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NOTES ON THE VEGETATION NEAR SUEZ AND FAYID (EGYPT)

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ABSTRACT

Data on the vegetation of four zones west of Suez and Fayid are presented. Edaphic conditions seem to be the most important factor influencing distribution of plant communities and richness of flora. The same factor also determines survival of plants after one or more extremely dry years.

INTRODUCTION

The vegetation of the Egyptian Desert east of the Nile was described by Davis (1953), Kassas (1952, 1953), Kassas and Imam (1954, 1959), Kassas and Zahran (1962) and Kassas and Girgis (1964, 1965). Several earlier studies are reviewed by Kassas and Zahran (1962). In the last months of 1973 the author visited some areas near Suez and Fayid where the vegetation had not been studied before. Observations made during this stay are reported below.

LOCATION, CLIMATE AND GEOMORPHOLOGY

According to Emberger's criterion (1951), the area concerned (Fig. 1) has a Saharan-Mediterranean climate with a pluviothermic quotient (Q) = 2 for Suez (Kassas and Zahran, 1962) and 12.8 for Port Said, more than 100 km north of Wadi el 'Ashara. Mean annual rainfall is 21 mm for Suez and 97 mm for Port Said, producing a north-south climatic gradient. As Wadi el 'Ashara, the most northern locality studied, is only 50 km northwest of Suez, its climate is presumably closer to that of Suez than of Port Said. Gebel 'Ataqa, reaching 871 m above m.s.l., though very close to Suez, has a different type of climate. It appears to have much more rainfall than Suez. Lichen cover here is much higher than in the other three zones.

According to Said (1962), the main geological and geomorphological features of the four zones studied are as follows:

Zone 1: Wadi el 'Ashara catchment area, a flat area of Miocene sandstones with gravel, with elevated points. Owing to pedogenetic processes, the upper layer of sandstone is rich in silt, gypsum and salt. Its depth and compactness greatly influence the infiltration of rain water. In the runnels, windblown sand accumulates near plants; its depth is a major factor in plant distribution.

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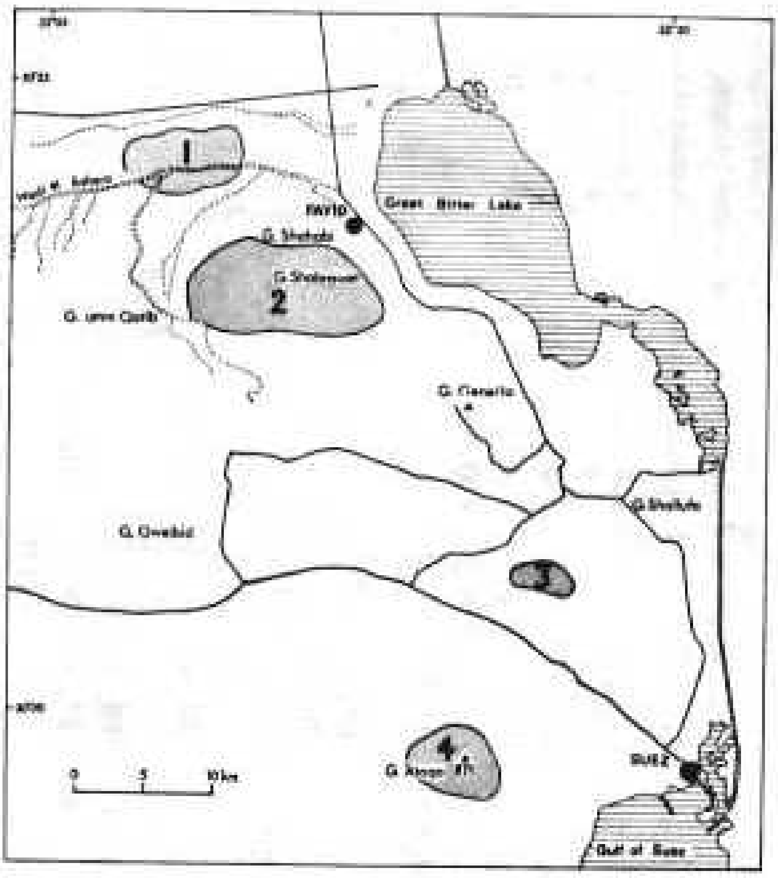

Fig. 1. Location map of Suez–Fayid area.

