A PHYTOSOCIOLOGICAL STUDY OF HALOPHILOUS COMMUNITIES FROM MAREOTIS (EGYPT)*)

By T. M. TADROS, M.Sc., Ph. D.,
Alexandria University, Faculty of Science, Alexandria.
(Burg-el-Arab Desert Research Station).

INTRODUCTION.

The Mediterranean coastal belt, extending from Alexandria westwards to Sallum for about 600 kilometres, and from the seashore inwards for 12-15 kilometres, is considered from the floristic point of view the richest part of Egypt, excluding the region of Gabal Elba to the south east of Egypt, where a type of tropical forest has established itself.

The number of species in this Mediterranean belt forms about 50 % of the total number of species that constitute the Egyptian flora which is estimated to be something between 1,800 and 2,000 species (see OLIVER, 1937, and TACKHOLM, 1941).

Botanical studies in this region have been attempted at several periods. The most recent studies, however, were carried out by OLIVER (1937, et seq.) in which he listed the commoner species, their seasonal aspects and general distribution. He also described the general topography of the region and the climatic and other environmental factors that contribute to the soil properties and ecology of the vegetation.

MONTASIR (1942) extended the ecological investigation to the soil-vegetation relationships in some detail. The writer (1936) carried out some measurements of the osmotic concentration of the juices of some plants from this region, especially halophytes. This was a general investigation of the relation between soil moisture and soil salinity and the osmotic concentration in Egyptian desert plants.

These studies were more or less restricted to the transect from the seashore at Taposiris (Abu-Sir) to Burg-el-Arab, 47 kms. south-west of Alexandria, the most commonly frequented part of Mareotis, generally taken as a representative of the whole region. The limits of this transect, however, end from the east towards the ancient site of Marea, and from the west towards El-Hammam, where the ancient (now dried) extension of the western arm of lake Mariut used to end.

Between Marea and Mex, the region is much broader and the relief is less regular; and several types of halophytic communities have been established. West of El-Hammam, the landscape rises gently and the saline bed of lake Mariut does not exist any longer and is more or less replaced by gypseous soil.

The regularity of the typical Taposiris-Burg transect becomes frequently disturbed in such a way that the dune belt forming the sea coast is interrupted by rocks; or, in other parts, depressions occur to the south of the dunes and form salt marshes which shelter a variety of halophytic communities. Frequently also, especially towards Mersa-Matruh and westwards, there exist a large number of ravines and wadis and even smaller depressions, in which varying microclimatic conditions are created where a variety of definite assortments of species are met with.

The study of these communities in relation to the properties of their environment can best be accomplished by phytosociological and synecological analysis. Phytosociology is apt to define the different associations,[1]) their relations to each other, and their possible stages of succession.

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[1]) The notion „association" here is meant to be the characteristic species combination as determined by their fidelity to each other and to their environment (see BRAUN-BLANQUET, 1928, and BRAUN-BLANQUET and PAVILLARD, 1928).

This work is the first attempt towards achieving this purpose. It deals only with the outstanding halophytic communities of Mareotis, having been perceived as the most stable communities in the region, being the least disturbed by cultivation or subjected to destructive factors.

The investigation is divided into two parts: the phytosociological part which forms the subject of the present article; and the synecological relationships of the distinguished communities which will be the subject of a forthcoming contribution. It is also hoped that this work will be extended to cover all other plant communities and environments of this interesting and important part of Egypt.

TECHNIQUE.

The method adopted in the phytosociological study is according to the Zurich-Montpellier school. It is based on listing the species occurring in a sample square which is chosen to represent a homogeneous plant community; and whose area is taken to be, as far as possible, that above which no new species appear in the community (BRAUN-BLANQUET, 1928, BLACKMAN, 1935). Every species is given two figures, the first expressing its abundance-dominance, and the second its sociability.

These list-quadrats are then tabulated in tables of 'présence' or occurrence, from which the species are classified together according to their affinities and fidelity into communities of different ranks.

The method is fairly accurate, practical and based on sound ecological and biological considerations. It excludes the elaborate and slow statistical treatments, which can only be executed by several workers and on small areas. It necessitates a good knowledge of the species and their habits for a correct judgment upon the homogeneity of the community to be investigated.

For acquaintance with this phytosociological technique, I am indebted to DR. J. BRAUN-BLANQUET, director of the S.I.G.M.A., of Montpellier, during a visit in the summer of 1948. He also kindly criticised the manuscript, and revised the classification and nomenclature of the communities.

I was enabled to pay this visit by a grant from the I.U.B.S., through the U.N.E.S.C.O., and by the Farouk I University, to the authorities of which I wish to express my gratitude.

For help in identification of the species, I wish to thank Prof. Mrs. V. TACKHOLM, author of the „Flora of Egypt", who also took part in several excursions.

The following floras were consulted: TACKHOLM'S Flora of Egypt (1941), MUSCHLER'S Manual Flora of Egypt (1912), POST'S Flora of Syria and Palestine, and the French Floras of FOURNIER and BONNIER, especially for the Mediterranean species.

TOPOGRAPHY.

The regions from which the list quadrats herewith included have been taken lie along the Mediterranean coast of Egypt.

Two parts have been subjected to careful investigation, although several reconnaissance excursions were made to other parts, like lake Manzala and El-Areesh (north of Sinai) to the east, from which plant lists were obtained but not sociologically studied.

Ecological studies of the Manzala lake were carried out by MONTASIR (1937); and a survey of some vegetational transects through the desert of Sinai was published by ZOHARY (1944).

The two parts referred to are:

1) The region of Amria„ 20-30 kms. south-west of Alexandria.
2) The region of Mersa-Matruh, 280-300 kms. west of Alexandria.

1. The Region of Amria.

A transect taken from the seashore inland in this region will show the following topography:

a. A belt of white oolitic sand dunes about 1 km. broad and varying in height from 1 to 10 metres above sea level. These shelter several associations of the Ammophiletalia. The soft sand dunes are mixed here and there with calcareous rocks of consolidated sand with different communities. The inner edge of this belt slightly rises, reaching 12 to 14 metres above sea level, and then it declines gently at an angle of about 45° to a depression which forms a salt marsh (b). The slope is planted mainly with figs and date palms.

b. The salt marsh extends for about 6 kms. from N.E. to S.W. with an elevation that varies from 50 cms. or less to 2 metres above sea level. The lower parts become filled with water during the rainy season and dry up in summer, causing accumulation of salts.

There are patches in the higher parts which are suitably drained and cultivated with barley. The soil here is sandy saline, the sand being derived from the adjacent dunes. In the lower parts organic decay is noticed. This more or less marshy strip following the dune belt is known as El-Diraa: el-Bahari, and is repeated westwards all along the coast. Wherever there are depressions a marshy habitat is produced with its characteristic halophytic communities. Then the land rises gradually to form:

c. A limestone rocky hill which in certain points reaches a height of 35 m. above sea level.

A similar hill which runs parallel to belt c, is found to the south, both being separated by the western arm of lake Mariut.

These two ridges are believed to be consolidated dunes. Both ridges slope gradually into the lake bed and halophilous communities are displayed in more or less regular strips following the slightly changing levels till the central and lowest parts of the bed which is completely vegetationless owing to excessive salt accumulation. Here and there in the lake bed are scattered small masses of rocky limestone of the same nature as the principal ridges referred to before. These two latter are about 5 kms. apart in this region, but they approach by a sudden bend of the south ridge to the north at the site of the pre-existing city of Marea.

Geologically the region belongs to Recent and Pleistocene formations.

2. The Region of Mersa-Matruh.

Towards Mersa-Matruh, the coast bends northwards for about 17 kms. and then abruptly westwards again at Ras Alam-el-Roum for about 25 kms. till it bends northwards again forming Ras Om-el-Rakham.

The coastal part facing east is formed of rocky Miocene limestone, interrupted by sandy depressions varying in breadth, which form salt marshes. One of these, lying 8 kms. south of Ras Alam-el-Roum and about 12 kms. south east of Mersa-Matruh, was examined phytosociologically.

This is the valley known as Wadi Simla, a narrow valley about 1 km. wide on the average and extending first S.E. and then bending with a right angle to the N.E. to end into the Mediterranean. The seaward side of the valley is low and becomes partly inundated with sea water at high tide, but it rises gradually inwards to about 20 m. or more above sea level.

The hills that limit the valley vary in height from 6 to 9 metres near the sea to 30-40 metres inwards. Well drained parts of the valley shelter a fine barley cultivation, but lower depressions and badly drained parts are covered more or less with halophytic communities. Some parts, mainly mine-field enclosures, have developed a dense shrub vegetation of *Atriplex Halimus* with a dense herbaceous stratum of *Brachypodium distachyon* and other herbs, as will be shown later.

On the other hand, the coastal part facing north and extending from Ras Alam-el-Roum to Mersa Om-el-Rakham, is distinguished by a strip of an average width of 1 km. from the seacoast southwards. This thin strip is more recent and interrupted by several salt lakes on both sides of Mersa-Matruh, being more numerous on the eastern side, forming depressions among rocky limestone hills which vary in height from 5 to 35 metres.

On the western side, however, in the region called El-Qasr there are sand dunes which in parts are consolidated into rocks. Further west the dune strip becomes very thin just forming a sandy beach but otherwise rocky. It is in this region that old Roman wells are frequent, which are responsible for the relative prosperity of cultivation.

Again halophytic communities flourish on the shores of these lakes culminating in Atriplicetum Halimi. Phytosociological studies were made in a typical region near El-Qasr, 10 kms. west of Mersa-Matruh, and in the vicinity of the latter.

