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The epiphytic lichen flora of Bahrain

Qaher A. MANDEEL[a] *& André APTROOT*[b*]

[a]*Department of Biology, College of Science,*
University of Bahrain, P. O. Box 32038 Sakheer Campus,
Kingdom of Bahrain;
qmandeel@sci.uob.bh

[b]*ABL Herbarium, G.v.d.Veenstraat 107,*
NL-3762 XK Soest, The Netherlands;
andreaptroot@wanadoo.nl

Abstract – Twelve epiphytic lichens are reported from orchards in Bahrain. They represent a significant enlargement of the poorly known lichen flora.

INTRODUCTION

Studies on the lichen flora of the Arabian Peninsula remain incomplete, despite the increasing number of scattered reports. Information on lichen ecology, biodiversity, distribution and biogeography is limited to a few published accounts and checklists, none of which are comprehensive. The first scientific report on lichens from this part of the world was by Lamb (1936), describing only six crustose species from arid habitats of Bahrain. Considerable attention was focussed on lichenological exploration in of Saudi Arabia (Abu-Zinada & Hawksworth 1975, Abu-Zinada *et al.* 1986, Kürschner 1984, Frey 1989, Bokhary *et al.* 1993), Oman (Ghazanfar & Rappenhoner 1994, Kürschner & Ghazanfar 1998, Ghazanfar & Gallagher 1998) and Socotra island, Yemen (Mies 1994). The studies collectively compiled more than 230 lichen species with several newly described, probably endemic, taxa, most of which were from Oman and Socotra Island. Mies (1994) has documented the highest record of 165 species, from Socotra Island, followed by 36 species reported by Ghazanfar & Gallagher (1998). In Saudi Arabia, Abu-Zinada *et al.* (1986) and Bokhary *et al.* (1993) reported 70 species. Evidently, more species are expected from this country due to its variation in habitats and climate. As yet, no recently published survey or list following the checklist of Bokhary *et al.* (1993) is available for Saudi Arabia or any other Gulf State, with the exception of one species of foliose lichen (*Ramalina lacera*) that has been reported from Qatar (Babikir & Kürschner 1992). Apart from fragmentary observations on lichens in Bahrain during early expeditions of soil geomorphology and pedology (Doornkamp *et al.* 1980), wildlife flora surveys (Good 1955, Virgo 1980) or excursions (Ghazanfar & Gallagher 1998, Kürschner & Ghazanfar 1998), few records were made, and the lichen flora remains the least investigated component of the flora. Brown *et al.* (2002) reported 24 saxicolous

* Corresponding author

and terricolous lichen taxa from the northern foothills of Oman, mostly of which are cyanobacterial with 17 new records. Moreover, an extensive survey in arid desert of Kuwait resulted in a list of 38 lichen species, 15 of which are cyanophilous (Brown 1998, Schultz *et al.* 2000). The lichen flora from the South Western and South Eastern mountain region of Yemen was expected to be rich and diverse, but only 36 species were collected, including some cyanophilous genera (Schultz 1998). Moreover, Mies & Schultz (2004) and Schultz & Mies (2003) have collectively reported 247 species from Sokotra Island, Yemen, most of which are saxicolous and terricolous, cyanobacterial lichens.

Distribution of lichens in Bahrain is still largely unknown, since research on the subject has not been extensive. Recently, Mandeel & Aptroot (2004) provided an overview of the lichen habitats and occurrences in Bahrain. Al of the species recorded by them are saxicolous and crustose, inhabiting dolomite limestone, calcareous rocks, exposed crevice, granite, igneous rock or stony regolith. However, the study did not include the foliose and fruticose representatives. Surprisingly, there turn out to be many more, partly foliose or fruticose, epiphytic species in the so far overlooked habitat of the gardenst. In this study, a first attempt was made to investigate the occurrence of lichens on branches, twigs and stems of fruit trees in date palm plantations and private gardens. The taxa recorded here were all collected after the completion of the previous report, partly due to accessibility difficulties.

Since many locations were either inaccessible or restricted, it becomes inevitable to emphasize that the limited species sampling is perhaps an outcome of the rather confined survey area and the limited collecting trips to only few localities. It is therefore expected that more species could be encountered in future if more sites are accessible. This account is thus not complete and gives no comprehensive list of epiphytic lichens in Bahrain, but merely a current status to our knowledge based on this survey.