Zone 2: The hills between Gebel Shabrawet, Gebel Shahabi and Gebel Umm Qatib, of Upper Eocene sandy limestone and limestones. In many places the Eocene rocks are covered with Oligocene sandy conglomerate. Owing to a dense series of faults, the same rock type is exposed in different dips, and various rock types occur in the same geomorphic structure. This greatly influences the weathering of the strata as well as the availability of water to plants.

Zone 3: An area of Pleistocene to recent terrestrial sediments; mainly conglomerates of varying depth overlying earlier sediments. In the locality studied by the author, this conglomerate covered yellow-green marls.

Zone 4: Gebel 'Ataqa, between the altitudes of 700–870 m. This area is built up of hard horizontally-bedded Middle Eocene limestone interbedded with thin or heavy layers of marl and chalk. The limestone produced slopes alternating with low cliffs. At the bottom of runnels the limestone forms smooth outcrops very rare in the other districts. The soil on the slopes and in the wadis contains very small quantities of sand but is rich in silty components.

VEGETATION

Vegetation in the area is mainly confined to runnels, i.e., "Végétation contractée" (Monod, 1931). Kassas and Imam (1954) and Kassas and Girgis (1965) treat

TABLE I

SPECIES WITH HIGH PRESENCE AND COVER IN SEVERAL ASSOCIATIONS IN THE AREA STUDIED

Zone	*1. Wadi el 'Ashara*				*2. Hills near Gebel Shahabi*			*4. Gebel 'Ataqa*		
Association*	1	2	3	4	5	6	7	8	9	10
Number of records	14	14	13	5	6	3	5	6	5	6
Mean cover (in percent)	11	5	4	4	7	6	4	2	7	5
Number of species/record	11.5	5.7	6.9	6	10	8	6	7	16	10
Anabasis articulata (Forssk.) Moq.					50; 2	100; 3	100; 92	50; 3		
Artemisia monosperma Del.	100; 51**			80; 4	83; 8	67; 3				
Asparagus stipularis Forssk.										83; +
Centaurea aegyptiaca L.					67; +					
Convolvulus lanatus Vahl	71; 2	93; 21	100; 70		50; 7					
Cornulaca monacantha Del.				100; 1						
Echinops spinosus L.									80; +	
Ephedra alata Decne.					50; +		60; +			
Erodium hirtum Willd.								83; +		67; +
Fagonia arabica L.	57; +		85; 2	100; 71	83; 3					
Farsetia aegyptiaca Turra					87; 4	100; 3	60; +			
Gymnocarpos decander Forssk.						67; +			100; 18	100; 39
Heliotropium digynum (Forssk.) Aschers.			69; 5							
Helianthemum kahiricum Del.									80; 5	100; 3
Hyoscyamus muticus L.	64; 2			60; +						

Iphiona mucronata (Forssk.) Aschers. & Schweinf.									100; 26	83; 9
Kickxia aegyptiaca (L.) Nab.	71; +									
Lasiurus hirsutus (Forssk.) Boiss.					67; 8					
Limonium pruinosum (L.) Ktze.									100; 3	100; +
Lycium shawii Roem. & Schult.									60; +	
Panicum turgidum Forssk.	100; 20	100; 65	85; 15		100; 69	100; 23				
Paronychia desertorum Boiss.	50; +			60; +						
Phagnalon rupestris (L.) DC.									60; +	50; +
Pituranthos tortuosus (Desf.) Benth. ex Aschers. & Schweinf.	93; +	93; 8	69; 2		83; 2	100; 63			80; 9	
Reaumuria hirtella Jaub. et Sp.									80; +	67; +
Salsola tetrandra Forssk.								100; 92		100; 3
Stachys aegyptiaca Pers.									100; 30	100; 43
Stipa parviflora Desf.									60; +	67; +
Stipagrostis plumosa (L.) Munro ex T. Anders.	57; +		77; 4	60; +						
Zilla spinosa (L.) Prantl	93; 7	57; +	100; 21		50; +	67; +				
Total no. of species	32	23	19	17	22	14	16	17	32	25

