EDINBURGH JOURNAL OF BOTANY 67 (2): 189–208 (2010)

doi:10.1017/S0960428610000089

IMPORTANT PLANT AREAS IN THE ARABIAN PENINSULA: 2. FARASAN ARCHIPELAGO

M. Hall[1], O. A. Llewellyn[2], A. G. Miller[1], T. M. Al-Abbasi[2], A. H. Al-Wetaid[2], R. J. Al-Harbi[2] & K. F. Al-Shammari[2]

The Farasan Archipelago in Saudi Arabia is an Important Plant Area (IPA) in the Arabian Peninsula. This paper describes the flora of the Farasan Islands and provides an up-to-date botanical checklist together with background information on the geology and fauna of the islands. It designates the locality as an IPA due to the presence of nationally and regionally rare species and the presence of good examples of mangrove vegetation, which is both regionally and globally threatened. In addition to conservation assessments, this study also examines conservation planning concerns, particularly the colonisation of the main island Farasan Al-Kabir by the invasive species *Prosopis juliflora*. Suggestions for conservation action are provided. A new combination is made for *Tetraena boulosii*.

Keywords. Conservation, Farasan Archipelago, Important Plant Area, rare species, Saudi Arabia.

Introduction

The Farasan Islands are a large archipelago of more than 170 low-lying (0–70 m altitude) coral islands and islets in the southern region of the Red Sea (see Fig. 1). Situated approximately 50 km offshore from the city of Jazan (16°44′15″N, 42°20′18″E), they are one of the most biodiverse sites in Saudi Arabia. Within the archipelago there are seven islands over 10 km^2: Farasan Al-Kabir (381 km^2), As-Saqid (Sajid) (150 km^2), Ad-Dissan (36 km^2), Zufaf (33 km^2), Sasawah (20 km^2), Qummah (15 km^2) and Dumsuk (12 km^2). Three of these islands, Farasan Al-Kabir, As-Saqid and Qummah, are inhabited. The two main islands, Farasan Al-Kabir and As-Saqid, form the main landmass in the archipelago and are joined together by a 300 m length road bridge.

The Farasan Archipelago is a site of significant biodiversity and has been managed by the Saudi Wildlife Commission (SWC) as a protected area since 1989. From a number of previous studies (Alwelaie *et al.*, 1993; Hassan & Al-Hemaid, 1996; Collenette, 1999; Atiqur Rahman *et al.*, 2002) and from a series of SWC field visits to the Farasan Islands, 218 plant species have been recorded from the archipelago (see

[1] Centre for Middle Eastern Plants, Royal Botanic Garden Edinburgh, 20A Inverleith Row, Edinburgh EH3 5LR, Scotland, UK. E-mail for correspondence: m.hall@rbge.ac.uk
[2] Saudi Wildlife Commission (SWC), PO Box 61681, Riyadh 11575, Kingdom of Saudi Arabia.

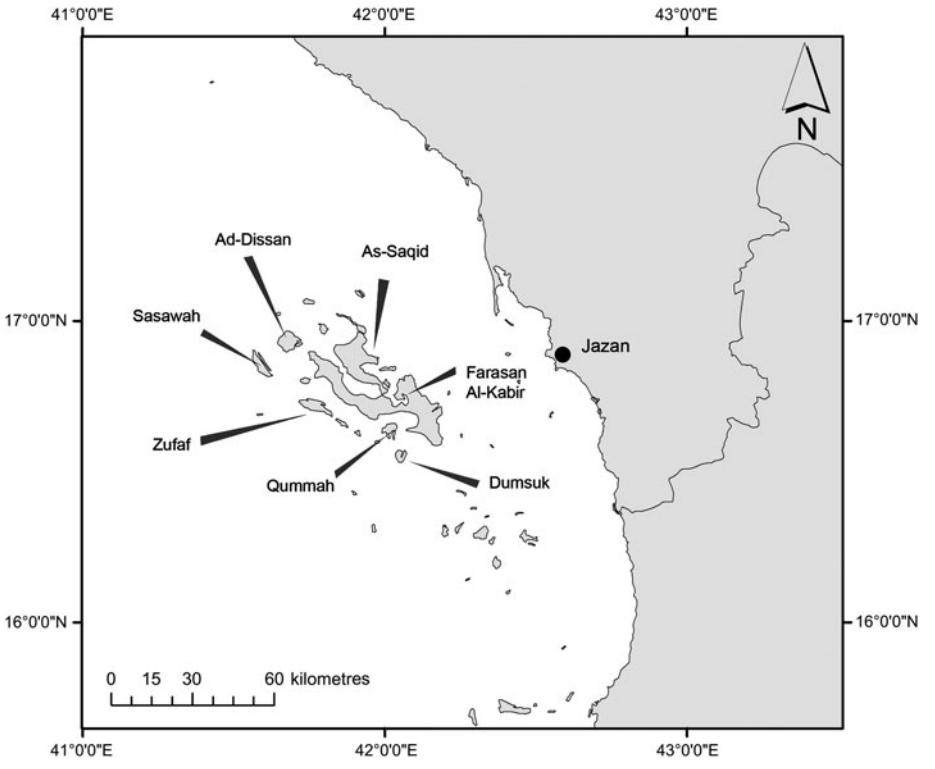

FIG. 1. The Farasan Archipelago (Saudi Arabia) is comprised of 170 coral islands and islets in the southern region of the Red Sea, approximately 50 km from the Saudi Arabian city of Jazan.