MATERIALS AND METHODS

Location

The Kingdom of Bahrain is a small island nation in the Arabian Gulf, consisting of 33 small natural islands, situated about midway between from the West to the Saudi Arabian Peninsula and Qatar to the east (25° 32” and 26° 20 N, 050° 20” and 050° 50 E) with a total area of about 720 km^2 and a maximum elevation of 134 meters. The largest of these is Bahrain Island with a pear-shaped land mass, 48 km long from North to South and up to 16 km wide at its maximum point from East to West. Bahrain Island accounts for nearly 85% of the total area of the Kingdom. Most of the Southern parts of the island is barren desert. Dense vegetation cover is confined to the Northern part of the main island with a narrow fertile strips extending down the North and North-Western coast, where water from underground wells is available for irrigation.

Climate

Bahrain, like mainland Arabia, falls within the north African–Euroasian climate province. The main island has a typical Saharo-Arabian climate, generally

described as mild, scanty rainy winters and hot humid rainless summers. Rainfall is seasonal, but irregular, usually occurring between the months of October to April (mean 9.28 mm.). The mean annual temperature is 27.4°C, with a recorded mean daily maximum from May to August is 34.06°C, and a December to March mean daily minimum is 19.51°C. Precipitation is low and, similarly is irregular, and mostly in the form of winter rain. Evaporation is generally high; with recorded highest mean in June (12.5 mm) and the lowest in January (4.05 mm). Solar radiation is usually high with sunny days over 300 throughout the year. The average maximum mean daily hours of sunshine is 11.5 in June and the minimum is 11.6 in March. Relative humidity is commonly high, ranging from a daily mean in January (69.5 %) and daily mean in May (49.5%). Winds usually are damp, blow from the north and northwest and are known as Shamals, with an average speed of 8.95 knots hr^{-1}. Occasional hot and dry winds known as Quws, blow from southwest with an average speed of 8 knots hr^{-1}.

Lichen sample collection

The materials were collected from May to September 2005 during an exploration survey of the Southern and Northern parts of Bahrain Island by the first author. Lichen species were identified by the second author and representative materials were deposited in the herbarium of the Adviesbureau voor Bryologie en Lichenologie (ABL). The specimens on which this contribution is based were duplicates from originals preserved in the Mycology Herbarium, Department of Biology, University of Bahrain, Kingdom of Bahrain. After giving a collection number to each one of the samples collected, they were stored by putting them into paper envelopes. The examined specimens are cited alphabetically by a code consisting of a the collector initial, locality number and herbarium as far as possible. Identification was based on morphological characters of thalli prepared by hand-made sections and spot reactions. All lichens listed are identified to species level and were compared to those of Mies & Schultz (2004). Wherever appropriate, reference is made to Abu-Zinada *et al.* (1986), Bokhary *et al.* (1993) and Schultz *et al.* (2000) for description and illustration.

Description of the study area

The geomorphological topography of the main island of Bahrain can be classified into five physiographic zones (Doornkamp *et al.* 1980): Central Plateau and Jabals, Interior Basin, Multiple Escarpment, Main Blackslope and Coastal Lowlands. The species reported on here come from Coastal Lowlands zone. This zone is at the base of the Blackslope, where a solid geology gives way to a surrounding fringe of young, unconsolidated, superficial deposits laid down by combination of marine and aeolian processes. The zone covers more than 50% of the total area of the island. The products of erosion of the Blackslopes are washed up and deposited in many areas in the Coastal Lowlands forming sand sheets. The mean general surface level is about 5-25 m above sea level. The dominant rocks are calcareous. The soils of this zone are mainly loamy, sandy and clay subgroups. Mostly, these soils are considered by having a high water table and are cultivated with many crops. The following lists the collection sites:

