J. Univ. Kuwait (Sci.) 1, 1974

ECOLOGICAL STUDIES ON THE DESERT OF KUWAIT
II THE VEGETATION

R. HALWAGY AND M. HALWAGY

Department of Botany, University of Kuwait

Abstract. The vegetation of Kuwait is a poor open scrub of undershrubs, perennial herbs and ephemerals. It is determined primarily by rainfall, to a lesser extent by landform and biotic factors, especially grazing. It shows a well marked seasonal aspect. Previous information on the vegetation is reviewed and the major communities defined by various authors are outlined. A new classification is proposed, based on variations in the habitat characteristics, especially landform and soils, and also on the dominant species. Four ecosystems are recognised : the sand dune ecosystem, the salt marsh and saline depressions ecosystem, the desert plain ecosystem and the desert plateau ecosystem. A new vegetation map is given and the possible successional relationships discussed.

INTRODUCTION

In a previous paper (Halwagy & Halwagy 1974), the salient features of the physical environment of the desert of Kuwait were outlined. The object of the present paper is to give an account of the vegetation of Kuwait as related to the different habitat characteristics.

GENERAL FEATURES

The vegetation of Kuwait is a poor open scrub of undershrubs, perennial herbs and ephemerals. Only in favoured sites do we find a scattering of taller shrubs, usually about man's height.

The vegetation is controlled primarily by rainfall, but landform and biotic factors are also important. The total amount of vegetation generally bears a direct relationship to the total annual rainfall. Thus, in years of above average rainfall e.g. 1967/1968, 1968/1969 and 1971/1972, where respectively 162, 159 and 223 mm were recorded at Shuwaikh, the desert was covered with a rich green mantle. Conversely, years of meagre rainfall such as 1966/1967 (57 mm) and 1969/1970 (54 mm) usually witness partial or complete failure of the vegetation.

Landform, especially microrelief, may influence the redistribution of rainwater and surface sediments, directing them towards lower ground. Such favoured sites e.g. drainage lines and sandy basins, often exhibit far more luxuriant growth than that on adjacent areas which are only a few decimetres higher up. Again, the accumulation of soft deposits, even a thin veneer of sand on top of hard ground or rock surface, provides a favourable seed bed particularly for winter annuals which usually germinate in profusion on such sites.

The length of the rainy season generally determines the length of the growth season. The first rains trigger the germination of the seeds of the desert ephemerals and stimulate the sprouting of perennials. It appears that an initial heavy rain of 20 - 25 mm is required and if subsequent rains are reasonably spaced, luxuriant growth may be ensured. Best growth is noticeable if the first rains are early e.g. during the ' Wasm' period (October 10 - November 5), when warm temperatures prevail and help seed germination and bud development. On the other hand, when the first rains are delayed until December or January, they frequently coincide with cold weather and plant activity may be retarded. The end of the rainy season, commonly in April, sometimes in March, brings about the maturation and drying up of the desert vegetation. A prolonged rainy season may cause the extension of the growth season. It is interesting to note that in 1968, dry weather prevailed from March 7 to April 8 and most ephemerals produced mature fruits and dried up. Following heavy rains on April 9 and April 22, a few individuals of *Schimpera arabica* Hochst. & Steud., a common annual crucifer, were seen on May 1 to possess dried up vegetative bodies with dry fruits, in addition to a number of new leafy and flowering branches. It thus appears that late rains may cause the rejuvenation even of annual plants.

The vegetation of Kuwait exhibits well marked seasonal aspects, which are determined essentially by the seasonality of climate, namely the winter rains, and accentuated by biotic factors especially grazing. Overgrazing by goats,

sheep and camels, is widespread and nomadic and seminomadic pastoralism is the usual practice. In years of good rainfall, animals usually find a sufficiency during the growing season, but continue to denude the land throughout the long drought season so that the rich green mantle in the spring and early summer contrasts so markedly with the poor, almost bare, desert aspect of summer and autumn. In bad or "mahal" years, grazing makes a bad situation worse and the landscape is thrown to desert almost past recovery. In 1966/1967 and 1969/1970, for example, the perennial vegetation, and especially the more palatable species were grazed down to the ground even during the "favourable" season so that the possibility of their recovery appeared remote. Fortunately, however, the occurrence of the subsequent years with above average rainfall allowed spectacular recovery.