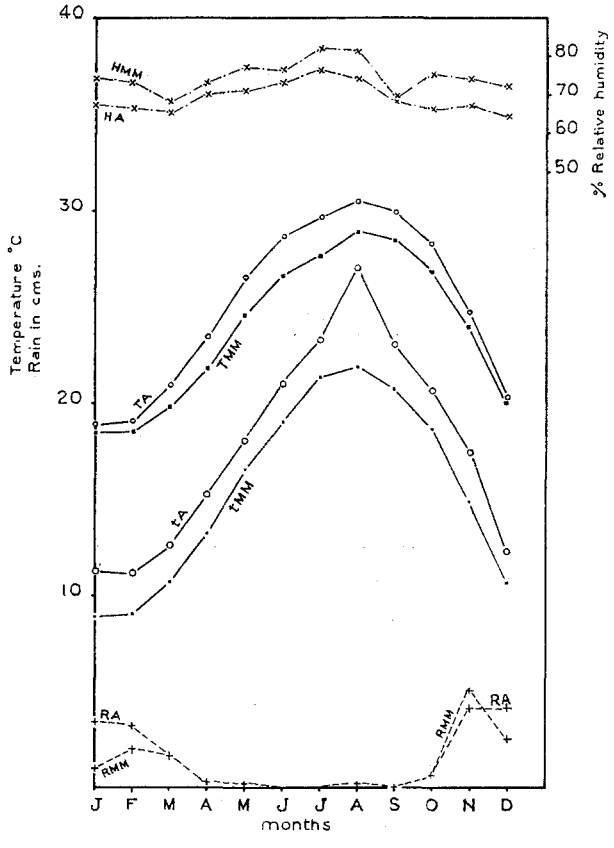


Fig. 1.

T = Average maximum temperature
t = Average minimum temperature
A = Alexandria observatory
MM = Mersa-Matruh observatory
R = Average rainfall
H = Average relative humidity

CLIMATE.

The following table includes the monthly averages of maximum and minimum temperatures, rainfall, and relative humidity for seven years, 1939, '40, '44, '45, '46, '47 and '48, as obtained from the observatories of Alexandria and Mersa-Matruh. They are illustrated in the hydrotherm (fig. 1). As for Amria region, there is no observatory except for a rain gauge recently introduced, but owing to its proximity to Alexandria its temperature data can be considered approximately the same. The rainfall differs slightly, however, being less than in both Alexandria and Mersa-Matruh.

It is evident from Table I that Alexandria is slightly hotter, more rainy, but less humid than Mersa-Matruh. Amria receives less rain than both the other two regions, as appears from the average of six years from 1938-1941 and from 1948-1949, as well as from the comparison of rainfall for one year. Evidently also the distribution of rain, especially during the most rainy months of December, January and February, is different in the three regions.

TABLE I.

Months		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Averages.
Alexandria	T.	18.9	19.0	20.9	23.4	26.5	28.7	29.6	30.5	30.0	28.3	24.7	20.3	25.2°C.
	t.	11.2	11.1	12.5	15.2	18.1	21.1	23.3	27.1	23.1	20.7	17.4	12.3	17.8°C.
	R.	35.0	31.1	16.3	3.6	2.0	drops	drops	2.0	drops	5.4	41.0	41.0	177.4 mm. (tota
	R.H. %	67.	66	65.	70.	71.	73.	76.	74.	68.	66.	67.	64.	69 %
Mersa-Matruh	T.	18.5	18.5	19.8	21.8	24.6	26.6	27.6	28.9	28.5	26.8	24.0	20.0	23.8°C.
	t.	8.9	9.0	10.7	13.2	16.5	19.0	21.3	21.9	20.8	18.7	14.9	10.7	15.5°C
	R.	11.0	20.0	17.0	3.0	2.0	drops	0.0	drops	1.0	6.0	50.0	25.0	135 mm. (total)
	R.H. %	74.	73.	68.	73.	77.	76.	82.	81.	69.	75.	74.	72.	75 %
ıria	R.	27.0	23.0	9.0	3.0	drops	0.0	0.0	0.0	0.0	drops	20.3	43.0	125.3 mm. (total)
:xandria [1]) 948.	R.	23.5	59.9	51.8	6.8	drops	0.0	0.0	0.0	drops	1.6	51.8	86.8	282.2 mm. (total)
ıria 1949.	R.	46.5	37.0	24.0	9.0	1.0	0.0	0.0	0.0	0.0	0.0	7.3	111.0	235.8 mm. (total)
rsa-Matruh 948.	R.	3.4	49.9	73.0	17.2	1.0	0.0	0.0	0.0	0.0	0.5	61.5	68.5	275.0 mm. (total)

Rainfall for 1948 was not obtained complete for Amria; and for 1949 was not obtained at all for Mersa-Matruh.

According to the interpretation of RAUNKIAER for the hydrotherms, the whole region in general is characterised by a long dry fairly warm season and a short slightly rainy temperate winter, favourable for a therophytic biological spectrum.

According to the suggested classification of EMBERGER for the Mediterranean climate, the phytogeographical position of this part of the Mediterranean basin will

become evident from a consideration of its pluviothermic coefficient. For Alexandria the annual pluviothermic coefficient will be:

$$\frac{177.4}{(30.5 + 11.2)\ (30.5 - 11.2)} \times 100 = 22.0$$

and for Mersa-Matruh:

$$\frac{135.0}{(28.9 + 8.9)\ (28.9 - 8.9)} \times 100 = 17.0$$

Permitting the validity of EMBERGER'S views (1942) concerning the classification of the Mediterranean climate into sub-regions, he stated that "from the phytogeographical point of view, for a station to possess a Mediterranean climate, it should have (1) a Mediterranean regime of rain, i.e. rain falls mainly during the colder season from autumn to spring, (2) a pluviothermic coefficient not exceeding 30, and (3) an estival pluviothermic quotient not exceeding 7."

Alexandria and Mersa-Matruh will therefore fall in two levels inside the zone of "warm semi-arid Mediterranean climate with very dry summer". The estival quotient in both localities is practically O.

This coefficient could have been higher had it taken into account the atmospheric humidity, which being higher in Mersa-Matruh all the year round may contribute to raise its pluviothermic quotient. It is to be regretted that, so far, we have no accurate information about dew and its important influence upon raising the moisture content of the soil. Casual observation showed that it is formed in considerable quantities especially in summer and autumn. This has been especially noticed in the Mediterranean part north of Sinai and in the eastern desert bordering the Nile valley. In the former, a superficial layer of soil about 5 cms. thick retains considerable quantities of dew water till about 9 a.m. in August. There is no doubt that this provides the perennials and the summer annuals with an important proportion of their requisite of water, and thus it is a factor that cannot be neglected in phytogeographical and ecological studies.

This coastal strip of Egypt is therefore, climatically, more Mediterranean than anything else, but from the phytogeographical point of view it shelters a mixture of species from different territories especially Saharo-Sindian perennials like *Anabasis articulata, Noaea mucronata, Moricandia fruticosa* and *Zilla spinosa* which become more distinct towards the southern boundary of the coastal belt.

The fact that the country is generally low and exposed to severe erosion by north-east as well as south-west winds all the year round, added to exhaustive grazing and collection of plants for fuel on a large scale, have undoubtedly hindered the natural development of the vegetation and of the soil.

Typical Mediterranean phanerophyte communities that have developed in some Mediterranean regions with similar climatic and edaphic conditions, e.g. in Palestine where four main groups of forest and maquis are represented (ZOHARY, 1942), do not exist here.

Plants like *Pinus halepensis, Ceratonia siliqua, Zizyphus lotus,* are only to be found under cultivation. Even plants of a lower developmental rank, such as *Retama Retam* and *Nicotiana glauca,* are only subspontaneous. So far, there is no definite indication of any relics of pre-existing forest communities. Whether they never existed or were completely devastated cannot be told with certainty under our present degree of knowledge.

THE HALOPHILOUS COMMUNITIES.

The region of El-Diraa-el-Bahari presents an interesting environment for studying the transition between the dunes and the adjacent salt marshes. *Sporobolus pungens* seems to be the species best suited for such transition. It forms an almost pure commu-

TABLE II.

Alliance: Plantaginion crassifoliae Br.-Bl.

Association 1. Junceto-Schoenetum Tadros ass. nov.
a. sub-association of Sporobolus pungens, Tadros sub-ass. nov.
b. sub-association of Juncus maritimus, Tadros sub-ass. nov.

Association 2. Schoenetum aegyptiacum, Tadros ass. nova.

	Sub-Association of Juncus maritimus					Junceto-Schoenetum		Sub-Association of Sporobolus pungens					Schoenetum aegyptiacum				
No. of list quadrat:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Characteristics of alliance: Plantaginion crassifoliae																	
Juncus maritimus var. arabicus Aschers. et Buchenau	4.4	4.4	4.4	4.3	4.4	4.4	3.3	3.3	2.3	2.2	2.3	3.2	+.1	1.2	4.4	—	4.4
Statice pruinosa L.	3.2	2.2	—	2.1	1.1	1.1	3.2	1.1	+.2	3.2	—	—	2.1	1.1	+.1	2.1	1.2
Sporobolus pungens (Schreb.) Kunth.	2.2	—	—	—	—	+	—	4.4	4.4	3.3	3.4	4.4	2.1	2.2	1.2	—	1.2
Schoenus nigricans L.	—	—	—	—	—	—	—	—	—	—	—	—	4.4	4.4	2.2	3.3	1.2
Plantago crassifolia Forsk.	3.3	3.3	+	+.1	+	2.1	2.1	+	—	2.2	—	—	3.2	3.2	4.3	3.2	4.3
Companions from other Communities:																	
Salicornia fruticosa L.	1.2	1.2	2.2	—	+.1	1.2	—	+.2	1.2	—	2.3	—	+.1	2.3	2.2	2.2	—
Atriplex portulacoides L.	—	1.2	—	—	—	2.2	2.2	+.1	—	1.2	+.1	2.2	—	—	—	+.2	4.4
Inula crithmoides L.	4.4	—	+.2	—	—	2.3	—	+.1	1.2	—	—	—	+.1	—	3.2	—	+.2
Limoniastrum monopetalum Boiss.	—	—	—	—	+.1	2.2	3.3	+.2	—	2.3	—	2.2	—	—	—	—	+.1
Frankenia laevis L.	—	1.1	—	—	+.2	1.1	—	1.1	—	—	—	—	—	—	—	+.1	+.1
Suaeda fruticosa Forsk.	—	1.2	—	+.2	—	1.2	+.2	+	—	—	—	+.1	—	—	—	+.1	+.2
Sphenopus divaricatus (Gouan) Reichb.	—	—	—	—	+	+.1	2.2	1.1	—	—	—	—	—	—	—	—	—
Lolium rigidum Boiss.	—	—	—	—	—	+.1	—	+.1	—	2.1	—	—	—	—	—	—	+
Pholiurus incurvatus Hitchc.	—	—	—	—	—	—	—	—	—	—	2.2	—	—	—	—	—	2.2
Polypogon monspeliensis (L.) Desf.	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—	—	—
Lygaeum spartum L.	—	—	—	2.2	2.2	3.3	+.2	—	—	—	—	2.2	—	—	—	1.1	+.2
Cynodon dactylon (L.) Pers.	—	—	—	3.3	2.3	—	3.2	—	—	—	—	—	—	—	—	—	—
Lycium europaeum L.	—	—	—	3.4	2.4	—	—	—	—	—	—	—	—	—	—	—	—
Echium sericeum Vahl.	—	—	—	1.2	+.2	—	—	—	—	—	—	—	—	—	—	—	—

