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Coastal Vegetation of Bahrain Island

Abstract: Vegetation of the coastal lowlands of Bahrain Island has been surveyed on the basis of seven habitat types: mangrove, salt marsh, dunes, coastal sabkha, reclaimed areas, coastal plantations and agricultural wastelands. Most of the habitats are saline and plants are mostly halophytic. Dominant species vary from one habitat to another in the different saline areas. Habitats with low salinity are occupied by glycophytes. Key species in the vegetation of coastal lowlands of Bahrain are found in similar habitats in Arabia, particularly the eastern coasts of Saudi Arabia and Qatar.

Keywords: Bahrain, Coastal lowlands, vegetation, Habitat types

الغطاء النباتي الساحلي في جزيرة البحرين

جميل عباس

المستخلص: تمت دراسة الغطاء النباتي للمناطق الساحلية المنخفضة في جزيرة البحرين من خلال مسح سبعة أنواع من البيئات. وهي المانغروف، المستنقعات الملحية، الكتبان الرملية، السبخ الساحلية، المناطق المستصلحة، المزارع الساحلية والمناطق الزراعية المهملة. وقد تم في هذا المسح تعريف المجتمعات النباتية من حيث الأنواع النباتية السائدة والأنواع الموجودة معها، وقد وجد أن معظم هذه البيئات ذات طبيعة ملحية، وبالتالي فإن معظم الأنواع النباتية السائدة ملحية. وتباينت الأنواع النباتية السائدة من بيئة إلى أخرى في المناطق الملحية. أما البيئات منخفضة الملوحة، فتميزت بسيادة غير ملحية، وعند مقارنة الأنواع النباتية الرئيسية في المناطق الساحلية المنخفضة في جزيرة البحرين مع مثيلاتها في شبه الجزيرة العربية، وجدت أوجه تشابه كثيرة، وخاصة في المناطق الساحلية للمنطقة الشرقية بالمملكة العربية السعودية ودولة قطر.

كلمات مدخلة: البحرين، السواحل المنخفضة، الغطاء النباتي، بيئات نبات

Introduction

Coastal habitats are highly stressful environments where salinity and the water-holding capacity of the substrate are the dominant abiotic influences (Deil, 1998). These stressful conditions are aggravated in the Arabian Peninsula by high temperature, reaching more than 45°C in summer. Many studies have been carried out on the coastal vegetation in Arabia. Coastal vegetation in Saudi Arabia (Frey *et al.* 1984; El-Demerdash *et al.* 1995), Yemen (Al-Gifri and Al-Subai, 1994), Oman (Ghazanfar and Rappenhoner, 1994), United Arab Emirates (Deil and Müller-Hohenstein, 1996), Qatar (Abdel-Razik and Ismail, 1990; Abulfatih *et al.* 2001), and Kuwait (Halwagy and Halwagy, 1977) has been documented with some detail.

Several studies have been carried out on the plant ecology and vegetation of Bahrain (Abbas *et al.*, 1991 a & b; Abbas and El-Oqlah, 1992; El-Oqlah and Abbas, 1992; El-Oqlah and Abbas, 1994; Abbas and El-Oqlah, 1996; Abbas, 1998). However, none of the previous studies have dealt exclusively with the coastal vegetation. Abbas and El-Oqlah (1992) and El-Oqlah and Abbas (1992) included mangrove and the supralittoral vegetation as part of a more comprehensive survey of the vegetation of Bahrain.

The present study deals exclusively with the coastal vegetation of Bahrain Island, as reflected in a number of habitats, and compares the Bahrain coastal vegetation with the coastal vegetation of Arabia.

Study Area

Bahrain is an archipelago of 33 islands located in the mid-western part of the Arabian Gulf about 25 km east of Saudi Arabia. The largest of these islands is Bahrain Island, with a total area of 612 km². Five physiographic zones characterize the topography of Bahrain (Doornkamp *et al.* 1980) which are: (i) the central plateau and jabs; (ii) the interior basin; (iii) the escarpments; (iv) the back slopes; and (v) the coastal lowlands (Fig. 1).