* 1. *Artemisia monosperma-Panicum turgidum* assoc. 2. *Panicum turgidum-Convolvulus lanatus* assoc. 3. *Convolvulus lanatus-Heliotropium digynum* assoc. 4. FAGONIETUM ARABICAE. 5. *Panicum turgidum-Farsetia aegyptiaca* assoc. 6. *Pituranthos tortuosus-Panicum turgidum* assoc. 7. *Anabasis articulata-Farsetia aegyptiaca* assoc. 8. SALSOLETUM TETRANDRAE. 9. *Iphiona mucronata-Gymnocarpos decander* assoc. 10. *Gymnocarpos decander-Stachys aegyptiaca* assoc.

** Left column denotes presence (in percent), right column denotes mean relative cover (in percent).

the succession and climax of wadi vegetation in terms of the geological time scale. However, in accordance with Davis (1953), it would be more correct to say that the vegetation of each wadi, if not influenced by man, represents a climax vegetation adapted to local fluctuations of climate in the desert, and to the water regime of a certain edaphic type, given specific geomorphic and micro-topographic conditions. The species assemblage of any particular community is a result of competition between species growing at present in the area (cf. Friedman, 1969). In fact, in deserts rather different plant communities may grow in close proximity if their edaphic-geomorphic conditions are different (Danin, 1971).

In this work we shall follow Lipkin's (1971) scheme for determining and describing wadi vegetation in extreme desert conditions. According to Lipkin, the ecology and vegetation of a wadi changes continuously along its course. Consequently, a series of plant communities can be identified, usually by means of their dominant species; each segment representing an association (sensu Braun-Blanquet, 1932). Our vegetation records were prepared following the slightly modified Braun-Blanquet method (see Danin, Orshan and Zohary, 1964). In some cases, however, only sample records were made. Ephemeral species were generally not included in the records, as only few such species were available at the time. To quote Kassas and Girgis (1965): "Perennial species form the permanent framework of the desert vegetation", and these can indeed serve to differentiate the various plant communities. Detailed lists are available at the Department of Botany, The Hebrew University of Jerusalem. The species with high presence values in the association are included in Table I. Total cover of vegetation was noted in percentages of stand surface; the relative coverage of each species was subsequently marked in percentages of the total vegetation cover. In Table I, the mean relative cover was calculated only for the records where the species occurred. Authors of plant names not mentioned in the text are listed in Table I. Samples of all plants mentioned in this article are deposited in the herbarium of the Hebrew University of Jerusalem (HUJ).

Zone I: Wadi el 'Ashara Catchment Area

As far as vegetation is concerned, this area comprises two main types of dry water course: (1) Wadi el 'Ashara proper and (2) its tributaries. Over a distance of 26 km, Wadi el 'Ashara descends very gently from 125 m to sea level (mean slope, 0.48%). It is 100–200(–500) m wide; its bottom is silty sand along its entire course, with silt proportion increasing near Fayid. Here, the *Artemisia monosperma-Panicum turgidum* association is dominant, reaching the highest total cover of all associations in the zone and the greatest floristic diversity. It includes several species which are rather rare in other associations, e.g., *Hyoscyamus muticus*, *Echinops spinosus* and *Acacia raddiana* Savi. The frequency of shrubs of *Artemisia monosperma* and *Panicum turgidum* varies according to the width of the main streaming channel. Where it is narrow, *A. monosperma* exceeds *P. turgidum*. *A. monosperma* is well known from the Western Negev, where it dominates in a diffuse pattern (Orshan and Zohary, 1963) and from the El 'Arish–Rafah area. With 100-200 mm annual rainfall, these areas are less arid than Wadi el 'Ashara. Hence, in the latter, *A. monosperma* is confined to narrower stretches of the wadi, with an adequate supply of water. The dominance of *A. monosperma* in Wadi el 'Ashara and in wadis further south, towards the Suez–Cairo road, is linked to a rather favourable water supply. This is contrary to Kassas' assumption (Kassas and Imam, 1959) that *A. monosperma* is linked to basalt outcrops.