1. West county: Dar Kulaib village, in private farm, 10 m, 26 04.217 N 50 29.933 E, 12. 05. 2005.

2. West county: Dar Kulaib village, in private farm, 10 m, 26 04.714 N 50 29.973 E, 19. 05. 2005.
3. West county: Karzakan village, in private farm, 8 m, 26 06.525 N 50 28.855 E, 12. 05. 2005.
4. West county: Karzakan village, in private farm, 9 m, 26 07.030 N 50 28.332 E, 19. 05. 2005.
5. West county: Dumistan village, in private farm, 13 m, 26 07.383 N 50 28.398 E, 26. 05. 2005.
6. West county: Hamalah village, near water stream, 6 m, 26 08.730 N 50 27.356 E, 16. 06. 2005.
7. West county: Hamalah village, in private farm, 7 m, 26 07.983 N 50 27.707 E, 08. 09. 2005.
8. North county: Janabyaih village, in private farm, 15 m, 26 11.622 N 50 28.204 E, 16. 06. 2005.
9. North county: Karaneh village, in private farm, 7 m, 26 13.828 N 50 30.943 E, 23. 09. 2005.
10. North county: Adahri village, in open farm, 11 m, 26 12.331 N 50 32.798 E, 17. 08. 2005.

Vegetation cover

Arable and permanent crop areas do not exceed 6,000 ha. of the whole cultivated sector. Natural vegetation is of limited extent, largely degraded and mainly xerophytes. Date palm (*Phoenix dactylifera*) is the oldest and dominant horticulture crop with more than 30 varieties. Other important grown garden crops include almonds, pomegranates, figs, lemon, sapota, mango, black mulberry, Syrian-thorn tree, guava, papaya fruit, wide range of vegetables and ornamental trees, including *Tamarix aphylla, Prosopis juliflora, Ricinus communis, Eucalyptus* spp*., Nerium* spp*., Sesbania* spp. and *Bougainvillea* spp. In the fields covered by tall date palm, fruit trees (occurring through flood irrigation) makes a suitable substratum for lichens to grow. Some of the most common phanerogamic plants in these zone (Virgo 1980) are *Zygophyllum qatarense, Juncus rigidus, Sporobulus arabicus, Aeluropus lagopoides, Calligonum comosum, Leptadenia pyrotechnica, Atriplex* spp*., Phragmites australis, Asphodelus tenuifolius, Emex spinosa* and *Alhagi maurorum.*

RESULTS AND DISCUSSION

The occurrence of the lichen species found in various sites investigated is listed in Table 1. All of the fourteen recorded species in the present study represent new country records for Bahrain. None of the species recorded was found to be common to all cultivated habitats surveyed. However, one species, *Arthonia punctiformis,* is common to seven of the ten locations. The frequency of occurrence (abundance) of the observed lichens varied greatly among the various habitats, without any clear distribution pattern and mostly in the magnitude of a low to very low density. Well developed communities of *Anaptychia ciliaris*, *Arthonia punctiformis, Parmelia sulcata*, *Punctelia borreri* and *Xanthoria parietina* are somewhat denser than others. The observed lichen species were epiphytic on

Table 1. Occurrence of lichens in cultivated habitats in Bahrain.

Accession code	*Lichen species*	*Family*	*Collection*[a] *site*	*Substratum* [b]	*Abundance* [c]	*Life form* [d]	*Reproductive* [e] *strategy*
QM 110	*Anaptychia ciliaris* (L.) Körb. ex A. Massal	Teloschistaceae	8	Epiph	++	Fol	S
QM 111	*Arthonia punctiformis* Ach.	Arthoniaceae	1-7	Calc/Tt	+++	F, Cr	S
QM 112	*Caloplaca cerina* (Ehrh. ex Hedw.) Th. Fr.	Teloschistaceae	6, 7, 9	Epiph	+	Cr	S
QM 113	*Hyperphyscia adglutinata* (Flörke) H. Mayrhofer & Poelt	Physciaceae	3, 4, 10	Epiph	+	Fol	A.s
QM 114	*Lecanora pulicaris* (Pers.) Ach.	Physciaceae	6, 9	Epiph	+	Frut	S
QM 115	*Lecidella euphorea* (Flörke) Hertel	Lecanoraceae	3-5	Epiph	+	Cr	S
QM 116	*Parmelia sulcata* Taylor	Lecanoraceae	6, 10	Epiph	++	Cr	A.s
QM 117	*Phaeophyscia ciliata* (Hoffm.) Moberg	Parmeliaceae	9, 10	Epiph	+	Fol	S
QM 118	*Phaeophyscia orbicularis* (Neck.) Moberg	Physciaceae	9, 11	Epiph / Sil	+	Fol	A.s
QM 119	*Physcia adscendens* (Fr.) H. Oliv.	Physciaceae	6, 7, 9, 10	Epiph	+	Fol	A.s
QM 120	*Physcia aipolia* (Ehrh. ex Humb.) Hampe	Physciaceae	6, 7, 9, 11	Epiph	+	Fol	S
QM 121	*Punctelia borreri* (Sm.) Krog	Physciaceae	1, 2, 4-8	Epiph	++	Fol	A.s
QM 122	*Rinodina sophodes* (Ach.) A. Massal.	Parmeliaceae	1, 2, 4-9	Calc / Epiph	+	Fol	S
QM 123	*Xanthoria parietina* (L.) Th. Fr.	Physciaceae	2, 5, 9, 10	Epiph	++	Fol	S