nity sometimes covering quite large patches at the line of separation between the dune and the marsh. Then passing down, the typical halophilous communities gradually appear in regular sequence towards the lowest most saline vegetationless parts. In the southwestern part of the marsh, however, the relief is not always so regular, but the different associations can still be distinguished, though mixed communities appear on soils disturbed by agricultural operations or road-building.

Analytical tables of the plant lists taken from a number of quadrats revealed the segregation of different plant communities. Communities belonging to the alliance Plantaginion crassifoliae are given in Table II. There are two associations:

Association 1: Junceto-Schoenetum with:

a. sub-association of *Sporobolus pungens,* Tadros sub-ass. nov.
b. sub-association of *Juncus maritimus,* Tadros sub-ass. nov.

Association 2: Schoenetum aegyptiacum Tadros ass. nov.

Juncus maritimus, Statice pruinosa, Plantago crassifolia and *Salicornia fruticosa* are characteristics of higher rank. The sub-association of *Sporobolus pungens* occupies the higher parts nearest to the oolitic sand dunes or where sand forms a higher proportion of the soil particles. The Schoenetum aegyptiacum is fairly common especially in this region. *Schoenus nigricans* is recorded for the first time in this part of Mareotis. This association is frequently met with scattered between patches of *Juncus maritimus* sub-association, but occupying slightly lower levels apparently with a higher moisture content. From a distance, it is difficult to separate the two communities, owing to the similarity in appearance between small bushes of *Juncus maritimus* and *Schoenus nigricans* (see photo 6).

It seems that in the Schoenetum, *Schoenus* tends to replace *Juncus,* as appears from the figures of dominance and sociability.

In a typical quadrat of the Schoenetum it was noticed that the sandy soil is shallow, being only 30 cms. deep, with limestone rock directly underlying. The following species occur as accidentals in the lists of Table II:

Cressa cretica L.
Medicago hispida (Gaertn.) Urban
Juncus bufonius L.
Thymelaea hirsuta (L.) Endl.
Calendula aegyptiaca Pers.
Koeleria phleoides (Vill.) Pers.
Melilotus sulcatus Desf.
Senecio coronopifolius Desf.
Phragmites communis Trin.
Spergularia salina Presl.
Polygonum equisetiforme Sibth et Smith.
Herniaria hemistemon J. Gay.
Schismus barbatus (L.) Thell.
Bromus rubens L.
Asparagus stipularis Forsk.
Cynomorium coccineum L.
Trigonella maritima Delile.

In list quadrats 4 and 5 the characteristics of the Junceto-Schoenetum are feebly represented giving way to species like *Lygaeum spartum, Lycium europaeum* and *Cynodon dactylon.* Thus these two quadrats represent an advanced stage of this association succeeding towards *Atriplex Halimus* as will be shown later.

List quadrat 17 is a mixed community including members from the Salicornieto-Staticetum which are fairly well represented, e.g. *Atriplex portulacoides* and *Pholiurus incurvatus,* whereas *Schoenus nigricans* is not so highly represented. It throws light upon the affinities between these two associations.

Table III includes the localities and other details about the list quadrats of Table II.

TABLE III.

Date.	No. of List Quadrat.	Locality.	Area m².	Degree of Cover %.	Height of Plants cms.
13/11/49	1	El-Diraà-el-Bahai, north of Matruh road.	25	50	10—30
11/ 2/50	2	Foot of a hill in the middle of the bed of lake Mariut, Amria region.	4	70	10—50
15/ 3/50	3	Bank of lake Mariut, south of Cairo road, before Amria.	1	100	15—60
13/11/49	4	El-Diraà-el-Bahari, southern margin of salt marsh.	16	90	10—100
	5		16	90	10—100
	7		50	75	5—50
18/ 5/49	6	—do— north of road junction.	100	95	10—50
13/11/49	8	—do— middle part further north of Matruh road.	25	95	5—50
	9		25	60	10—30
11/ 2/50	10	Slope of a hill in the middle of bed of lake Mariut, Amria region.	4	95	10—50
11/ 2/50	11	El-Diraà-el-Bahari south of Matruh road.	25	90	10—40
24/ 2/50	12	El-Diraà-el-Bahari, middle of salt marsh.	25	100	10—50
24/ 2/50	13	—do— south of dunes.	25	90	5—50
13/11/49	14	—do— —do—	25	60	10—50
13/11/49	15	—do— —do—	50	70	10—50
24/ 2/50	16	—do— —do—	100	70	10—50
18/ 5/49	17	—do— at K. 27 south of Matruh road.	100	95	5—70

Communities belonging to the alliance Salicornion in this region are given in Tables IV and V. These associations inhabit the lower parts of the salt marshes, which are relatively richer in salt content. They exhibit a marked zonation, especially the initial stages. Starting from the lower highly saline vegetationless part, *Halocnemum strobilaceum* starts to appear, sometimes forming pure stands, but more often it becomes associated with *Arthrocnemum glaucum* and *Salicornia fruticosa.* These two latter species are very difficult to distinguish from each other vegetatively. It is only at their time of flowering that they can be separated. *Arthrocnemum* begins flowering in April, *Salicornia* much later. Thus, these two species are given the same abundance-dominance-sociability figures. There is reason to believe that *Arthrocnemum* is more abundant than *Salicornia* in the Arthrocnemeto-Limoniastretum.

Halocnemum, Salicornia, Arthrocnemum and *Limoniastrum* bushes and their remains accumulate soil and form small hillocks which may reach considerable dimensions, especially with *Limoniastrum* (see photo 3). These hillocks gradually become washed down by rain, trap the dust blown by the south-westerly winds and dust storms, and thus the proportion of the fine fraction of the soil increases. The humus fraction of the soil is raised as well through the remains of these plants, and so new species which are less tolerant to salinity appear. It is very likely that the coalescence of these hillocks, in course of time, has contributed a good deal to the rise of the general level of the ground. This is especially marked in the more ancient western marshes towards Mersa-Matruh, where the succession of the halophilous communities seems to have attained a higher stage of development.

The soil of the dried bed of lake Mariut differs in texture from the soil of the marshes adjacent to the dunes, being less sandy owing to the silting up of the lake bottom in older times when the lake was still connected with the Nile (see also OLIVER, 1937). Associations of the Salicornion are more frequent and more stable under such conditions than those of the Plantaginion crassifoliae where the soil is more sandy. The surface of the soil in the lake bed is usually slimy when wet, cracking when dry, contrary to the surface of the more sandy saline soil of the marshes adjacent to the dunes.

TABLE IV.

Alliance: Salicornion, Br.-Bl.
Association 3: Ass. of Halocnemum strobilaceum Tadros. [1])
Association 5: Arthrocnemeto-Limoniastretum monopetali Tadros ass. nova.

No. of list quadrat:	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
Characteristics of initial stage: Ass. (3) Halocnemum strobilaceum and Arthrocnemum glaucum																				
Salicornia fruticosa L.																				
Arthrocnemum glaucum (Del.) Unger-Sternb.	1.3	1.2	2.2	2.2	2.2	1.3	3.3	2.2	3.3	2.3	+.1	2.2	3.4	3.3	4.3	1.3	1.2	—	2.2	3.3
Halocnemum strobilaceum M. Bieb.	3.3	4.2	2.2	2.2	1.2	3.4	1.2	—	1.2	—	3.4	+.1	1.2	2.3	—	—	3.4	+.1	3.3	4.4
Characteristics of Assoc. (5): Arthrocnemeto-Limoniastretum.																				
Limoniastrum monopetalum Boiss.	—	+	—	—	—	—	—	—	2.2	—	2.3	1.2	1.2	1.2	2.2	+.2	2.3	1.2	2.2	1.2
Frankenia laevis L.	—	—	—	—	+	—	—	—	1.1	1.1	1.1	—	—	1.1	—	—	—	+	1.2	1.2
Cressa cretica L.	—	—	—	—	—	—	—	—	—	—	—	+.1	+.1	1.1	+	—	—	5.4	—	—
Mesembryanthemum nodiflorum L.	—	—	—	—	—	—	—	—	—	—	+	—	—	—	—	4.4	—	3.3	2.2	—
Pholiurus incurvatus Hitchc.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2.2	—	(+)	1.1	—
Characteristics of alliance: Salicornion:																				
Atriplex portulacoides L.	—	—	—	—	—	—	2.2	3.3	—	1.1	—	2.2	—	1.1	2.2	—	—	—	—	—
Sphenopus divaricatus (Gouan) Reichb.	—	—	—	—	—	—	—	—	2.2	4.3	—	—	—	—	2.2	2.1	2.1	+.1	2.1	4.2
Inula crithmoides L.	—	—	—	—	—	—	—	—	—	—	—	2.2	—	2.3	—	—	2.2	—	—	—
Species belonging to: Plantaginion crassifoliae:																				
Statice pruinosa L.	—	—	—	—	—	—	1.2	—	—	—	—	—	—	3.2	+.1	—	+.1	—	+.2	—
Juncus maritimus var. arabicus Aschers. et Buchenau	—	—	—	—	—	—	—	—	—	—	—	—	1.2	—	2.2	—	2.3	—	—	—
Sporobolus pungens (Schreb.) Kunth.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	1.2	1.2	—	—	—
Plantago crassifolia Forsk.	—	—	—	—	—	—	—	—	—	—	—	—	—	+.1	—	—	—	—	—	—
Bupleurum semicompositum L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	+	—	—	—
Companions:																				
Suaeda fruticosa Forsk.	—	—	—	—	—	—	—	—	—	—	+.1	—	—	—	—	+	—	(+)	2.2	2.3

[1]) Probably a subassociation of the ass. of Halocnemum and Frankenia of Br.-Bl. (1949).