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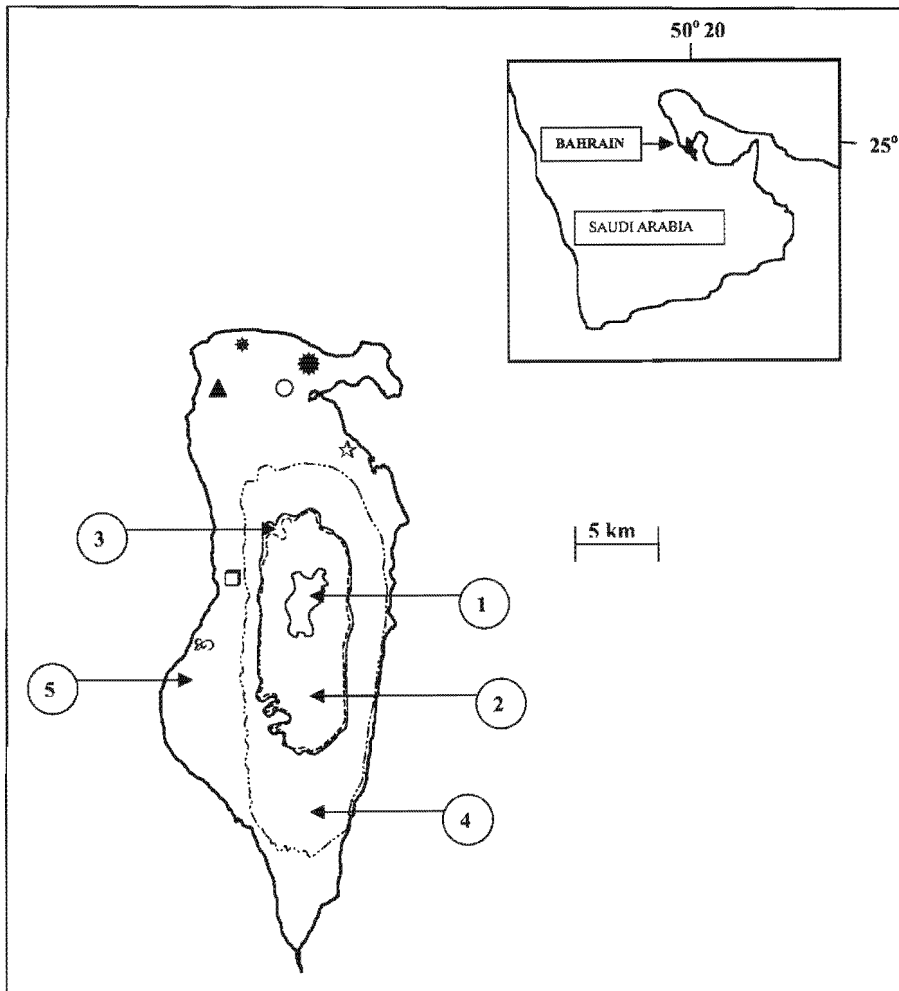


Fig. 1. Map of Bahrain Island showing the physiographic zones and the habitat types studied. Physiographic zones: 1 = central plateau and jabals; 2 = interior basin; 3 = escarpments; 4 = backslopes; 5 = coastal lowlands. Habitats: (∂) = mangrove; (p) = salt marsh; (r) = dune; (δ) = coastal sabkha; (ø) = reclaimed areas; (Ø) = coastal plantations; (δ) = agricultural wastelands.

The coastal lowlands surround the central rocky core of Bahrain extending from the base of the backslope, where the elevation is approximately 10 m, to sea level. The coastal lowlands consist largely of young, unconsolidated, superficial deposits laid down by the combination of marine and Aeolian processes. This covers an area of approximately 275 Km² (Doornkamp *et al.* 1980).