Distribution of plant communities in the first to third order tributaries of Wadi el 'Ashara is influenced by edaphic conditions and particularly by the nature of the watershed and the substrate of the wadi. The watersheds between the wadis consist of consolidated silty sand covered with some gravel and pebbles. Gypsum concretions of various dimensions have been described by Kassas and Imam (1959: 292).

Localities where this consolidated layer is 5–15 cm deep, and where the wadi cuts through it reaching loose sandstone, support the *Convolvulus lanatus-Heliotropium digynum* association. Where the consolidated layer that overlies the loose sandstone is 20–50 cm deep, the above association is replaced by the *Panicum turgidum-Convolvulus lanatus* association. Records of the latter which were obtained from localities with an additional 20–50 cm deep layer of windblown sand, had a higher percentage vegetation cover as compared with localities without such sand. This phenomenon has already been described by Davis (1953). The influence of the coarse unconsolidated Miocene sandstone on the *Convolvulus lanatus-Heliotropium digynum* association is reflected by the importance (cf. Table I) of the psammophytes *Heliotropium digynum*, *Stipagrostis plumosa* and *Convolvulus lanatus* in the association. Where the upper soil layer has a high proportion of silt, with no accumulation of windblown sand above it, *Fagonia arabica* is dominant. More dead plants were observed in this silty habitat than in the above-mentioned sandy ones. Records of this association refer to the vicinity of Fayid, hence, some anthropogenic influence on vegetation cannot be excluded.

Zone 2: The Hills East and West of Gebel Shahabi

The vegetation here is mainly restricted to runnels. There are several habitats with diffuse vegetation, e.g., slopes which benefit from the runoff from higher reaches. The *Anabasis articulata-Farsetia aegyptiaca* association is developed on the northern side of bases of the 50-200 m long consequent slopes which run parallel to the strata. Here stones are mixed with sand and silt and diffuse ANABASETUM is developed. This association has few components (six species per record) and a low cover (4%); *Anabasis articulata* usually accounts for over 90% of the total vegetation cover (cf. assoc. 7 in Table I). Diffuse ANABASETUM has also been described from the desert near Cairo, and south of the Suez–Cairo road (Davis, 1953).

Another habitat with diffuse vegetation is a north facing dip-slope of a hard Eocenian limestone (10 km SW of Fayid; alt. 200 m), which supports the *Echinops spinosus-Ephedra alata* association. The rock outcrop is smooth faced, and soil is confined to crevices and soil pockets. Both the relevant records comprise 11 chamaephytes and several hemicryptophytes and geophytes. *Echinops spinosus* and *Ephedra alata* account for 65–70% of the total vegetation cover of 3–5%. They are accompanied by *Gymnocarpos decander*, *Helianthemum kahiricum*, *Pituranthos tortuosus*, *Farsetia aegyptiaca*, *Kickxia aegyptiaca* and others.

This floristic richness can be explained by the relatively stable water supply obtained, even from weak showers, as runoff from the smooth-faced rock outcrops. Soil pockets and crevices of variable dimensions provide a variety of microhabitats where many species flourish. A similar phenomenon was found in the Negev and Sinai (Danin, 1972).

Six km SW of G. Shahabi there are deep sandy wadis on a hard limestone hill, where *Artemisia monosperma*, *Calligonum comosum* L'Hér., *Cornulaca monacantha* and *Panicum turgidum* predominate. These wadis are on a north to northeast slope, which favours accumulation of sand owing to its protection from the prevailing winds. Wadis of the horizontally bedded Upper Eocene limestone plateau of Gebel Shahabi carry the *Pituranthos tortuosus-Panicum turgidum* association. Though represented in many associations in the area studied, it is here that *P. tortuosus* reached its highest dominance, accounting for as much as 60–70% of the perennial vegetation.