The following associations were distinguished, starting from the more saline to the less saline:

Association 3. Ass. of *Halocnemum strobilaceum* (Table IV).
Association 4. Ass. Salicornieto-Staticetum, with:
a) sub-association of *Atriplex portulacoides* (Table V),
b) sub-association of *Phragmites communis* (Table V).
Association 5. Ass. of Arthrocnemeto-Limoniastretum monopetali (Table IV),
Association 6. Ass. of *Zygophyllum album* Tadros ass. nova (Table V).

The sub-association of *Atriplex portulacoides* is very frequent and luxuriant, but that of *Phragmites communis* is relatively poorer in species, *Phragmites* itself being feebly represented. This sub-association is often met with where there are depressions appreciably lower than the level of the previous associations, where rain water accumulates in winter and keeps for some time, so that the water content of the soil is higher all the year round.

There is also distinguished an association of *Zygophyllum album* which follows in succession the Arthrocnemeto-Limoniastretum on elevated sandy, less saline, soils (see photos 3 and 4).

TABLE IVa.

includes the localities and other details about the list quadrats in Table IV.

Date.	No. of List Quadrat.	Locality.	Area m².	Degree of Cover %.	Height of Plants cms.
10/ 4/49	18	Mallaha depression, mouth of Wadi Simla, south-east of Mersa-Matruh.	100	60	30—40
4/ 2/50	19 & 26	El-Diraà-el-Bahari, southwestern end of salt marsh.	100	70	30—40
4/ 2/50	20	Amria region, dried bed of lake Mariut gradually towards the lowest vegetationless part.		60	
	27		100	90	10—40
	& 25			70	
4/ 2/50	21	Sidi-Matouk, edge of dried lake bed, north of inner ridge.	100	70	10—40
15/ 3/50	22	Bank of lake Mariut, Amria region, south of Cairo road.	100	50	20
	& 24		100	40	20—30
13/11/39	23	El-Diraà-el Bahari, lower parts.	100	70	10—30
1/ 1/50	28	Amria, border of dried bed of lake Mariut.	100	70	30—40
13/11/49	29	El-Diraà-el-Bahari, lower parts.	100	50	
	30	—do—	100	60—70	10—30
	31	—do—	100	60	
	32	—do—	100	95	10—50
18/ 5/49	33	Burg-el-Arab, dried bed of lake Mariut.	100	80	5—20
10/ 4/49	34	Mallaha depression, mouth of Wadi Simla (Matruh).	100	60	20—40
9/ 4/49	35	Salt marsh on sea-coast at Ras Alam-el-Roum.	100	80	5—20
25/ 3/49	36 & 37	Burg-el-Arab region, dried bed of lake Mariut.	100	60—70	5—40

The following species have been recorded as accidentals in the communities of Table V:

Cynodon dactylon (L.) Pers.
Polypogon monspeliensis (L.) Desf.
Cynomorium coccineum L.
Hordeum murinum L.
Carex divisa Huds.
Thymelaea hirsuta (L.) Endl.
Herniaria hemistemon, J. Gay.

Photo 1. (Photo C. EEMAN)
Kisenyi et la baie limitée par le Promontoire Sud planté d'Eucalyptus. Au fond à droite l'Ile Idjwi. Vue sur les pentes inférieures de la dorsale orientale, avec bananeraies, jachères, et savanes à Hyparrhenia cymbaria et filipendula.

Photo 2. (Photo C. EEMAN)
Kisenyi et plaine de lave en direction de Goma et Sake. A droite, les pentes inférieures du Volcan Nyiragongo.

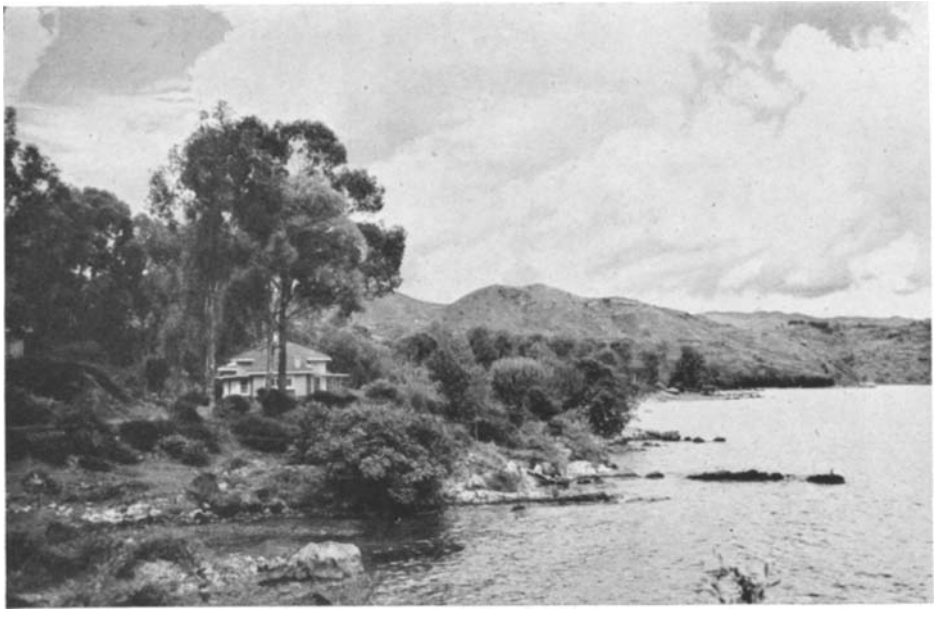


Photo 3. (Photo C. EEMAN)
Rive du lac Kivu entre Goma et Kisenyi, constituée par de la lave. Au fond les pentes du Mont Kama et la chaine de la Dorsale Orientale. Savanes à Hyparrhenia cymbaria et filipendula sur les versants les plus abrupts, bananeraies et jachères sur les pentes plus douces.

Photo 4. (Photo VAN DEN HEUVEL)
Arête dénudée par érosion éolienne près du sommet du Volcan éteint de Goma. Le tuf volcanique stratifié est mis à nu et est péniblement colonisé par la végétation. A droite touffes d'*Hyparrhenia filipendula.*

Phot. 1. Salicornieto-Staticetum: sub-association of Atriplex portulacoides (Abu-Sir).
(Photo by T. M. TADROS)

Phot. 2. Arthrocnemeto-Limoniastretum (Abu-Sir).
(Photo by T. M. TADROS)

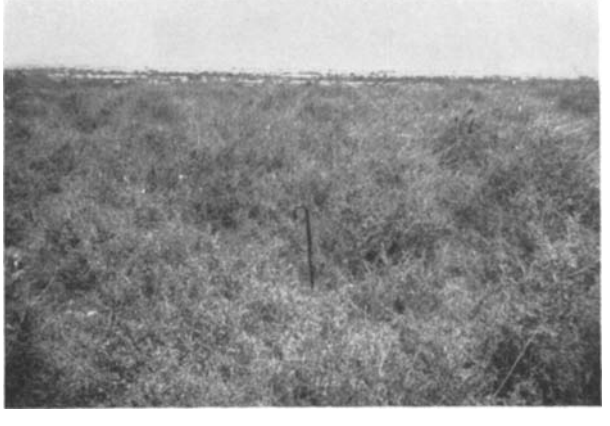
Phot. 3. Limoniastrum monopetalum on hillocks (south-western part of El-Diraà-el-Bahari). (Photo by T. M. TADROS)

Phot. 4. Zygophyllum album-association, (south-western part of El-Diraà-el-Bahari). (Photo by T. M. TADROS)

Phot. 5. Community of Lygaeum spartum. (south-western part of El-Diraà-el-Bahari). (Photo by T. M. TADROS)

Phot. 6. Schoenetum aegyptiacum (El-Diraà-el-Bahari). (Photo by T. M. TADROS)

Phot. 7. Atriplex Halimus-Picris radicata-association (Wadi Simla).
(Photo by T. M. TADROS)



Phot. 8. Atriplex Halimus-Picris radicata-association with an olive garden in the background (El-Romani, near El-Qasr village, Mersa-Matruh).
(Photo by T. M. TADROS)

TABLE V.

Alliance: Salicornion Br.-Bl.

Association 4: Salicornieto fruticosae — Staticetum pruinosae Tadros ass. nov., Sub-association of Atriplex portulacoides Tadros sub-ass. nov., sub-association of Phragmites communis Tadros sub-ass. nov.

Association 6: Ass. of Zygophyllum album Tadros ass. nov.