Previous Information

Published information on the vegetation of Kuwait is considerably scarce. Apart from casual reference, mostly in mimeographed FAO or service reports, the vegetation has received little attention. Dickson (1955), in her book entitled "The wild flowers of Kuwait and Bahrain", published a sketch map of Kuwait showing the "distribution of flora" (Fig. 1).

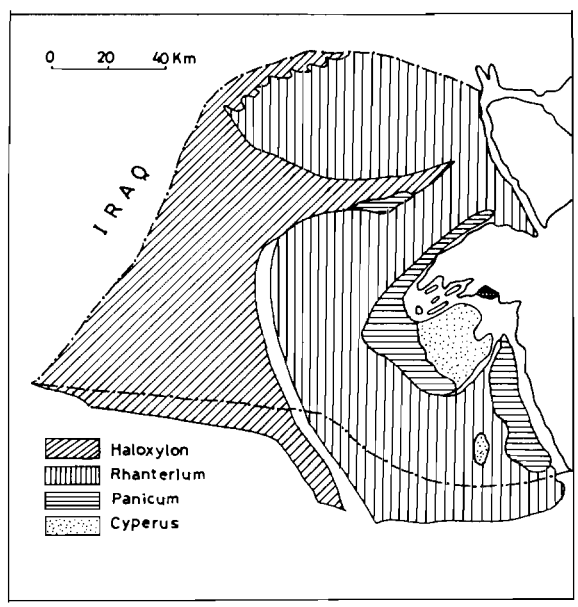

FIG. 1. VEGETATION MAP OF KUWAIT (AFTER DICKSON 1955)

Four plant communities are recognised:

1. Community of *Haloxylon salicornicum* (Moq.) Bge., with *Anabasis articulata* (Forssk.) Moq. as a common associate, in the west.
2. Community of *Rhanterium epapposum* Oliv. in the central, northern, northeastern and southern parts of the State.
3. Community of *Panicum turgidum* Forssk., occupying relatively small areas in the central and southeastern regions.
4. Community of *Cyperus conglomeratus* Rottb., also of limited extent and occurring south and southeast of Kuwait City.

Kernick (1963a) states that the perennial vegetation of Kuwait comprises the following major plant communities:

1. Coastal salt bush associations: these are most local in distribution and usually occur in low-lying saline areas. They are composed chiefly of *Zygophyllum coccineum* L., growing in association with other halophytes such as *Nitraria retusa* (Forssk.) Aschers. & Schweinf., *Halocnemon strobilaceum* (Pall.) M.B., *Seidlitzia rosmarinus* Bge. ex Boiss., *Suaeda vermiculata* Forssk., *Salsola baryosma* (Schult.) Dandy, *Cornulaca leucacantha* Charif & Aellen and *Aeluropus lagopoides* (L.) Trin. ex Thw.
2. Coastal sand associations: which occur round the Bay of Kuwait and down the Gulf coast. The chief constituent is *Panicum turgidum* which grows on top of mounds of blown sand.
3. *Cyperus* steppe: represented by *Cyperus conglomeratus* on the deeper sandy areas of the southern half of the State, mainly between Kuwait City and the Burgan oilfield.
4. *Rhanterium* steppe: which is dominated by *Rhanterium epapposum* and occupies a very large area of the State.
5. *Haloxylon* steppe: composed chiefly of *Haloxylon salicornicum* and occurs mainly on hard gravel areas in the north and south, associated with *Anabasis articulata, Anabasis setifera* Moq. and *Zilla spinosa* (L.) Prantl in the west.