In many wadis of the second to fourth order, *Panicum turgidum* and *Artemisia monosperma* or *Convolvulus lanatus* predominate. Time did not suffice to determine the components of this complex of associations.

Zone 3: Wadi el Kabir–Wadi el ʻAgrud

This zone is dominated by dissected terraces of Pleistocene to recent conglomerates. The predominant characteristic species in plant communities are *Lasiurus hirsutus*, *Panicum turgidum* and *Zygophyllum coccineum*. A somewhat similar association has been described by Kassas and Imam (1959) from Oligocene conglomerates near Cairo, with sandy matrix. Here, the conglomerate, which is compacted by silt, covers marine marls. Wherever these come close to the surface, *Zygophyllum coccineum* occurs in large quantities. In a first order wadi, with a stony bottom, the following sample record was taken:

Vegetation cover	= 5%
Lasiurus hirsutus (Forsk.) Boiss.	60%

Fagonia bruguieri DC.	20%
Zygophyllum coccineum	8%
Centaurea aegyptiaca L.	+
Stipagrostis raddiana (Savi) De Winter	+
Anastatica hierochuntica L.	+

In larger and more sandy wadis, *Panicum turgidum*, *Crotalaria aegyptiaca* Benth. and *Taverniera aegyptiaca* Boiss. were found. In wadi Abu Sayal, 21 km NNW of Suez, several dwarf trees of *Acacia tortilis* (Forssk.) Hayne were recorded in a sandy-silty wadi dominated by *Lasiurus hirsutus* and *Zygophyllum coccineum*.

As in Täckholm's (1956) report on this area, the *Acacia* species are undetermined; it should be noted that apart from the dwarf *Acacia tortilis* (Forssk.) Hayne, growing in small wadis, rather large trees of *Acacia raddiana* occur in Wadi el Gara, 25 km NW of Suez near the road to Cairo.

Zone 4: Gebel 'Ataqa

Kassas and Zahran (1962) recorded wadi vegetation at the foot of G. 'Ataqa. Davis (1953) studied the summit of G. 'Ataqa in 1944, and described the *Salsola tetrandra* community. The abundance of annual species in his list, as well as the rainfall data for Cairo (Kassas and Imam, 1957), suggests that this was a rainy year for G. 'Ataqa. At the end of 1973 the SALSOLETUM TETRANDRAE described by Davis (1953) had a rather poor appearance, with numerous dead *S. tetrandra* shrubs on all slopes.

However, even after several dry years, living shrubs of *S. tetrandra* survived in wadis and on slopes facing west and north, especially near steps formed by outcrops of hard limestone, where moisture conditions are somewhat more favourable (cf. Danin, 1972). The other constant components of SALSOLETUM TETRANDRAE are *Erodium hirtum* and *Anabasis articulata*. *Noaea mucronata* (Forssk.) Aschers. et Schweinf., a typical Irano-Turanian species, was found once on a cliff facing north. Here and there steps of hard limestone carried *Gymnocarpos decander*, *Stachys aegyptiaca* and *Iphiona mucronata*.

The vegetation of the wadis is related to their order with SALSOLETUM TETRANDRAE in the valley head. Here, most plants were alive and the composition is rather similar to that of the slope vegetation. In the wadis of first and second order, the vegetation is much richer both in cover (cf. Table I) and in number of species per record. In contrast with other habitats in the four zones, the *Gymnocarpos decander-Stachys aegyptiaca* association includes many chasmophytes, e.g., *Phagnalon rupestris*, *Helianthemum kahiricum*, *Stipa parviflora* and *Asparagus stipularis*.