	Sub-Assoc. of Atriplex portulacoides.					Sub-Assoc. of Phragmites communis.				Ass. of Zygophyllum album.			
No. of list quadrat:	38	39	40	41	42	43	44	45	46	47	48	49	50
Salicornietum fruticosae:													
Salicornia fruticosa L.	4.4	+.3	1.2	+.1	2.4	4.4	2.2	3.2	4.4	—	—	—	—
Juncus maritimus var. arabicus Aschers. et Buchenau	4.3	—	3.2	1.3	—	2.3	—	—	4.3	—	—	—	—
Statice pruinosa L.	2.2	—	+	+.1	+.1	—	—	—	+	—	—	+.1	—
Inula crithmoides L.	—	—	—	2.2	1.3	—	—	2.3	—	—	—	—	—
Plantago crassifolia Forsk.	2.2	+.1	+.1	1.3	1.2	—	—	—	—	—	—	—	—
Pholiurus incurvatus Hitchc.	—	3.3	—	—	—	1.2	—	—	—	—	—	—	—
Sphenopus divaricatus (Gouan) Reichb.	—	—	—	3.3	+.1	—	—	—	2.1	—	—	1.1	—
Sub-Assoc. of Atriplex portulacoides:													
Atriplex portulacoides L.	2.3	5.5	5.5	3.4	2.4	+.1	3.3	—	2.2	—	—	—	—
Sub-Assoc. of Phragmites communis:													
Phragmites communis Trin.	—	—	—	—	+.1	2.2	3.2	+.1	+.1	—	—	—	—
Association of Zygophyllum album:													
Zygophyllus album L.	—	—	—	—	—	—	—	—	—	2.2	2.2	2.3	1.3
Species belonging to other communities:													
Limoniastrum monopetalum Boiss.	+.2	—	+.2	—	—	—	—	—	—	—	3.2	—	—
Frankenia laevis L.	+	—	—	—	+.1	—	—	—	—	+.1	—	—	—
Suaeda fruticosa Forsk.	+.1	1.2	—	—	—	—	—	—	—	—	+	—	—
Sporobolus pungens (Schreb.) Kunth	—	1.3	—	—	1.3	—	—	—	1.2	—	—	—	—
Lygaeum spartum L.	—	1.2	—	—	—	—	—	—	—	1.2	—	1.2	—
Mesemb. nodiflorum L.	—	+.2	—	—	—	—	—	—	—	—	—	—	—
Spergularia salina Presl.	—	—	—	—	—	—	—	1.1	—	—	—	—	—
Atriplex Halimus L.	—	—	—	—	—	—	—	—	—	—	+	2.2	1.2
Halocnemum strobilaceum M. Bieb	—	—	—	—	—	—	—	—	—	—	—	1.2	2.3
Salsola vermiculata L.	—	—	—	—	—	—	—	—	—	—	—	1.1	—

From the list quadrats of this association (27—30, Table V), it is clear that *Zygophyllum album* excludes the characteristics of higher rank in the Salicornion and is associated sometimes with *Limoniastrum monopelatum,* and sometimes with *Halocnemum* together with *Atriplex Halimus,* the latter being well represented. This suggests that the appearance of the *Z. album* association is a stage of advancement towards *A. Halimus.*

A community or more, which forms a part of this series of succession includes *Lygaeum spartum* as a principal characteristic, as it was found to be an important constituent of several list quadrats, sometimes forming quite distinct homogeneous communities, the species itself forming luxuriant tufts. The following list quadrat (No. 51) is a typical community of *Lygaeum spartum.* It was taken in the south-west part of El-Diraà-el-Bahari on 4/2/1950, cover 80-85 %; area of quadrat 50 m²; height of plants 50 cms.:

5.5 Lygaeum spartum L.
3.2 Statice pruinosa L.
2.1 Atriplex Halimus L.
3.2 Sporobolus pungens (Schreb.) Kunth.
1.1 Frankenia laevis L.

Another quadrat (No. 52), area 100 m²; cover 95 %; height of plants up to 50 cms., taken at about 3 kms. to the east of the previous one, on somewhat elevated ground gave the following list: (date: 18/5/1949):

3.4 Lygaeum spartum L.
3.3 Juncus maritimus, var. arabicus Aschers. et Buchenau
2.3 Limoniastrum monopetalum Boiss.
2.2 Atriplex portulacoides L.
2.2 Inula crithmoides L.
2.1 Plantago crassifolia, Forsk.
1.2 Salicornia fruticosa L.
1.1 Frankenia laevis L.
+.1 Sphenopus divaricatus (Gouan) Reichb.

TABLE VI.

includes the localities and other details about the list quadrats of Table V.

Date.	No. of List Quadrat.	Locality.	Area m².	Degree of Cover %.	Height of Plants cms.
13/11/49	38	El-Diraà-el-Bahari, north of Mersa-Matruh road.	50	70	5—50
11/ 2/50	39	El-Diraà-el-Bahari, south of Matruh road at K. 27.	25	90	10—40
4/ 2/50	40	Sidi-Kreir: small marsh between road and dunes.	100	100	10—50
15/ 3/50	41	Bank of lake Mariut, south of Cairo road	1	100	15—60
	42	before Amria.	1	100	15—60
18/ 5/49	43	El-Diraà-el-Bahari, south of Matruh road at K. 27.	100	75	5—70
18/ 5/49	44	—do—	25	70	5—70
15/ 3/50	45	Bank of lake Mariut, south of Cairo road, before Amria.	4	60—70	10—15
4/ 2/50	46	Sidi-Kreir: small salt marsh south of dunes.	25	80	5—80
4/ 2/50	47	El-Diraà-el-Bahari, south-west part of salt	25	50	10—30
	48	marsh.			
10/ 4/49	49	Mallaha depression, mouth of Wadi Simla.	16	50	10—40
	50				

This community is richer in species than the previous one, and appears to be a mixture of other associations.

In the list quadrats Nos. 4 and 5 (Table II), it is noticed that *Lygaeum spartum* appears fairly represented in the sub-association of *Juncus maritimus* together with *Statice pruinosa, Cynodon dactylon* and *Lycium europaeum.*

Lygaeum spartum has also been recorded in other communities of which the following list quadrats are examples:

No. 53: Mallaha depression, mouth of Wadi Simla; area 100 m²; cover 60 %; height of plants 5—30 cms. (date 10/4/1949):

+.1 Lygaeum spartum L.
1.2 Statice pruinosa L.
+.2 Atriplex Halimus L.
1.2 Inula crithmoides L.
+.2 Suaeda fruticosa, Forsk.
1.2 Frankenia laevis L.
2.1 Sphenopus divaricatus (Gouan) Reichb.
+.2 Thymelaea hirsuta (L.) Endl.
1.2 Herniaria hemistemon, J. Guy.
+.1 Salsola vermiculata L.
1.2 Reaumuria hirtella, Jaub et Spach.
2.2 Chenolea arabica, Boiss.
2.1 Bupleurum semicompositum L.

No. 54: Rocky limestone ridge at Ras Alam-el-Roum; area 25 m².

2.3 Lygaeum spartum L.
2.2 Asphodelus microcarpus Viv.
1.2 Onopordon sibthorpianum Boiss. and Heldr. var. alexandrinum, Boiss.
2.2 Thymelaea hirsuta (L.) Endl.
1.2 Pithyranthus tortuosus, Benth. et Hook.
3.2 Lotus corniculatus L. ... etc.

Thus, *Lygaeum spartum* forms a constituent of several communities with different affinities. Quadrat 52 is related both to the Plantaginion crassifoliae and to the Salicornion. In quadrats 50 and 53, *Atriplex Halimus* is represented, whereas quadrat 54 includes species which are not common as halophytes.

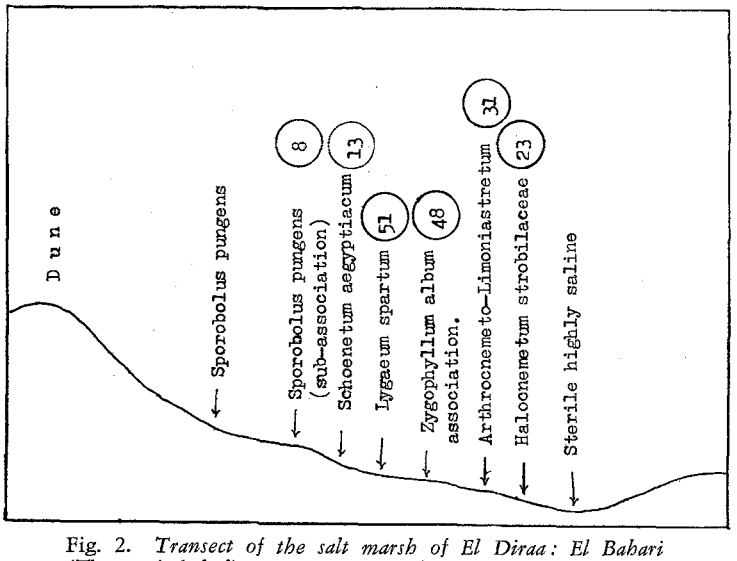


Fig. 2. *Transect of the salt marsh of El Diraa: El Bahari*
(The encircled figure is the no. of a typical list quadrat).

The relative distribution of the previous communities in the marsh of El Diraa El Bahari is shown in fig. 2.

Association 8: Ass. of *Atriplex Halimus* and *Picris radicata* Tadros ass. nova.

Analysis of this association is given in Table VII, the supplementary data of which are given in Table VIII.

This association is physiognomically the most highly developed one of the halophilous communities. It covers considerable areas of land all round the Mersa-Matruh region, and it is especially developed in minefields which have been enclosed since 1942 (see photos No. 7 and 8).

TABLE VII.

Association 8: Atriplicetum Halimi (A. Halimus & Picris radicata) Tadros ass. nova.