Kernick (1963 b) gives the approximate surface area of the major plant communities in Kuwait as follows:

18,200	hectares under *Zygophyllum coccineum* and other halophytic plants
28,400	hectares under *Panicum turgidum*
68,900	hectares under *Cyperus conglome-*

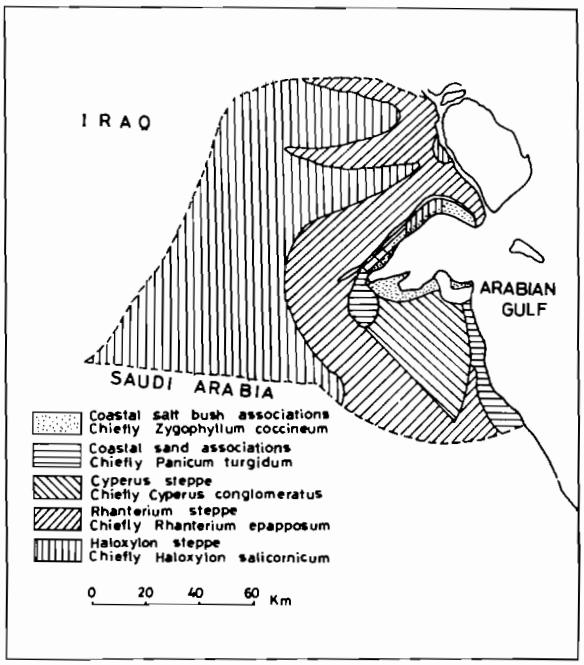

FIG. 2. VEGETATION MAP OF KUWAIT (KERNICK 1964)

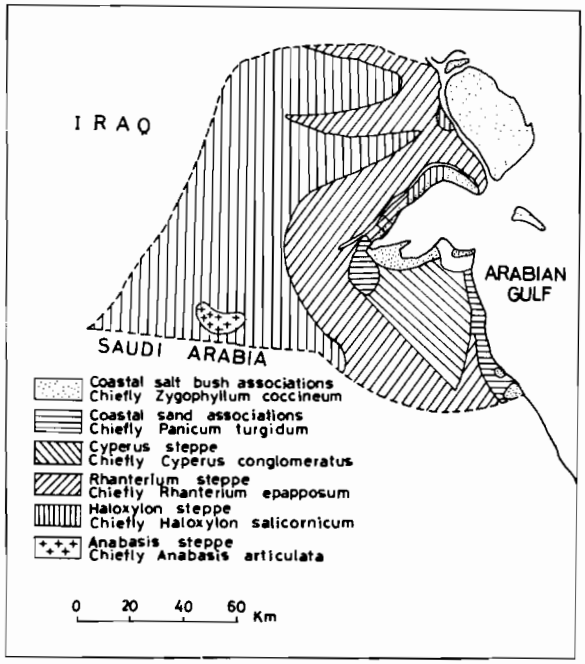

FIG. 3. VEGETATION MAP OF KUWAIT (KERNICK 1966)

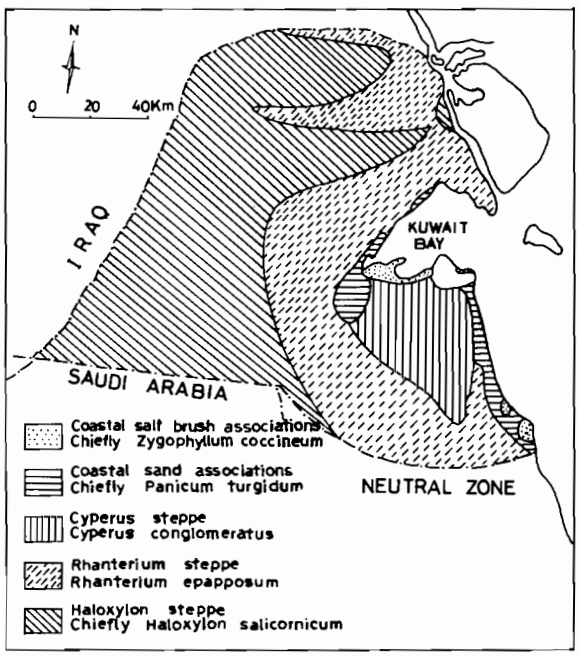

FIG. 4. VEGETATION MAP OF KUWAIT (ERGUN 1969)