[a] Collection: refer to Materials and Method section.
[b] Substratum: Calc: calcareous rocks, dolomite, Epiph: epiphytic, Terr: Terricolous and muscicolous, Tt: tree twigs.
[c] Abundance: +++ (high), ++ (medium), + (low).
[d] Life form: Cr: Crustose, Fol: Foliose, Frut: Fruticose, Lepr: Leporse, F: non-lichenized fungus.
[e] Reproductive strategy: S: sexual reproduction prevalent. A.s: reproduction mainly by soredia.

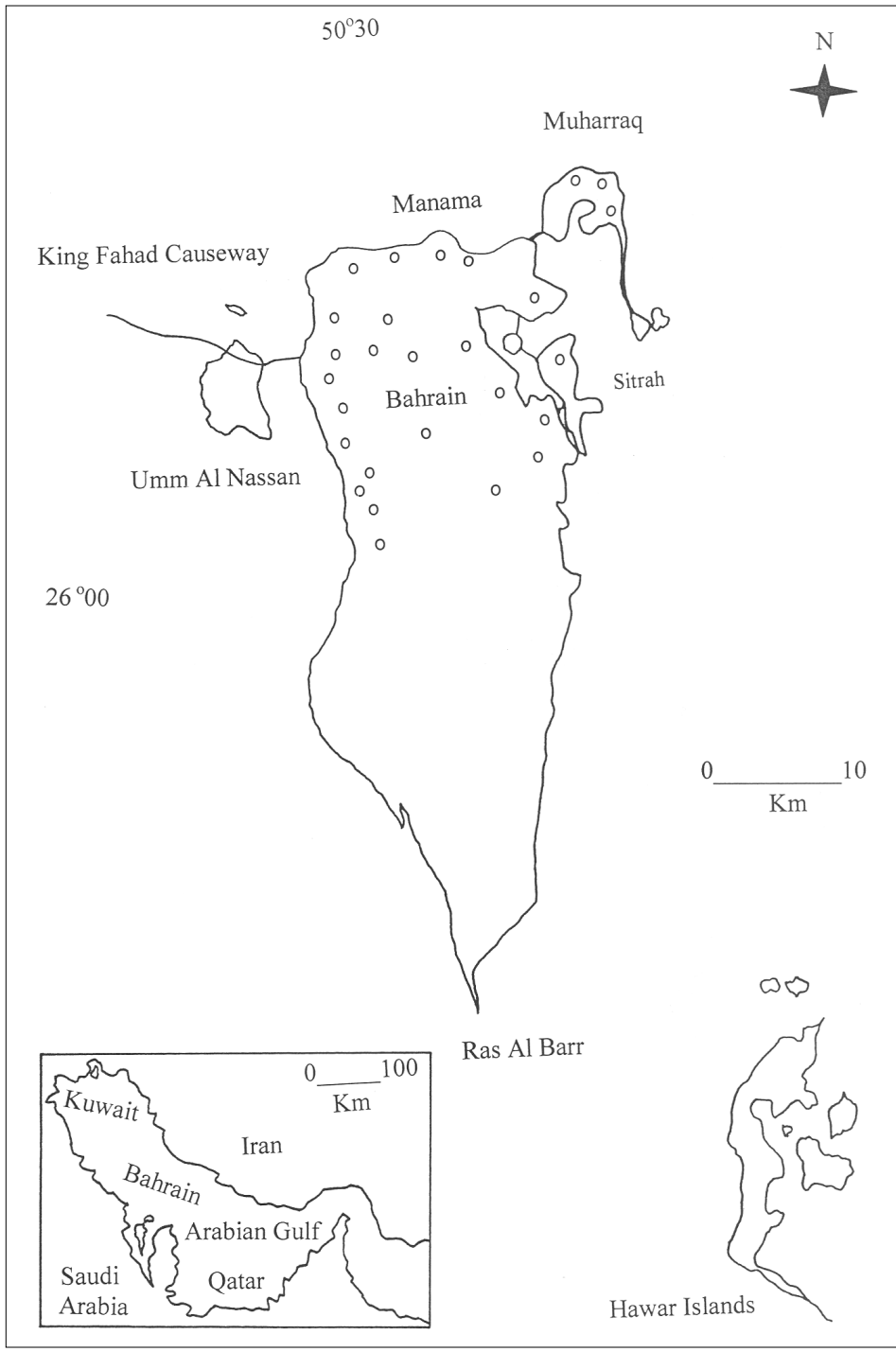
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Fig. 1.