No. of list quadrat:	55	56	57	58	59	60	61	62
Characteristics and differential species of the Atriplicetum Halimi:								Intermediate Community
Atriplex Halimus L.	5.5	5.4	4.4	3.3	1.3	1.2	2.2	3.2
Koeleria phleoides (Vill.) Pers.	+	+	2.1	1.1	2.1	+	+	+
Lolium rigidum Boiss.	4.2	4.4	2.1	—	3.1	1.1	+.1	+.1
Picris radicata Less.	+	—	+	+	2.2	+	+	+
Bromus rubens L.	2.2	—	1.1	—	+.1	+	+.1	2.1
Medicago minima (L.) Desr.	—	—	3.2	2.2	2.2	—	1.1	1.1
Hordeum murinum L.	2.2	2.1	1.1	1.1	2.1	—	—	—
Schismus barbatus (L.) Thell.	—	—	2.1	—	—	+	+.1	2.2
Salvia lanigera Poir.	—	—	+	+.1	—	—	+.1	+
Chrysanthemum coronarium L.	1.1	1.1	+	—	—	—	—	+
Anthemis microsperma Boiss et Kotchy.	+	—	+.1	—	—	+	+	—
Stipa capensis Thunb.	—	—	+	1.1	—	2.1	1.1	—
Cistanche lutea Hoffmg. et Link.	1.1	+.1	+.1	—	—	—	—	—
Chenolea arabica (?) Boiss.	—	—	—	—	—	1.2	1.2	—
Lycium europaeum L.	—	—	—	+.2	—	—	—	—
Characteristic species of other associations & companions:								
Thymelaea hirsuta (L.) Endl.	—	—	1.2	2.2	—	—	1.2	2.2
Carthamus lanatus L.	3.2	+	—	—	3.2	—	—	—
Erucaria microcarpa Boiss.	—	—	—	1.1	+	+.1	+.1	—
Atractylis sp. (?)	+	—	—	—	+.2	—	+	+.1
Trifolium sp.	—	—	3.2	—	2.2	—	—	+
Centaurea alexandrina Del.	+.2	—	—	1.2	1.2	—	—	—
Matthiola humilis DC.	—	—	—	+.1	+	+	—	—
Plantago coronopus L.	—	—	—	2.1	—	+	—	+
Brachypodium distachyon P. Beauv.	2.2	—	1.1	—	—	—	—	+
Echium sericeum Vahl.	—	—	+.1	+	—	—	—	+.1
Avena sterilis L.	+.1	+.1	+.1	—	—	—	—	—
Suaeda fruticosa Forsk.	+.2	—	—	—	—	2.3	—	—
Spergularia diandra (guss.) Heldr. et Sart.	—	—	—	1.1	—	3.1	—	—
Filago spathulata Presl.	—	—	—	1.1	—	+	—	—
Anacyclus alexandrinus Willd.	—	—	—	1.1	—	+	—	—
Launea nudicaulis Hook.	—	—	—	+.1	—	—	—	+
Suaeda vermiculata Forsk.	—	—	+.2	—	2.3	—	—	—
Orlaya maritima Koch.	—	—	+.1	—	—	—	+	—
Aegilops kotschyi Boiss.	+	—	—	—	+	—	—	—
Beta vulgaris L. var. maritima (L.) Boiss.	—	+.2	—	—	+	—	—	—
Bupleurum semicompositum L.	—	—	—	—	—	+	+.1	—
Scorzonera alexandrina Boiss.	—	—	—	—	—	+.1	+	—
Anabasis articulata Moq.	—	—	—	—	—	+.2	+.2	—
Sphenopus divaricatus (Gouan) Reichb.	—	—	—	—	—	1.1	1.1	—
Limoniastrum monopetalum Boiss.	—	—	—	—	—	—	—	4.4
Statice pruinosa L.	—	—	—	—	—	+	—	—
Mesembryanthemum nodiflorum L.	—	—	—	—	—	2.2	—	—

The community is composed of 2 layers, a shrub layer with *Atriplex Halimus* as the principal constituent and a herbaceous layer with *Lolium rigidum, Koeleria phleoides, Medicago minima, Picris radicata, Brachypodium distachyon* and a swarm of others, as shown in Table VII. A very characteristic feature is *Cistanche lutea* growing as a root parasite on *A. Halimus.* Although represented by a few individuals, yet it is very distinct even from a distance.

The association perhaps includes some sub-associations, but in order to decide this question further detailed analysis as well as a consideration of the adjacent communities will be required.

The relation of this association to the other halophilous communities will be elucidated by the following transects cut across three different parts of Wadi Simla (Figs. 3, 4 and 5). The numbers of the typical list quadrats are indicated in these transects.

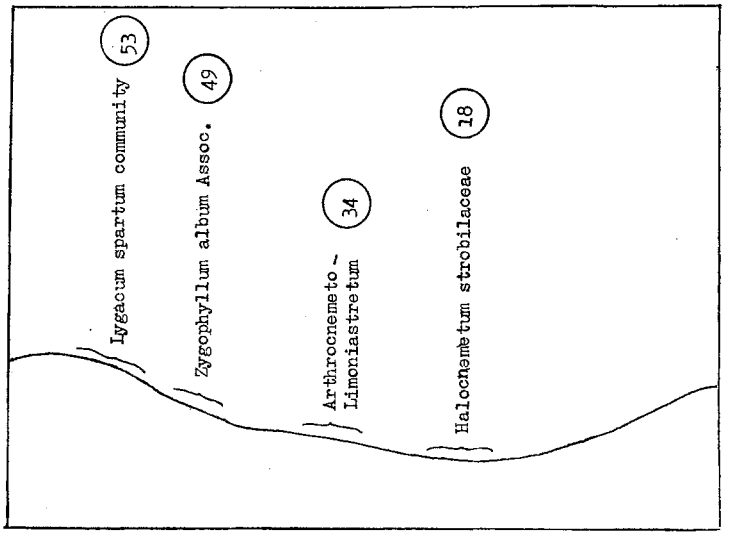


Fig. 3. *Transect towards the mouth of Wadi Simla.*

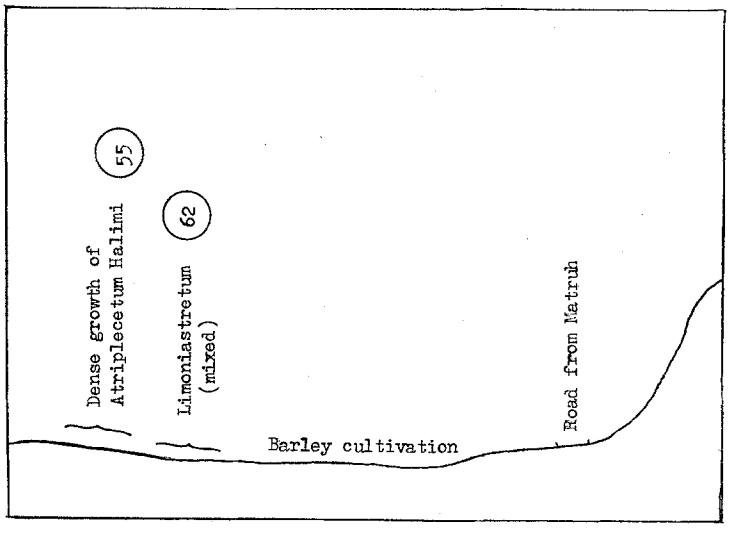


Fig. 4. *Transect in the middle of Wadi Simla.*

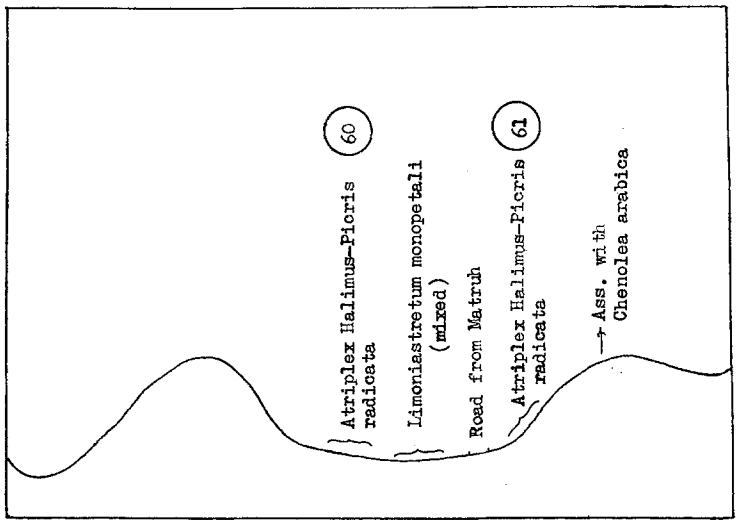


Fig. 5. *Transect towards the end of Wadi Simla.*

In the lower parts of the wadi, nearer to the sea, where the soil is sandy and salinity is relatively high, the following associations are met with: the Halocnemetum, the Arthrocnemeto-Limoniastretum, the Zygophylletum and the Lygeetum more or less regularly disposed from the lower to the higher levels on both sides of the wadi (see Fig. 3).

As the general level of the wadi increases with the distance from the sea, the Limoniastretum becomes more dominant. The Atriplicetum occupies still higher levels as shown in Figs. 4 and 5.

The soil occupied by the Atriplicetum is of a finer sandy structure probably with a higher fraction of silt and clay, darker in colour than the coarser sandy soils occupied by the other associations. The dense growth of *Atriplex* produces a thin layer of dried leaves over the soil surface; and of numerous roots which are more frequent in the upper 30—40 cms. of the soil and less abundant below. The soil is deep and the water table lies at a depth of 5—8 metres.

TABLE VIII.

Association 8: Ass. of Atriplex Halimus and Picris radicata.