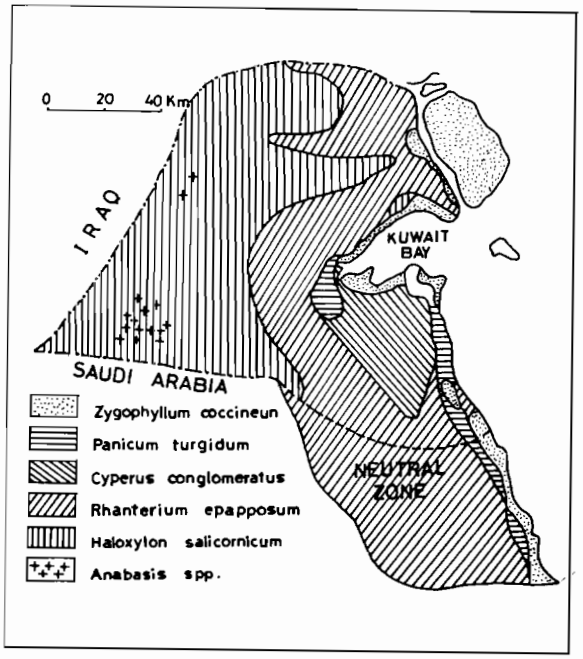

FIG. 5. VEGETATION MAP OF KUWAIT (AFTER MACKSAD 1969)

ratus

526,500 hectares under *Rhanterium epapposum*

688,500 hectares under *Haloxylon salicornicum*

In 1964, Kernick estimates the area covered by *Panicum turgidum* as 36,500 hectares and that covered by *Cyperus conglomeratus* as 109,400 hectares. He also published two vegetation maps of Kuwait which are reproduced in Figs. 2 and 3 (Kernick 1964, 1966). Ergun (1969) prepared a vegetation map (Fig. 4) presumably based on information supplied by Kernick (Macksad, personal communication). Finally Macksad (1969) gave a vegetation map of the State of Kuwait and the Neutral Zone (Fig. 5).

It should be mentioned that Emberger *et al.* (1969) proposed a vegetation map of the Mediterranean zone. They distinguish four climatic and two edaphic formations in Kuwait. These are at variance with our own observations. However, it must be remembered that in their map (scale 1: 5,000,000), approximations and generalisations are inevitable. Emberger *et al.* (1969), further point out that for some regions, including Arabia and Iran, cartographic documents were either inaccurate or non-existent. Their bibliography includes none from Kuwait.

While discussing the vegetation of a small country like Kuwait, mention should perhaps be made of the vegetation of neighbouring regions i.e. southern Iraq and northeastern Saudi Arabia. Published accounts are given by Zohary (1950), Guest (1953), Springfield (1954), Harris (1960), Chapman (1960) and Guest (1966) in Iraq. In Saudi Arabia, the only relevant information is due to Vesey-Fitzgerald (1957).

A comparison of the various local maps reveals several differences. These may be due to actual vegetational changes, but varying degrees of accuracy by the different authorities may also be responsible. The main differences between the maps by Dickson (1955) and Kernick (1964) are:

1. Dickson (1955) does not recognise a community of *Zygophyllum coccineum;* this is obviously due to an oversight by Dickson.
2. The *Panicum turgidum* community of Dickson (1955) has retreated considerably by 1964, having been replaced by *Cyperus conglomeratus* and *Rhanterium epapposum* (Kernick 1964). This may be due to overgrazing, since *Panicum* is more palatable than either *Cyperus* or *Rhanterium.*
3. *Haloxylon salicornicum* in the north, has increased at the expense of *Rhanterium epapposum* between 1955 and 1964. Biotic factors may again be responsible, *Rhanterium* being more palatable than *Haloxylon.* Moreover, *Rhanterium* is renowned for its aromatic fragrance and therefore was more extensively used as firewood especially before the untold wealth from oil revenues changed the pattern of life. *Rhanterium* was then cut in quantity and sold in Kuwait City.
4. A small area dominated by *Haloxylon salicornicum* appears for the first time in 1964 opposite the coast of Bubiyan Island. This may be due to oversight by Dickson (1955).
5. *Haloxylon salicornicum* replaced *Panicum turgidum* over a limited area north of the Bay of Kuwait.

In 1966, Kernick modified his earlier map. He extends the coastal salt bush communities to cover the islands of Warba, Bubiyan and Failakka, as well as two small pockets amid *Panicum turgidum* country along the Gulf coast south of Kuwait City. He also inserts an *Anabasis* steppe (chiefly *Anabasis articulata*) among *Haloxylon* steppe in the west of the State.

