ECOLOGICAL STUDIES ON THE DESERT OF KUWAIT
II THE VEGETATION

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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).

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., *Halocnemum storbiaceum* (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-
ratus

526,500 hectares under Rhanterium epapposum
688,500 hectares under Haloxylen 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 (Mackas, 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 Embarger 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. Embarger 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. Haloxylen 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 Haloxylen salicornicum appears for the first time in 1964 opposite the coast of Bubiyan Island. This may be due to oversight by Dickson (1955).
5. Haloxylen 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 Haloxylen 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 Haloxylen 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 Haloxylen 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 cocineum.
4. Zygophyllum cocineum 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:

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 cocineum. On higher ground, Cyperus conglomeratus and occasionally Panicum turgidum may gain importance.
4. Bubiyan island is not dominated by Zygophyllum cocineum. 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 cocineum 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 Mack sad 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 Mack sad (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-Dha’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 _Aeluropia glauca_ (M. Bieb.) Aellen. _Nitraria retusa_ may become dominant locally. _Lycum 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, _Halocnemen 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 lago- poides_ (L). Trin., _Aeluropus littoralis_ (Gouan) Parl., _Seidlitzia rosmarinus_ and _Cressa cretica_ L. _Juncus arabiicus_ (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 _Halocnemen 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 southwest 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 forsskallii (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, gypseous, sometimes also gravelly and saline. The hard layer occasionally outcrops on the surface. The dominant species is Rhanterium epapposum, frequently associated with Convolulus oxyphyllus Boiss., Molthiopsis ciliata (Forssk.) Johnst., Asthenatherum forsskallii 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 monotonous tone 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 salicornium occur, collecting more sand underneath and round them. A gypseous 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 salicornium. In some places, generally or level ground, perennials are completely absent and the land is covered with a fairly dense carpet of annuals especially Arnedia spp., Helianthemum spp., Atragalus 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.

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دراسات بيئية في صحراء الكويت
الجزء الثاني: الك(cells) الخضري
رياض السيد الحوليجي ومحمد حسين الحوليجي
قسم النبات بجامعة الكويت

خلاصة

يتكون الكفاء الخضري في الكويت من خليط من النباتات الصحراوية والاشجار المعمورة والخليجيات.

ويregunta المطر كميتة السنوية وتوزيعه الموسمي - أهم العوامل التي تحدد الكفاء الخضري، يليه في الأهمية جودة الري والرياحية والري بحالة خصبة.

ولكن الكفاء الخضري في الكويت مظاهرة موضحة.

وقد تمت استعراض ما سبق نشره من الكفاء الخضري، والمجتمعات النباتية التي عليها الباحثون السابقون. ثم وضعت خريطة نباتية جيدة، كما اقترح نظام بديل للتصنيف بأخذ في الاعتبار التباين في أصناف البيئة، وشكل الأرض ونوع التربة بحالة. وعلى هذا الأساس تم تميز أربعة نشاطات بيئية في الكويت هي: الكفاء الرملية، والكفاء المستنقعات والمنخفضات الملحية، والسهل الصحراوي، والهضبة الصحراوية.
Vegetation is sparse. Physically the land is mainly flat desert, the highest point being Mutla Ridge, which runs along the north coast of Kuwait Bay. There are nine islands off the Kuwait coast, but only Failaka Island is inhabited. Kuwait has a desert climate typical of the region, which indicates wide temperature ranges, little rainfall, and dust storms from March through August. Summer (April-October) temperatures often exceed 120 degrees Fahrenheit. The weather is hot, especially in July and August when shade temperatures can reach 110°-115°. Periods of high humidity occur, but during the