Date.	No. of List Quadrat.	Locality.	Area m².	Degree of Cover %.	Height of Plants cms.
10/ 4/49	55	Wadi Simla: Atriplex thicket.	100	100	10—100
7/ 4/49	56	El-Qasr region, near Roman well (El-Romani)	100	100	30—100
10/ 4/49	57	Wadi Simla, 12 kms. S.E. of Mersa-Matruh.	100	95	30—100
8/ 4/49	58	A hill at 299 k. from Alexandria, west of Mersa-Matruh, about 3 kms. south of main road.	100	50	10—60
10/ 4/49	59	Wadi Simla, 12 kms. S.E. of Mersa-Matruh.	100	95	30—100
10/ 4/49	60	Wadi Simla.	100	40	10—40
10/ 4/49	61	—do— northern slope of hill inclination about 40° facing north.	100	60	10—40
10/ 4/49	62	Wadi Simla: margin of Atriplex thicket.	100	90	10—100

The following species have been recorded as accidentals in this association:

Statice tubiflora Delile
Echinops spinosus L.
Lotus creticus L.
Onobrychis Crista-galli Lam.
Achillea santolina L.
Emex spinosus L.
Enarthrocarpus strangulatus Boiss.
Herniaria hemistemon J. Guy.
Dactylis glomerata L.
Allium sp.
Malva aegyptia L.
Silene colorata Poir.
Trigonella stellata Forsk.
Erodium hirtum (Forsk.) Willd.
Gymnocarpus fruticosus Pers.
Reaumuria hirtella Jaub. et Spach.
Salsola vermiculata L.
Odontospermum pygmaeum Benth et Hook.
Anagallis arvensis L.
Ononis sicula Guss.
Pithyranthus tortuosus Benth. et Hook.
Marrubium Alysson L.
Phalaris sp.
Polygonum equisetiforme Sibth. et Smith
Convolvulus arvensis L.
Eryngium creticum Lam.

DISCUSSION.

The Significance of the Associations.

Table IX includes the characteristic species and their relative occurrence in the different communities. The individuality is especially clear in the Atriplicetum Halimi (Association of *Atriplex Halimus* and *Picris radicata*).

Figures 2 and 3 show the distribution of these communities along transects made in the regions of El-Diraà-el-Bahari and Wadi Simla.

Further observations and records made during later visits in 1951 and 1952 to other salt marshes of Mareotis, have shown that the communities described herein are repeated under similar conditions and have a definite identity as well as a definite sequence as shown in general outline by the suggested scheme on page 21.

These associations, especially of the right hand side of the scheme, are disposed in regular belts from the highly saline lower parts to the more elevated less saline parts; and where the environmental conditions change we find mixed communities of overlapping associations. The salt marsh of Wadi El Naghamish (5 kms. south east of W. Simla) and the still larger one east of El-Garawla (20 kms. s.e. of W. Simla) provide excellent localities for the confirmation of such a conclusion. There, the belts can be distinguished from a distance by the practised eye.

Relation with Other Halophytic Communities Around the Mediterranean.

A comparison between the halophytic associations distinguished in this work and parallel associations described in other circum-Mediterranean regions, shows that the former have a special composition though some of the principal characteristic species are common.

Thus, in the Mediterranean region of France, BRAUN-BLANQUET (1933, 1947) distinguished several associations belonging to two orders, the Salicornietalia and the Juncetalia maritimi. From these associations, only the following bear certain relationships to ours, viz. the Arthrocnemetum with the Halocnemetum, and the Limoniastretum with the Arthrocnemeto-Limoniastretum.

TABLE IX.

Relative Occurrence of the Different Species in the Different Communities.

Species.	Junceto-Schoenetum		Schoenetum aegyptiacum	Halocnemetum strobilacei	Arthrocnemeto-Limoniastretum	Salicornieto-Staticetum		Zygophylletum albi	Ass. of Atriplex Halimus & Picris radicata
	Sporobolus pungens	Juncus maritimus				Atriplex portulacoides	Phragmites communis		
Juncus maritimus var. arabicus Aschers. et Buchenau	**100**	**100**	**80**	—	25	**60**	**50**	—	—
Statice pruinosa L.	**60**	**80**	**100**	12	33	**80**	25	25	14
Sporobolus pungens (Schreb.) Kunth.	**100**	20	**80**	—	25	40	25	—	—
Schoenus nigricans L.	—	—	**100**	—	—	—	—	—	—
Plantago crassifolia Forsk.	40	**100**	**100**	—	8	**100**	—	—	—
Salicornia fruticosa L.	**60**	**80**	**80**	**100**	**90**	**100**	**100**	—	—
Arthrocnemum glaucum (Del.) Unger-Sternb.	—	—	—	—	—	—	—	—	—
Halocnemum strobilaceum M. Bieb.	—	—	—	**88**	**75**	—	—	**50**	—
Limoniastrum monopetalum Boiss.	**60**	20	20	—	**90**	40	—	25	—
Frankenia laevis L.	20	40	40	—	**60**	40	—	25	—
Cressa cretica L.	—	—	—	—	**33**	—	—	—	—
Mesembryanthemum nodiflorum L.	—	—	—	—	33	20	—	—	14
Pholiurus incurvatus Hitchc.	20	—	20	—	17	20	—	—	—
Inula crithmoides L.	40	40	**60**	—	25	40	25	—	—
Atriplex portulacoides L.	**80**	20	40	25	33	**100**	**75**	—	—
Phragmites communis Trin.	—	—	—	—	—	—	**100**	—	—
Zygophyllum album L.	—	—	—	—	—	—	—	**100**	—
Sphenopus divaricatus (Gouan) Reichb.	20	20	—	—	**68**	40	25	25	29
Lygaeum spartum L.	20	40	40	—	—	20	—	**50**	—
Atriplex Halimus L.	—	—	—	—	—	—	—	**75**	**100**
Picris radicata Less.	—	—	—	—	—	—	—	—	**85**
Koeleria phleoides (Vill.) Pers.	—	—	—	—	—	—	—	—	**100**
Lolium rigidum Boiss.	40	—	20	—	—	—	—	—	**85**
Bromus rubens L.	—	—	—	—	—	—	—	—	**72**
Medicago minima (L.) Bartel.	—	—	—	—	—	—	—	—	**57**
Hordeum murinum L.	—	—	—	—	-	—	—	—	**72**
Schismus barbatus L.	—	—	—	—	—	—	—	—	43
Salvia lanigera Poir.	—	—	—	—	—	—	—	—	43
Chrysanthemum coronarium L.	—	—	—	—	—	—	—	—	43
Anthemis microsperma Boiss.	—	—	—	—	—	—	—	—	**57**
Stipa capensis Thunb.	—	—	—	—	—	—	—	—	**57**
Cistanche lutea Hoffmg. et Link.	—	—	—	—	—	—	—	—	43
Chenolea arabica (?) Boiss.	—	—	—	—	—	—	—	—	29
Lycium europaeum L.	—	40	—	—	—	—	—	—	14
Suaeda fruticosa Forsk.	20	—	40	—	17	40	—	25	—

N.B. Figures in heavy type refer to the species most highly represented in each community.

In the Tunisian Sahara, BRAUN-BLANQUET (1949) distinguished several halophytic associations inhabiting the salt marshes called Sebkhas. The pioneer community is an association of Halocnemum strobilaceum belonging to an alliance called Halocnemion occidentale. This is followed in the succession by another association inhabiting higher levels, the leading species of which are *Limoniastrum guyonianum, Nitraria retusa, Suaeda vermicultata* and *Zygophyllum album.* He incorporated it in another alliance, viz. the Limoniastro-Nitrarion. This association is ecologically comparable to our Arthrocnemeto-Limoniastretum and Zygophylletum albae together.

In Spain, the same author (1936) recorded *Zygophyllum album* as a characteristic species of a special salt marsh association with *Statice delicatula,* which belongs to the alliance Staticion galloprovincialis and covers hillocks 40 cms. above water level.

Lygaeum spartum is an interesting species, forming a, sometimes fairly important constituent, of more than one type of community, of which some are related to the halophilous communities herein described and some to other non-halophilous communities of Mareotis which have not yet been described.

Lygaeum spartum was described by BRAUN-BLANQUET (1936) as a tall steppe grass growing on clay soils of Mauritania and forming fairly dense populations associated with other steppe species, e.g. *Stipa parviflora, Schismus calycinus, Herniaria fruticosa, Adonis microcarpa, Peganum harmala, Marrubium alysson, Artemisia herba-alba* and others. These species are not infrequent in Mareotis, but so far we have not noticed their association with *Lygaeum spartum.* More extensive phytosociological studies might reveal the relation between the different communities in which *Lygaeum spartum* occurs, and the other halophilous and non-halophilous communities described from the other Mediterranean regions.

In Algeria, the vicinity of Beni Ounif was studied by KILLIAN and LEMÉE (1948), who distinguished five halophytic associations.

These too, are not identical with those of Mariut, though certain characteristic species are represented in both, such as *Salicornia fruticosa, Juncus maritimus, Phragmites communis, (Polypogon monspeliensis)* in the more humid variant of the first association; and *Atriplex Halimus* and *Zygophyllum album* in the drier variant of the same association. The latter, however, corresponds to a certain extent with our Zygophyllum album association.

Richer communities of the steppe type with *Atriplex Halimus,* such as observed in the region of Mersa-Matruh are likely to be the product of more humid conditions and better drained soil than at Beni Ounif. MAIRE and WEILLER (1947) distinguished a steppe vegetation with *Atriplex Halimus* and *Lygaeum Spartum* in the silty parts of the northern littoral zone; and with *Aristida pungens* in the sandy parts of Tripolitania. This part is actually the western extension of Mareotis with a similar annual rainfall of 150 to 200 mm., whereas the region around Beni Ounif receives only 80 to 100 mm.

ZOHARY (1944) distinguished an association of *Zygophyllum album, Z. coccineum* and *Plantago cylindrica* and called it Zygophylletum albi. According to him, it is common on flat and saline lands in the coastal plain of the Red Sea bordering the desert of Sinai.