The maps by Kernick (1966) and Ergun (1969) are basically similar; the main differences are:

1. The vegetation of Warba, Bubiyan and Failakka islands is not mentioned by Ergun.
2. Ergun rightfully ignores the *Anabasis* steppe in the western part of the State.
3. The salt bush association on the coast northeast of Kuwait Bay (Kernick 1966) is replaced by *Rhanterium epapposum* (Ergun 1969).
4. The limited community of *Haloxylon salicornicum* on the northern shore of the Bay of Kuwait (Kernick 1966) is absent in Ergun's map, having been partly replaced by *Panicum turgidum.* This agrees to some extent with Dickson's map. It is difficult to imagine the occurrence of any substantial vegetational changes over a period of 3 years. Moreover, it is more logical to expect *Haloxylon* to replace *Panicum.*

The map proposed by Macksad (1969) reveals the following features, as compared with that of Ergun (1969):

1. The vegetation of the Neutral Zone is shown for the first time.

2. Bubiyan Island is occupied by *Zygophyllum coccineum.*
3. *Zygophyllum coccineum* forms a small community opposite the coast of Bubiyan Island, in place of the *Haloxylon salicornicum* community of Ergun (1969).
4. *Zygophyllum coccineum* has expanded along the north coast of Kuwait Bay and also along the greater part of the Gulf coast in the southeast of the State of Kuwait.
5. Macksad more or less reinstates the small area occupied by *Haloxylon salicornicum* on the north coast of Kuwait Bay to its former position as shown by Kernick (1966).
6. Community of *Anabasis articulata* and *Anabasis setifera* is shown in the west, among *Haloxylon salicornicum.*

Present Condition

In the opinion of the authors, the present state of the vegetation requires the introduction of several refinements and corrections over the earlier maps. A tentative vegetation map is proposed by the authors (Fig. 6). Its salient features are:

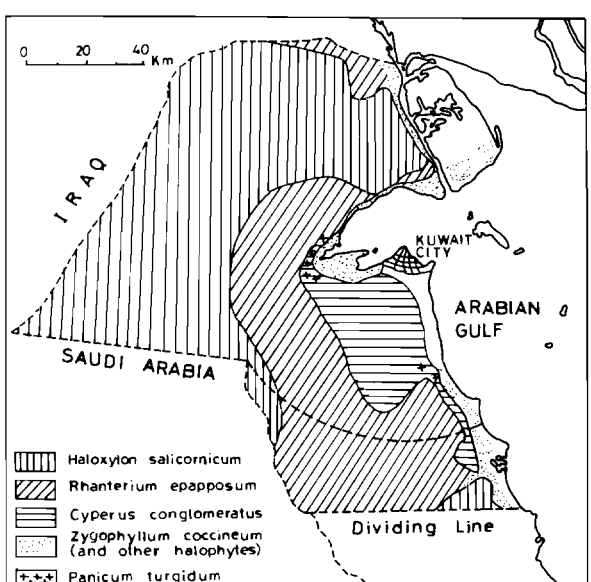

FIG. 6. VEEGTATION MAP OF KUWAIT (PROPOSED BY THE AUTHORS)

1. *Haloxylon salicornicum* (not *Rhanterium epapposum*) occupies the southeastern and northwestern parts of the divided Neutral Zone.
2. *Anabasis* spp. do not constitute a well distinguished community anywhere in Kuwait. In fact they are not even important members in other communities.
3. The coastal strip between Kuwait City and south of Shua'ibah is at present much disturbed as a result of intensive urbanisation and industrialisation. It should perhaps be excluded from any attempt to map the "natural" vegetation. Further south, the lowland saline depressions are occupied by a salt marsh community dominated by *Zygophyllum coccineum.* On higher ground, *Cyperus conglomeratus* and occasionally *Panicum turgidum* may gain importance.
4. Bubiyan island is not dominated by *Zygophyllum coccineum.* It is a dreary mud flat, more or less barren and wet throughout. Only on low ridges does *Halocnemon strobilaceum* occur, while the higher sandy mounds in the south are dominated by *Seidlitzia rosmarinus.*
5. The coasts of the Bay of Kuwait and Khor Al-Sabiyah are occupied by a salt marsh community in which *Halocnemon strobilaceum* occurs most seawards, while *Zygophyllum coccineum* usually dominates further inland.
6. *Panicum turgidum* has retreated considerably and may soon disappear in Kuwait. At present, it rarely forms a pure community over large areas, except perhaps at Al-Atraf, southwest of the corner of Kuwait Bay. Overgrazing is no doubt responsible.

