelaea hirsuta ENDL.	–	–	+	–
Verbascum letourneuxii	–	–	–	+
Mesembryanthemum nodiflorum L.	+	–	–	–
Papaver rhoeas L.	+	–	–	–
Thesium humile VAHL	+	–	–	–
Anagallis arvensis L.	+	–	–	–
Chenopodium murale L.	+	–	–	–

1962). *F. bruguieri* by contrast to *F. glutinosa* and *F. arabica*, is common in the southern Arabian desert mainly of Nubian sandstone. GIRGIS 1965 recorded it in eleven community types with presence values higher than 50% in three of them. These are *F. bruguieri*, *Crotalaria aegyptiaca* and *Zilla spinosa* community types in the limestone and Nubian sandstone territories to the north and south of wadi Qena. KASSAS & GIRGIS 1964 found it growing in 2 community types in the limestone country extending to the east of the Nile in the northern Arabian desert.

5.5. *Fagonia parviflora*

This species has a narrow geographical range and is mainly restricted to the southern part of the Arabian desert and Gebel Elba. This species grows rarely in margin lands of the Nile Valley particularly in Assiut vicinity. Soils supporting this species have low soluble salts and carbonate contents.

The meteorological data of Qena station represent the conditions under which this species lives. As evident from Table 2, this species lives under drier conditions than the other studied species. Rainfall in the localities inhabited by this species is very scarse and sporadic amounting to an average of 4 mm per year.

The vegetation studies (Table 3) show that there are 5 species confined to plant growth with *F. parviflora*, these are *Morettia phileanae*, *Schouwia thebaica*, *Cassia alexandrina*, *Tribulus longipetalus* and *Lotononis platycarpa*. Moreover, there are 5 species which grows with *F. pariflora* and *F. bruguieri*. Other few species grow with *F. parviflora* and the studied *Fagonia* species. GIRGIS 1965 found that *F. parviflora* is moderately represented in 4 community types ($P<50\%$), and with higher presence value in the community type dominated by *Schouwia thebaica* in the southern Arabian desert.

5.6. *Fagonia arabica*

This species grows in sandy soil with low carbonate and soluble salt contents (Table 1). It may grow in sandy accumulations of limestone origin, but with low density. The sandy plains and deep runnels transecting the gravel deserts represent the most favourable habitat for *F. arabica*.

F. arabica lives under wide range of climatic conditions, e. g., Almaza, Helwan, Suez, and El Arish (Table 2).

Vegetation studies (Table 3) show that there are 10 species associated with *F. arabica* and *F. glutinosa* and 4 species with *F. arabica* and *F. bruguieri*. This means that these species are ecologically related.

KASSAS et al. 1954 & 1962 recorded *F. arabica* in 3 community types in the gravel desert and in 8 community types in the limestone country along Cairo—Suez road. It grows with 4 community types in the limestone wadis of the northern Arabian desert (KASSAS & GIRGIS 1965), while GIRGIS 1965 found that it grows in one community type in the Qena region.

The species is of wide distribution, but with low abundance values, in other localities as wadi El Arish, Oases and Lybian desert.

6. Conclusions

The number of associate species with each couple of the studied ones may show how far these *Fagonia* species are ecologically related. The floristic composition of the studied stands (Table 3 & 4) show that there are couples of species which are ecologically related, except *F. cretica* which has its own ecological amplitude. The following couples may be distinguished with respect to their ecological relations: a) *F. mollis* and *F. glutinosa*; b) *F. glutinosa* and *F. arabica*; c) *F. arabica* and *F. bruguieri* and d) *F. bruguieri* and *F. parviflora*. In other words, *F. mollis* and associates are not recorded in the habitats of *F. parviflora* and associates. This is shown by their distribution as shown in Fig 7. *F. mollis* has its special habitat comprising sandy places where *F. glutinosa* may grow. *F. glutinosa* and *F. arabica* are closely related They grow in the same habitat as evident from Table 3 in stands 9, 10 and 11, both grow in sandy areas. *F. arabica* has wider ecological and geographical ranges than *F. glutinosa*. This is evident from the distribution of both species.

F. bruguieri and *F. parviflora* are ecologically related. Both species are recorded by Girgis 1965 as associate species in the community type dominated by *Leptadenia pyrotechnica* in the area south of wadi Qena. *F. bruguieri* has wider ecological and geographical ranges than *F. parviflora*: the former can grow in the sandstone and limestone territories in the northern Arabian desert, while the latter species is restricted to the southern part of the Arabian desert of Nubian sandstone. *F. bruguieri* grows with *F. mollis* in the same habitat (Kassas & El Abyad 1962) with presence values of more than 50% in the community type dominated by *Zygophyllum coccineum* and *Launaea spinosa*. It could be stated that *F. mollis*, *F. parviflora* and *F. cretica* have narrow ecological and geographical ranges, while the other studied species have wider ranges than these species.

7. Summary

The Egyptian Zygophyllaceous species, though small in number, are important constituents of the desert vegetation. One of the important genera belonging to this family in *Fagonia*. This genus comprises about 18 Egyptian species. The distribution of these species is interesting. The autecology of 6 common species is studied. Although more than one species may be present in the same locality, yet each of these species seems to have its ecological limits. The studied species, particularly *F. parviflora*, withstand very dry conditions. The carbonate content and the total soluble salts vary widely in the habitats of the different species. The chemical nature of the soil parent material seems to effect the distribution of the

studied species. An ecological relation is observed between some species. Couples of ecologically related species could be distinguished. These are: a) *F. mollis* and *F. glutinosa*, b) *F. glutinosa* and *F. arabica*, c) *F. arabica* and *F. bruguieri* and d) *F. bruguieri* and *F. parviflora*.

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