In larger wadis, of the second or third order, rock outcrops are more common. *Varthemia montana* (Vahl) Boiss., *Ficus pseudo-sycomorus* Decne. (near a cliff), *Phagnalon rupestris*, *P. barbeyanus* Aschers. & Schweinf., and other chasmophytes grow here. In wadis of higher order the substrate is mainly composed of pebbles and gravels and many of these chasmophytes are absent. A wadi of the fourth order carried *Retama raetam* (Forssk.) Webb, *Lycium shawii*, *Ochradenus baccatus* Del., *Scrophularia xanthoglossa* Boiss., *Oryzopsis miliacea* (L.) Aschers. & Schweinf. and *Hyparrhenia hirta* (L.) Stapf.

Wadis of all orders, as noted by Davis (1953) may have *Limonium pruinosum* and *Salsola tetrandra* along their sides.

CONCLUSIONS

Although the desert area west of the Gulf of Suez and the Suez Canal seems to have a similar flora to that of the area east of them, several leading species are not common to both areas. *Zygophyllum dumosum* Boiss., which dominates the limestone hills east of the Suez up to the Judean Desert, was not found west of Suez–Fayid. *Zygophyllum decumbens* Del., which dominates wadis of second to fourth order in G. 'Ataqa below the altitude of 700 m, is very rare east of Suez. The same is true of *Echinops spinosus*, a common chamaephyte of G. 'Ataqa and the wadis west of Suez. *Acacia tortilis* and *Taverniera aegyptiaca* which are thermophilous plants growing in wadis northwest of Suez can be found in Sinai near Sharm esh Sheikh, ca. 300 km southeast of their location near Suez. On the other hand, *Artemisia monosperma*, *Panicum turgidum*, *Convolvulus lanatus* and *Heliotropium digynum* are common to both areas. They are found in a diffuse pattern east of Suez, through N Sinai up to the sandy areas of the Western Negev. As the annual rainfall west of Suez–Fayid is lower than that of N Sinai and the Western Negev, the above-listed psammophytes are restricted, west of Suez–Fayid, to runnels. The more silty ground west of Fayid–Suez influences this pattern as well. Silty top-soil decreases water infiltration. In sandy ground, infiltration is higher and water is accumulated in deeper layers; thus it is less influenced by direct evaporation. As a result, there is more available water in the wadis with sandy ground and chamaephytes can survive better there. This water regime can also explain the higher plant mortality in the silty wadis in the zone of Wadi el 'Ashara over a series of dry years.

Diffuse vegetation in the area west of Suez–Fayid occurs on slopes with heterogeneous water absorption. Such a slope can be divided into microcatchments and small "receiving areas". If the roughness (depression storage) of the microcatchment is low, runoff yields to the adjacent receiving area is high. Such edaphic conditions are uncommon on the hills of soft rocks west of the Great Bitter Lake (Zone 2). They are found here in smooth-faced outcrops of hard limestone with few crevices and in sand-rich colluvium at the piedmont of limestone hills. Here, the upper part of the slope contributes water to the piedmont. Slopes without such sandy receiving areas or with very small catchment areas do not support diffuse vegetation. Zone 2 is built up of many rock types and thus supports many different associations. The area occupied by each association depends on the dimensions of the outcrop of the rock type concerned. Although most of the vegetation here is restricted to wadis it has a variability of association similar to that of the diffuse vegetation found in the anticlinal ridge of the Rakhme Mountains in the Northern Negev (Danin, 1971).

In G. 'Ataqa, rock steps supplied sufficient water to ensure survival of shrubs of *Salsola tetrandra*. It should be noted that east of the Suez Canal through Northern and Central Sinai to the Negev and the Judean Desert, *S. tetrandra* grows on chalky-marly ground. The occurrence of *S. tetrandra* on hard limestone at G. 'Ataqa should be understood in terms of microcatchments and the characteristics of the receiving areas. Water which runs from the hard limestone is accumulated in the interbedded chalky-marly strata. *S. tetrandra* roots are therefore harboured in the chalky-marly ground, their common soil type.

Owing to an improved water regime in rock crevices and in soil pockets in the bottom of the wadis, these habitats support the richest assemblage of chamaephytes.

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