Bahrain, like mainland Arabia, falls in the North African-Euroasian dry climate province (McGinnies, 1979). According to climatic norms obtained from the Civil Aviation Directorate (Bahrain), the climate is characterized by the prevalence of mild winters and very hot summers. The mean annual temperature is 17.3°C, with a June maximum of 47.5°C and a January minimum of

2.8°C. The climatic diagram of Bahrain shows that the dry period extends from May to October and the wet period extends from November to April. The mean annual rainfall is 74 mm, with a mean monthly rainfall in summer of less than 1 mm and of 15 mm in winter.

Relative humidity is generally high. The highest mean daily maximum relative humidity is 88% (October), and the lowest mean daily minimum relative humidity is 40% (May).

Methods

Seven habitat types in the coastal lowlands of Bahrain Island were selected. The habitats included mangrove, salt marshes, dune forms, coastal sabkhas (saline soils), reclaimed areas, agricultural wastelands, and coastal plantations (Fig. 1). Each habitat was visited at least once and the vegetation of a minimum of three stands per habitat was inspected visually. Species from each habitat were identified according to Mandaville (1990) and

specimens were kept in the Department of Biology Herbarium at the University of Bahrain.

Results

1. Mangrove

Mangrove swamps are located around the muddy shores of the northeastern part of the island (Tubli Bay) where a bridge, and two small islands shelter the bay. The vegetation of the intertidal zone and the margins of the tidal channels are dominated by *Avicennia marina* (Forssk.) Vierh. It contributes to more than 90% of the cover. Intertidal species associated with this plant are found in a zonation pattern. These species include *Arthrocnemum salicornicum* (Moric.) Moris & Delponte, *Salicornia europaea* L., *Suaeda maritima* (L.) Dum, and *Arthrocnemum macrostachyum* (Moric.) Moris & Delponte (see, Table 1).

2. Salt Marsh

At the northwestern part of the island, where cultivation ends near the coast, seawater intrusion, with the borders of streams and ditches through coastal ridges, forms areas of salt marsh. Soils are characteristically sandy, calcareous and saline, often gypsic, with high saline water-table levels (Doornkamp *et al.*, 1980). Species are mainly halophytic and found along streams and ditches. *Phragmites australis* (Cav.) Trin. ex Steud and *Juncus rigidus* Desf. dominate the vegetation. Other species include *Cyperus rotundus* L., *Alhagi maurorum* Medikus, and *Aeluropus littoralis* (Gouan) Parl. (see, Table 1).

3. Dunes

Further inland and away from the northern and northwestern coasts, and moving southward at the base of the backslope, dunes of various heights can be seen. Relatively high dunes are found in the northwest and southwest. The dunes are composed mainly of quartzose sands, but in places the gypsum content of the sands may be high (Doornkamp *et al.*, 1980). In the large dunes the main species are large plants including *Leptadenia pyrotechnica* (Forssk.) Dcne., *Calligonum comosum* L'Her., *Zygophyllum qatarense* Hadidi, and perennial grasses such as *Panicum turgidum* Forssk., and *Pennisetum divisum* (Gmel.) Henr. Two types of smaller dunes are found in the western and northern regions. Some are in inland areas with relatively low salinity. These are mainly in the form of phytogenic mounds of *Z. qatarense*. In addition to *Z. qatarense*, *Cyperus conglomeratus* Rottb., *P. divisum*, *P. turgidum*, *Helianthemum kahiricum* Del. and *Cynomorium coccineum* L. are found. Other small dunes are found in the western and southern saline coastal areas. In these areas, *Seidlitzia rosmarinus* L., *J. rigidus*, *Sporobolus ioclados* (Ness ex Trin.) Ness, *Aeluropus lagopoides* (L.) and *Suaeda vermiculata* Forssk. ex J.F. Gmelin dominate the vegetation (see, Table 1).