twigs and bark of wild trees such as *Prosopis juliflora, Albizzia lebbek, Eucalyptus* spp. and *Acacia spp.*, or fruit trees like dates, almonds, pomegranates, figs, lemon, mango, black mulberry, Syrian thorn tree and guava. Similar lichen records were reported from some parts of Saudi Arabia (Abu-Zinada & Hawksworth 1975, Abu-Zinada *et al.* 1986, Bokhary *et al.* 1993), Kuwait (Brown 1998, Schultz *et al.* 2000) and Oman (Ghazanfar & Rappenhoner 1994, Kurschner & Ghazanfar 1998, Ghazanfar & Gallagher 1998, Brown *et al.* 2002), all countries with comparable climatic conditions. However, the earlier reported desert habitat communities, consisting of crustose lichens on exposed calcareous rocks and regolith stones (Mandeel & Aptroot 2004) were not detected in these studies and seem to be special for Bahrain.

It is interesting to note that although the island of Bahrain is geographically located in the Arabian Peninsula, within the arid desert belt of the Northern Hemisphere, the North-Western coast has somewhat different ecological parameters from the desert locations. Overall, the mixed vegetation cover is dense with rich-fertile sandy-loam soil, and water from natural springs or underground wells is available to support open vast cultivated fields. Morning dew and evening seasonal fog is common in agriculture fields, usually between November to May. Dewfall formation may play an important role for the lichen vegetation (Kurschner & Ghazanfar 1998). In addition, the water supply is here much better than in other parts of the island, resulting in somewhat cool and wet breezes, forced by North and North-West damp winds from the coast. Undoubtedly, such circumstances provide high relative humidity levels, and shading from tall trees and nutrient-rich bark support many lichens. The epiphytic lichen flora was thus found to prefer the slightly shadier, moist and cool Northern side of the island and was found mostly around water wells or streams.

The lichen flora of the desert habitats (in the Southern part of the island) is quite different from those of the agriculture locations (in the North-Western part of the island), with only five genera and seven species, recently reported by Mandeel & Aptroot (2004). These are *Buellia tesserata, Caloplaca aurantia, Caloplaca lithophila, Caloplaca variabilis, Lecania turicensis, Peltula obscurans* and *Psorotichia schaereri.* Among the species previously reported from Bahrain by Lamb (1936), only one, *Xanthoria steineri,* is epiphytic. It was reported from decorticated twigs of the Arabian boxthorn tree (*Lycium arabicum*), from an unknown location. The rather confined lichen diversity in Bahrain may suggest that the lichen flora has undergone great alterations in recent decades, which would be due to mainly man-made interference and activities. Some of these activities include the removal of trees, urbanization and an increase of the water table and salinity in both soil and irrigation water. In addition, the general paucity of favourable habitats imposes constrains on both lichen growth and distribution in Bahrain. As most of the encountered lichens are surveyed in private farms, in which accessibility is a limiting factor, it is perhaps possible to find more species in future.

The lichen flora of arid regions in Arabia is rather poorly studied. The admittedly narrow spectrum of species diversity of the taxa in this study still constitues a major addition to the knowledge of the lichen flora in the region. It illustrates the continuing need for further exploration.

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