Successional Relationships

The differences in information reported by the various authors (Dickson 1955; Kernick 1964, 1966; Ergun 1969; Macksad 1969) must not always be construed to indicate any real vegetational changes. They have to be treated with caution since inaccuracies are evident here and there. Some authors are not botanists and most are non-ecologists. For all its value, Dickson's book (1955) is essentially a floristic list of species with amateur's descriptions. The list has been subsequently expanded and nomenclature revised by Halwagy and Macksad (1972). The book makes no claim to ecological studies, except for the map showing the "distribution of

flora", using the local, rather than the scientific, names of the dominant species. Ergun is FAO soil scientist and presumably based his botanical information on Kernick's. Kernick, FAO botanist, and Macksad, his counterpart, are reported to have landed by helicopter in Saudi Arabia by mistake, where they encountered the *Anabasis* steppe (Kernick 1966 and Macksad 1969). Such an error is quite understandable in the absence of any prominent landmarks in the desert. However, frequent trips to the west of Kuwait since 1968, have failed to take the present authors to any *Anabasis* community. Nomads report the occurrence of *Anabasis articulata* and *Anabasis setifera* in quantity in the neighbouring regions of Saudi Arabia.

In view of the above considerations and the lack of reliable information about the previous condition of the vegetation, the exact successional relationships cannot be understood. However, the following sequence of succession appears feasible:

1. *Cyperus* and *Rhanterium* replace *Panicum* under conditions of overgrazing, *Panicum* being more palatable.
2. *Haloxylon* replaces *Rhanterium* as a result of overgrazing, cutting or soil erosion. *Rhanterium* is more in demand. *Haloxylon* grows on thin soil (10 - 50 cm) overlying hardpan while *Rhanterium* seems to flourish on deeper soil. *Haloxylon* has expanded considerably at the expense of *Rhanterium* in the north of the State (cf. Dickson 1955 and the present authors' map).
3. The suggestion that *Zygophyllum* replaces *Panicum* along the north coast of the Bay of Kuwait and the greater part of the Gulf coast south of Kuwait City does not appear justified (see p.91). It should be mentioned that although both *Panicum* and *Zygophyllum* occur on deep coarse sandy soils, yet they occupy different habitats: *Panicum* occurs on higher, presumably less saline ground than *Zygophyllum*. When *Panicum* is destroyed, it is replaced by *Cyperus* which appears to have the same ecologic amplitude, and not by *Zygophyllum*.

Proposed Ecological Classification

The vegetation of Kuwait can be described under four ecosystems. These are distinguished on the basis of variations in the habitat, chiefly landform and soil characteristics, and also in floristic composition, particularly the dominant species. Plant names are in accordance with those given by Dickson (1955), Rechinger (1964) and Halwagy and Macksad (1972). The ecosystems are :

I The sand dune ecosystem
II The salt marsh and saline depressions ecosystem
III The desert plain ecosystem
IV The desert plateau ecosystem

I - *The sand dune ecosystem.* Apart from the dunes of Umm Negga in the extreme northeast of the country, the sand dune ecosystem comprises a series of low coastal dunes which extend along the Gulf coast from Al-Dba'iyyah southwards. The soil is loose coarse sand, predominantly oolitic, and occasionally lime-cemented. They are usually dominated by *Zygophyllum coccineum* and/or *Seidlitzia rosmarinus,* occasionally by *Atriplex leucoclada* Boiss. and *Aellenia glauca* (M. Bieb.) Aellen. *Nitraria retusa* may become dominant locally. *Lycium shawii* Roem. & Schult. and *Pennisetum divisum* (Gmel.) Henr. are common associates. *Cistanche tubulosa* (Schenk) Wight, a common root parasite, occurs on *Zygophyllum coccineum* and *Seidlitzia rosmarinus.*