4. Coastal Sabkha

The main coastal sabkhas are found in the southwest and in the south. Extensive parts of the southwest sabkha are subjected to marine inundation. The soil is composed mainly of loose, homogenous, laminated, poorly graded, medium-fine gypseous calcareous quartzose sand. *A. lagopoides*, *Z. qatarense*, *Halopeplis perfoliata* (Forssk.) Bunge. ex Aschers., and *S. ioclados* dominate southwest sabkha. Scattered among these

plants are *Limonium axillare* (Forssk.) O. Kuntze, and *Tamarix arabica* DC. In the south sabkha, the dominant species is *H. perfoliata*. Associated with this species are *A. macrostachyum*, *Halocnemum strobilaceum* (Pall.) M. Bieb., *S. vermiculata*, *Z. qatarense*, and *S. rosmarinus* towards the southern tip of the island (see, Table 1).

5. Reclaimed Areas

A number of coastal areas in the north and the northeast of the island have been reclaimed for urban and industrial projects. In such areas, parts of the shallow seawater were filled with sand and other dumping materials. Therefore, the surface soil is mainly of unconsolidated sand. Dominant species in such new habitats are *Sesuvium verrucosum* Raf. and *Salsola villosa* Del. ex Roem. Associates include *Sporobolus spicatus* (Vahl) Kunth, *Anabasis setifera* Moq., and *Fagonia indica* Burm. (see, Table 1).

6. Coastal Plantations

Plantations are concentrated along the northern, northeastern, and northwestern areas. Date palm, *Phoenix dactylifera* L., is the main planted tree in Bahrain. However, ornamental trees and shrubs have been grown in gardens and parks and along the roads. Most of these are introduced plants, including *Eucalyptus camaldulensis obtusa* Dehnh., *Ficus retusa nitida* (Th.) Miq., *Prosopis juliflora* (Sw.) DC., and *Nerium oleander* L. A number of native plants and weeds grow in these agricultural habitats. The following species were found in or at the boundaries of date palm plantations: *Capparis spinosa* L., *Phragmites australis*, *A. maurorum*, *Euphorbia peplus* L., *Prosopis farcta* (Banks & Sol.) Macbride, *Centaurium pulchellum* (Sw.) Druce, *Convolvulus arvensis* L., and *Dactyloctenium aegyptium* (L.) Willd. (see, Table 1).

7. Agricultural Wastelands

Many areas show the remnants of dead *P. dactylifera*. These areas are mainly saline and thus occupied in many places by dense thickets of *S. vermiculata*. Other halophytic species frequently seen in such wastelands include *Cressa cretica* L., *H. strobilaceum*, *P. australis*, and *A. maurorum*. In wasteland with low salinity other species were found, including *Aizoon canariense* L., *Heliotropium crispum* Desf., and *P. farcta* (see, Table 1).

Table 1. The seven habitats and their related species.