Appendix 1*). Phytogeographically the flora of the island is predominantly Somalia-Masai. There are no plant species which are endemic to the islands, but the Farasan Archipelago does hold an Arabian endemic, alongside other geographically restricted plant species.

The Farasan Islands are also an important site for faunal diversity. The area holds the largest population of Idmi gazelle in Saudi Arabia (805 counted in 1995). Several species of bat occur, including Patrizi's trident leaf nose bat *Asellia patrizii* DeBeaux. Sea mammals recorded in the coastal waters include a small remnant population of dugong *Dugong dugon* Müller and three species of dolphin, *Stenella longirostris* Gray, *Tursiops truncatus* Montagu and *Stenella attenuate* Gray. Humpback whale *Megaptera novaeangliae* Borowski and minke whale *Balaenoptera acutorostrata*

* All literature records have been included in this checklist, but a number of these are extremely doubtful and are listed as unconfirmed records at the end of the checklist. In particular, the record of *Erica arborea* by Atiqur Rahman *et al.* (2002) appears extremely unlikely as in Arabia this species is restricted to high-altitude mist forests. The abundance of recorded species in taxonomically critical groups such as *Tetraena* and *Suaeda* may also be due to misidentification, and future floristic research must be aimed at resolving such inaccuracies.

Lacépède have also been recorded in the waters of the archipelago. Other prominent animal species include the globally Endangered green turtle *Chelonia mydas* L. and the Critically Endangered hawksbill turtle *Eretmochelys imbricata* L. More than 145 bird species have been recorded from the Farasan Archipelago, and the Farasan Islands are listed as an Important Bird Area (Evans, 1994). Two of the most significant bird species are the pink-backed pelican *Pelicanus rufescens* Gmelin and the osprey *Pandion haliaetus* L. Approximately 40 breeding pairs of pelicans live on the islands, which is likely to be the largest breeding colony of this species in the whole of the Red Sea. With more than 42 breeding pairs of osprey the Farasan population is the largest population of this species in the Middle East.

Geology, Soils and Climate

The Farasan Archipelago is formed from uplifted fossil coral reef. These are continental islands, lying on the Arabian continental shelf. Geologically, the islands are composed primarily of pavements and faulted blocks of uplifted fossil reef limestone. These were formed in Tertiary seas and raised up by a salt dome, the product of intense Miocene evaporation when the Red Sea was cut off from the Indian Ocean. The Pleistocene tectonic shifts which led to the widening of the Red Sea also caused further uplifting of the Farasan Islands (Dabbagh *et al.*, 1984).

Most of the islands in the archipelago have active fringing reefs, which date from the last rise in sea level 7000 years ago, with patch reefs of sand-covered pavement and shoals in the shallows between them. On some shoals, coral fragments have been cemented into beach rock (*farush*), which is the base for sandbanks formed by windswept sand. Where not surfaced with coralline limestone, the islands are capped with beach sand.

The soils on the islands can be largely characterised as Udipsamments-Torripsamments: marine flats and dunes, and coral rock outcrops. They are almost entirely derived from the fossil coral bedrock or weathering of the coral reef and beach shells. The fossil coral produces a poor, infertile lithosol of gravelly sand and, over parts of the islands, low soil moistures and a dearth of soil micro-organisms result in a lack of soil altogether. Fine-textured silty clay soils are found in the long narrow ravines resulting from leaching away of the underlying salt stratum, and in cracks, gullies and depressions relatively fertile calcareous silt and clay have accumulated. There are numerous short gullies found in faults in the coral, but only one wadi on the islands, Wadi ‘Abarah south from Al-Muharraq. The shorelines of the larger islands are predominantly sand beaches, although mud flats and coralline limestone rock are also common. In sheltered coastal inlets, silty mud underlies mangrove stands. On the north-facing coasts, seawater intrusion has created a semi-*sabkah* area of silt sands.