II - *The salt marsh and saline depressions ecosystem.* The salt marshes fringe the coast of Kuwait Bay and Khor Al-Sabiyah. They also occur on Bubiyan and Warba Islands. The soil ranges from loamy sand to sandy clay. These marshes are influenced primarily by tidal action and by the shallow saline water table. With the exception of Bubiyan and Warba, salt marshes show a distinct zonation which varies according to locality. In general, *Halocnemon strobilaceum* dominates nearest the shore, followed by *Nitraria retusa,* while *Zygophyllum coccineum* dominates most landward. *Tamarix passerinoides* Del. may form a distinct zone in certain places. Important species of the salt marsh include *Aeluropus lagopoides* (L). Trin., *Aeluropus littoralis* (Gouan) Parl., *Seidlitzia rosmarinus* and *Cressa cretica* L. *Juncus arabicus* (Aschers. & Buch.) Adams may form extensive patches on wetter ground.

Saline depressions occur on either side of the Kuwait - Ras Al-Khafji road, usually west of the coastal dunes. These are of varied size. Soils are usually similar to those of salt marshes. These depressions are affected mainly by the shallow saline water table. The centre of the depression may be bare or covered with *Halocnemon strobilaceum,* often fringed with *Bienertia cycloptera* Bge., while the sandy edges are frequently covered by *Zygophyllum coccineum.*

III - *The desert plain ecosystem.* The desert plain occupies the greater part of the country, west of the coastal region of salt marshes and saline depressions. The soils are varied and support different communities:

a—*Cyperus* steppe: dominated by *Cyperus conglomeratus* to the south and south-west of Kuwait City. The soil is deep, moderately loose, coarse sand, without a hardpan. *Panicum turgidum* occurs here and there, particularly increasing around Al-Atraf. On gravelly soil or on disturbed sites, *Cornulaca leucacantha* · Charif & Aellen gains importance. On hard ground e.g. near the Burgan Hills, *Cyperus conglomeratus* may be replaced by *Asthenatherum forsskalii* (Vahl) Nevski and *Stipagrostis plumosa* (L.) Munro ex. T. Anders.

b—*Rhanterium* steppe: this occurs in the centre, and in the extreme northeast of the country. The soils are shallow to moderately deep, with hardpan which is calcareous, gypsiferous, sometimes also gravelly and saline. The hard layer occasionally outcrops on the surface. The dominant species is *Rhanterium epapposum,* frequently associated with *Convolvulus oxyphyllus* Boiss., *Moltkiopsis ciliata* (Forssk.) Johnst., *Asthenatherum forsskalii and Stipagrostis plumosa.* A number of playas are encountered, some of which may be few acres in extent. The surface is generally impervious and rich in silt and clay. The soil underneath is very compact and hard to dig. Such playas support pure stands of the colourful *Iris sisyrinchium* L., which break the monotony of the surrounding grey green.

c—*Haloxylon* steppe: this is dominated by *Haloxylon salicornium.* It occurs in the northern parts of the country. The soils are shallow or very shallow, with hardpan often outcropping. On low lying areas, deeper accumulations of sand are washed or blown, allowing the growth of almost pure stands of *Chrozophora hierosolymitana* Spreng.

IV - *The desert plateau ecosystem.* This occurs in the extreme west of the country. The soil is predominantly a gravel desert, more or less devoid of vegetation. Where sand accumulates, clumps of *Haloxylon salicornicum* occur, collecting more sand underneath and round them. A gypsiferous and/or calcareous, sometimes also saline and gravelly hardpan is almost always present. *Citrullus colocynthis* (L.) Schrad. is a frequent associate. *Cistanche tubulosa* is a common parasite on *Haloxylon salicornicum.* In some places, generally on level ground, perennials are completely absent and the land is covered with a fairly dense carpet of annuals especially *Arnebia* spp., *Helianthemum* spp., *Astragalus* spp. and *Schismus barbatus* (L.) Thell. The soil generally consists of a few inches of coarse or soft loamy sand over a hardpan. In Wadi Al-Batin, *Zilla spinosa* may attain local dominance.

Acknowledgments

It is a pleasure to express our endebtedness to Mr. A. Al-Nouri, Secretary General, University of Kuwait, and his staff, for providing facilities which made this work possible. Thanks are due to Mr. A. Macksad, Department of Agriculture for supplying various information, to Mr. A.R. Badran and Mr. F. Sanad, Photographic Section, for their help in connection with the photographic work. We are also grateful to Mr. I. A. Razek for his assistance with the maps.