Evidently this is different from the Zygophylletum albae of Mareotis.

In Palestine, ZOHARY (1947) distinguished some halophytic communities of which the following may be related to our associations:

From the Junceto-Phragmition, a community with *Juncus maritimus* var. *arabicus, Inula crithmoides* and *Statice Limonium.*

From the Atripliceto-Suaedion, a. the Atriplicetum Halimi Jordanicum and b. the Atriplex Halimus - Suaeda fruticosa association.

EIG (1946) recorded his association (No. 83) containing *Atriplex Halimus* and several accessory species of the Atriplex Halimus-Picris radicata association, though the principal characteristics are different.

He also mentioned an Arthrocnemetum glauci (his no. 84) containing several species which are distinguished here as characteristic species of other associations, such as *Plantago crassifolia* and *Lolium rigidum.*

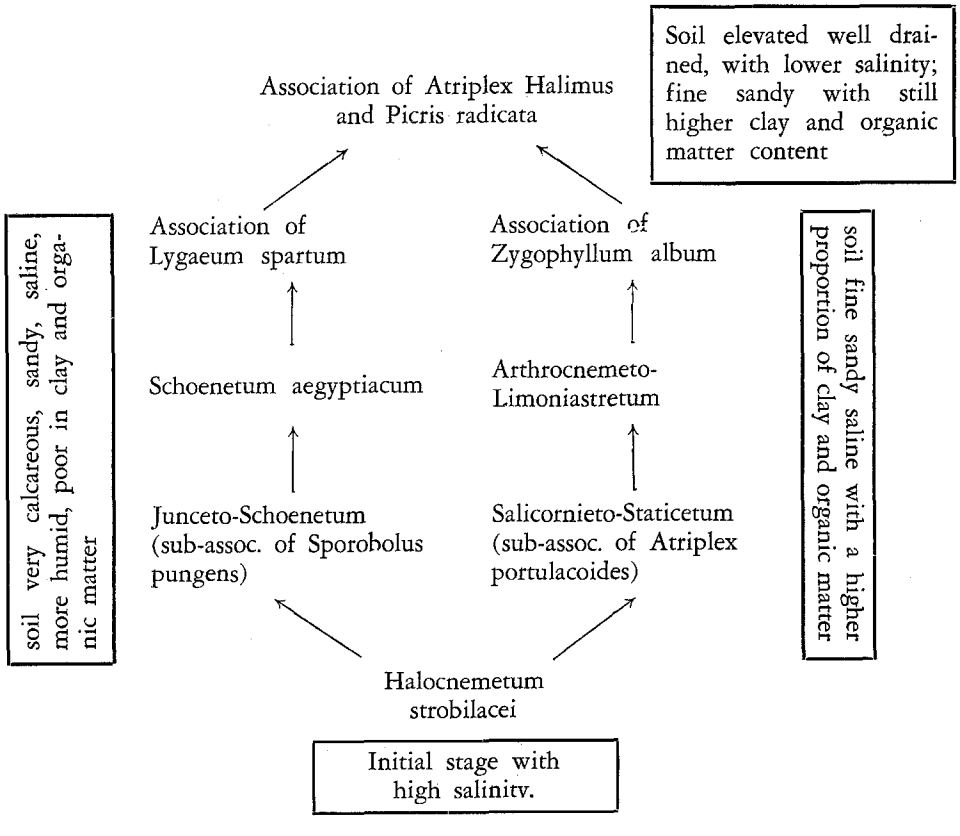
The association of Juncus maritimus and Schoenus nigricans (No. 73) of the same author again differs from the Schoenetum aegyptiacum. Both differ markedly in composition from the Schoeneto-Plantaginetum crassifoliae analysed by BRAUN-BLANQUET (TOMASELLI 1947 in the littoral zone of Montpellier.

From this review of the available literature the conclusion may be drawn that the halophytic associations described in this investigation are peculiar and reflect their own special ecological conditions. They are, however, related to other halophytic circum-Mediterranean communities by the principal characteristics which have a wider distribution and a greater ecological amplitude than the local members of the associations.

For the establishing and understanding of these relationships, further, more detailed, work and regulated collaboration are required.

Possible Successional Relationships.

From the facts revealed by the analytical tables given in this work, as well as from direct field observations, I have made the following scheme illustrating the possible successional relationships between the distinguished associations, based principally upon changes of relief which bring out changes in the texture, salinity and water content of the soil:



This is, however, a provisional general outline of the successional relationships of these salt marsh communities. There are some more communities that have been distinguished during later studies and which will be inserted in their proper place in this scheme.

The link between the communities of the left hand side of the scheme and the initial stage is somewhat vague. They may be derived from a separate line of succession, which is to be sought perhaps in the submerged communities. These points are still the subject of more extended phytosociological and ecological studies in progress.

The conclusion that may be drawn from this scheme reveals the importance of natural succession and development of plant communities in reclaiming these marshy localities which cover considerable areas in the Mediterranean coastal part of Egypt.

This natural reclamation is evidently delayed or even hindered by the abuse of the vegetation, and therefore one should stress the necessity of taking strict and rapid measures to limit the destruction of vegetation by grazing and cutting. Such a management would raise the agricultural value of these areas in a relatively short time, especially in parts which are very remote from the Nile Valley and to which irrigation projects will never arrive.

SUMMARY

1. This investigation is a sociological study of the halophytic communities of the coastal Mediterranean part of Egypt west of Alexandria (Mareotis).
2. The study was localised in two regions, viz. the region of Amria and the region of Mersa-Matruh, of which a brief description of the relief and climate is given.
3. The communities were studied by the list quadrat method according to the Zurich-Montpellier school.
4. The following communities could be distinguished:

Plantaginion crassifoliae:

Association 1: Junceto-Schoenetum
- a. sub-association of Juncus maritimus
- b. sub-association of Sporobolus pungens

Association 2: Schoenetum aegyptiacum

Salicornion:

Association 3: Halocnemetum strobilacei

Association 4: Salicornieto-Staticetum
- a. sub-association of Atriplex portulacoides
- b. sub-association of Phragmites communis

Association 5: Arthrocnemeto-Limoniastretum monopetali

Association 6: Ass. of Zygophyllum album

Association 7: A Community of Lygaeum spartum

Association 8: Ass. of Atriplex Halimus and Picris radicata.

The separation was based on the fidelity of the species and their relative occurrence, abundance and sociability.

5. It was shown that each association occupies habitats of definite sea levels which show differences in soil texture, salinity, water and organic matter contents. The details of soil analysis will be given in a subsequent contribution.

6. The associations were discussed with regard to their successional relationships as well as to their relations to other halophytic circum-Mediterranean communities.
7. It was concluded that these associations of Mareotis have their individuality and reflect local environmental conditions, though they are related by the major characteristic species to the other circum-Mediterranean communities.

REFERENCES.

ADRIANI, M. J., 1945 — Sur la Phytosociologie, la Synécologie et le Bilan d'eau de halophytes de la région Néerlandaise méridionale, ainsi que de la Méditerranée Française. *Comm. de la S.I.G.M.A.*, Montpellier, **88**.

BLACKMAN, G. E., 1935 — A Study by Statistical Methods of Species in Grassland Associations. *Ann. Bot.* **49**, p. 749.

BRAUN-BLANQUET, J., 1932 — Plant Sociology (English Translation by FULLER and CONARD); McGraw Hill Co., New York.

—, 1933 — Prodrome des Groupements Végétaux. Fasc. 1: Ammophiletalia et Salicornietalia Mediterranea.

—, 1936 — L'Excursion de la S.I.G.M.A. en Catalogne. *Comm. de la S.I.G.M.A.*, **38**.

—, 1949 — Premier aperçu phytosociologique du Sahara Tunisien. Memoirs hors-serie de la Société d'Hist. Nat. de l'Afrique du Nord, Tome II.

—, et J. PAVILLARD, 1928 — Vocubulaire de Sociologie Végétale. Montpellier.

EIG, A., 1946 — Synopsis of the Phytosociological Units of Palestine. *Palestine J. Bot.*, Jerusalem series, Vol. **III**.

EMBERGER, L., 1942 — Un Projet d'une Classification des Climats du Point de Vue Phytogéographique. *Bull. Hist. Nat. de Toulouse*, **77**.

KILLIAN, Ch. et G. LEMÉE, 1948 — Etude Sociologique, Morphologique et Ecologique de quelques Halophytes Sahariens. *Rev. Gén. Bot.* **55**, p. 376.

MAIRE, R. et M. WEILLER, 1947 — Rémarques sur la Flore et la Végétation de la Tripolitaine et de la Cyrénaique Septentrionales. *Réc. Trav. Inst. Bot. Montpellier*, Fasc. **3**.

MONTASIR, A. H., 1943 — Soil Structure in Relation to Plants at Mariut. *Bull. Inst. d'Egypte*, **35**.

OLIVER, F. W., 1945 — Flowers of Mareotis, parts I and II. *Trans. Norfolk & Norwich Naturalists Society.*

—, 1945—1946 — Dust Storms in Egypt and their Relation to the War Period as Noted in Mariut (1936—45). *Geogr. J.*, **106**, 1—2, July-Aug. 1945, and **108**, 4-6, Dec. 1946.

TADROS, T. M., 1936 — Osmotic Pressure of some Egyptian Desert Plants in Relation to their Water Supply. *Bull. Fac. of Sc., Egyptian Univ.* **7**.

TOMASELLI, R., 1947 — Metodi di Rilevamento Fitosociologico in Uso nella Stazione Internazionale di Geobotanica di Montpellier. *Comm. de la S.I.G.M.A.*, Montpellier, **95**.

ZOHARY, M., 1944 — Vegetational Transects through the Desert of Sinai. *Palestine J. Bot.*, **III**, 2.

—, 1947 — A Vegetation Map of Western Palestine. *J. Ecol.*, **34**, 1.