Habitat	Species composition
Mangrove	<i>Avicennia marina</i> , <i>Arthrocnemum salicornicum</i> , <i>Salicornia europaea</i> , <i>Suaeda maritima</i> , <i>Arthrocnemum macrostachyum</i>
Salt Marsh	<i>Phragmites australis</i> , <i>Juncus rigidus</i> , <i>Cyperus rotundus</i> , <i>Alhagi maurorum</i> , <i>Aeluropus littoralis</i>
Dunes	<i>Leptadenia pyrotechnica</i> , <i>Calligonum comosum</i> , <i>Zygophyllum qatarense</i> , <i>Panicum turgidum</i> , <i>Pennisetum divisum</i> , <i>Cyperus conglomeratus</i> , <i>Helianthemum kahiricum</i> , <i>Cynomorium coccineum</i> , <i>Seidlitzia rosmarinus</i> , <i>Juncus rigidus</i> , <i>Sporobolus ioclados</i> , <i>Aeluropus lagopoides</i> , <i>Suaeda vermiculata</i>
Coastal Sabkha	<i>Aeluropus lagopoides</i> , <i>Zygophyllum qatarense</i> , <i>Halopeplis perfoliata</i> , <i>Sporobolus ioclados</i> , <i>Limonium axillare</i> , <i>Tamarix arabica</i> , <i>Arthrocnemum macrostachyum</i> , <i>Halocnemum strobilaceum</i> , <i>Suaeda vermiculata</i> , <i>Seidlitzia rosmarinus</i>
Reclaimed Areas	<i>Sesuvium verrucosum</i> , <i>Salsola villosa</i> , <i>Sporobolus spicatus</i> , <i>Anabasis setifera</i> , <i>Fagonia indica</i>
Coastal Plantations	<i>Phoenix dactylifera</i> , <i>Capparis spinosa</i> , <i>Phragmites australis</i> , <i>Alhagi maurorum</i> , <i>Euphorbia peplus</i> , <i>Prosopis farcta</i> , <i>Centaurium pulchellum</i> , <i>Convolvulus arvensis</i> , <i>Dactyloctenium aegyptium</i>
Agricultural Wasteland	<i>Suaeda vermiculata</i> , <i>Cressa cretica</i> , <i>Halocnemum strobilaceum</i> , <i>Phragmites australis</i> , <i>Alhagi maurorum</i> , <i>Aizoon canariense</i> , <i>Heliotropium crispum</i>

Discussion and Conclusion

Most of the habitats of the coastal lowlands of Bahrain have an electrical conductivity ranging from 6.8 to 76.6 mS cm⁻¹ (Abbas and El-Oqlah, 1992), which is above the 4 mS cm⁻¹ reported by Gorham (1993) as the limit that separates glycophytes from halophytes. In such habitats the key species are either obligate halophytes or salt tolerant species, including *Avicennia marina* and *Arthrocnemum salicornicum* in the mangrove; *Juncus rigidus* and *Aeluropus littoralis* in the salt marsh; *Aeluropus lagopoides* and *Sporobolus ioclados* in the coastal sabkha; and *Suaeda vermiculata* and *Halocnemum strobilaceum* in the agricultural wastelands. Most of these species are represented in the coastal vegetation in the saline habitats of Arabia (Deil, 1998) and to a certain extent in some of the Mediterranean coasts (Shaltout and El-Ghareeb, 1992). Boer and Gliddon (1998)

identified 22 halophytes in a survey of the coastal zone of Abu Dhabi, United Arab Emirates, most of which are reported in the present study.

One of the distinctive habitats of Bahrain and the whole region is that of the mangrove where *Avicennia marina* is dominant. *Avicennia marina* occupies muddy habitat protected from strong wind by a variety of natural or artificial barriers. This is seen in the Gulf of Aqaba (Danin, 1983), the eastern coast of the Red Sea (Mahmoud *et al.* 1985), Yemen (Al-Hubaishi and Müller-Hohenstein, 1984), Oman (Ghazanfar and Rappenhoner, 1994), United Arab Emirates (Boer and Gliddon, 1998), and Qatar (Abdel-Razik, 1991; Abulfatih *et al.* 2001). Associated species with *Avicennia marina* in these mangrove habitats vary from one place to another. Nevertheless, species with relatively wide phytogeographical distribution may be found in most of these places, such as *Halopeplis perfoliata* and *Seidlitzia rosmarinus* (Freitag, 1991), and

Halocnemum strobilaceum, which is a pluri-regional species occurring in the Mediterranean/Saharo-Sindian/Irano-Turanian phytocoria (Deil, 1998).

The exception to the dominance of halophytic species in the studied habitats is the vegetation of sand forms and plantations, which have relatively low saline soils. The majority of species of these habitats are glycophytes, except in some localities where salinity is high.

It is worthwhile to mention that the vegetation of coastal lowlands of Bahrain shows a high degree of similarity to that of the coastal regions of eastern Saudi Arabia and Qatar.

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