References

Chapman, V. J. 1960. Salt marshes and salt deserts of the world. Leonard Hill.

Dickson, V. 1955. The wild flowers of Kuwait and Bahrain. Allen and Unwin.

Emberger, C., Guessen, H., Kassas, M. & de Philippis, A. 1969. Vegetation map of the Mediterranean Zone. Explanatory Notes. Arid Zone Research 30. UNESCO.

Ergun, H. 1969. Reconnaissance soil survey. Report to the Government of Kuwait. FAO/KU/TF 17. Mimeo., 16pp.

Guest, E. 1953. The Rustam Herbarium, General and ecological account. Kew Bull. 8 : 383 - 403.

Guest, E. 1966. Flora of Iraq, vol. 1, Introduction. Baghdad, Iraq, Min. of Agric.

Halwagy, R. & Halwagy, M. 1974. Ecological studies on the desert of Kuwait. I - The physical environment. J. Univ. Kuwait 1 : 75 - 86.

Harris, S. A. 1960. The distribution of certain plant species in similar desert and steppe soils in central and northern Iraq. J. Ecol. 48 : 97 - 105.

Kernick, M.D. 1963a. Natural vegetation and animal production in Kuwait. Third meeting of the FAO working party on the development of the grazing and fodder resources of the Near East. Damascus, Syria. Mimeo., 14 pp.

Kernick, M.D. 1963b. A modern approach to the development of range management and animal production in Kuwait. Mimeo., 14 pp.

Kernick, M.D. 1964. Pasture, fodder production and range management project for sheep production in the region of Jahra, Kuwait. Mimeo., 16 pp.

Kernick, M.D. 1966. Plant resources, range ecology and fodder plant introduction. Report to the Government of Kuwait. FAO, TA 181. Mimeo., 95 pp.

Macksad, A.M. 1969. The desert flowers of Kuwait (in Arabic). Al-Arabi **132** : 94 - 103, Ministry of Information, Kuwait.

Springfield, H.W. 1954. Natural vegetation in Iraq. Dept. Agric. Iraq Tech. Bull.

Vesey - Fitzgerald, D.F. 1957. The vegetation of central and eastern Arabia. J. Ecol. **45** : 779 - 798.

Zohary, M. 1950. The flora of Iraq and its phytogeographical subdivision. Baghdad, Government Press, Bull. **31** : 1 - 201.

(Received 30 December 1972)

دراسات بيئية في صحراء الكويت

الجـزء الثاني : الكساء الخضري

رياض السيد الحلوجي ومحمد حسين الحلوجي

قسم النبات بجامعة الكويت

خلاصـــة

يتكون الكساء الخضري في الكويت من خليط من الشجيرات الصحراوية والاعشاب المعمـــرة والحـوليـــات .

ويعتبر المطر ـ كميته السنوية وتوزيعه الموسمي ـ أهم العوامل التي تحـــدد الكساء الخضري ، يليه في الاهمية شكل الارض والعوامل الاحيائية والرعي بخاصة . وللكساء الخضري في الكويت مظاهر موسمية واضحة .

وقد تم استعراض ما سبق نشره عن الكساء الخضري ، والمجتمعات النباتية التي عينها الباحثون السابقون . ثم وضعت خريطة نباتية جديدة ، كما اقترح نظام بديل للتصنيف بأخذ في الاعتبار التباين في الصفات البيئية ، وشكل الارض ونوع التربـة بخاصة . وعلى هذا الاساس تم تمييز أربعة نظم بيئية في الـــكويت هي : الكثبان الرملية ، والمستنقعات والمنخفضات الملحية ، والسهل الصحـــراوي ، والهضبة الصحـــراوية .

The purpose of this study is to further describe the distribution, habitats, and ecological characteristics of the natural vegetation in the northern sector of the northern Mojave Desert. Sixty-six stands were classified on the basis of shared leading dominant species. Each of these groupings is well defined and represents a sociologically distinct entity quite recognizable in the field. The relationships between each vegetational grouping and several environmental variables were statistically analyzed. Significant differences were found among plant groupings with respect to soil moisture tens