The climate of the Farasan Islands is arid and subtropical, with high humidity, high mean annual temperatures and low rainfall. The nearest meteorological station at Jazan (7 m altitude) indicates a mean annual rainfall of 129 mm per year (Table 1), with rain recorded from both the late winter/spring and summer rainfall systems. Rainfall on the Farasan Islands is probably lower than on the mainland coast with

TABLE 1. Comparative measurements from seven major meteorological stations in Saudi Arabia. The nearest station to the Farasan Archipelago is Jazan. Data adapted from Ghazanfar & Fisher (1998)

Meteorological station	Location	Altitude (m)	Annual rainfall (mm)	Maximum temperature (°C)	Minimum temperature (°C)	Mean temperature (°C)	Mean fog days
Jazan	16°52′N, 42°34′E	7	129	45.3	11.8	30.6	1.4
Riyadh	24°42′N, 46°43′E	614	126	47.4	−4.4	24.8	5.1
Jeddah	21°33′N, 39°10′E	4	47	49.0	9.8	28.4	4.8
Tabuk	28°23′N, 36°34′E	768	46	44.4	−3.7	22.0	0.5
Najran	17°30′N, 44°12′E	1212	50	42.0	−0.5	24.7	0.5
Hail	27°31′N, 41°41′E	1002	116	43.5	−9.4	21.5	6.6
Taif	21°16′N, 40°25′E	1453	204	39.5	−1.2	22.9	12.1

its larger landmass and convection currents. As in other parts of Arabia, condensation of dew is likely to be one of the major contributors to available soil moisture for vegetation. Winds can be constant and relatively strong. The winter sea level is 0.5–1 m higher than in summer because evaporation is less. This causes flooding of low-level coastlines, which become temporary lagoons.

VEGETATION

Mangrove

In sheltered coastal areas there are significant stands of mangrove vegetation. There are large stands of *Rhizophora mucronata*† in the area of Khawr Kandarah on the NE of Farasan Al-Kabir (see Fig. 2), to the north of Farasan town, North Sulayn Island and about 20 ha of *Rhizophora* mangrove on Zufaf Island. The total area of *Rhizophora mucronata* mangrove vegetation is approximately 330 ha. In addition, relatively large areas of black mangrove *Avicennia marina* line sheltered coastal flats, creeks and channels. *Avicennia marina* grows on 15 of the northern islands, with the most significant populations around Kharij Haddar, on the NE of Farasan Al-Kabir and NW Zufaf Island. There is also a prominent stand of *Avicennia marina* in Khawr Farasan (Mandura & Khafajii, 1993) which was restored to the area by a successful SWC mangrove restoration programme.

Rare species

The mangrove *Rhizophora mucronata* is currently known in the Arabian Red Sea region from the Farasan Archipelago, Baish Al Semirat and Ras Um Rubaise (El-Juhany, 2009). Wood (1997) notes that the Bové record of *Rhizophora mucronata* from Hodeidah (Yemen) is no longer found at this locality.

† For species authorities see Appendix 1.

FIG. 2. The largest population of *Rhizophora mucronata* in the Arabian Red Sea region occurs on the Farasan Archipelago.

Acacia woodland

On the eastern side of Farasan Al-Kabir, open *Acacia* Mill. woodland occurs in depressions and areas of good soils, dominated by *Acacia ehrenbergiana* with scattered *Acacia tortilis* subsp. *tortilis*. Trees and shrubs such as *Commiphora gileadensis*, *Salvadora persica*, *Indigofera oblongifolia*, *Grewia tenax* and *Maytenus parviflora* are also prominent. This vegetation is open and supports a well-vegetated ground flora that is dominated by *Tetraena simplex*. Other herbaceous plants include *Blepharis ciliaris*, *Abutilon fruticosum*, *Cucumis prophetarum* and the tussock-forming grass *Desmostachya bipinnata*.

Dense *Acacia ehrenbergiana* woodland occurs in the silty Al-Muharraq area, providing suitable habitat for the Idmi gazelle *Gazella gazella* Pallas. Trees here include *Ziziphus spina-christi*, *Commiphora gileadensis* and *Maerua oblongifolia*. Bushes of *Asparagus flagellaris* up to 3 m high are often covered with the climbers *Cissus quadrangularis*, *Pentatropis nivalis*, *Ipomoea obscura*, *Ipomoea hochstetteri* and *Kickxia corallicola*. These dense pockets of vegetation are being invaded by *Prosopis juliflora*. A much more open, less species-rich *Acacia* woodland also occurs around cultivated areas, along with occasional groves of *Hyphaene thebaica* and individuals of *Ziziphus spina-christi*.

Rare species

The Saudi Arabian endemic *Kickxia corallicola* is an annual herb often found climbing over shrubs within open *Acacia* woodland on Farasan Al-Kabir. This species also occurs on the mainland Red Sea coast, but as a protected area, Farasan is the most important site for this species. The site of *Acacia* woodland in Al-Muharraq, Farasan Al-Kabir is the only Arabian locality for the African species *Nothosaerva brachiata* and *Basilicum polystachyon*. Farasan is also the only site in Saudi Arabia from which the widespread African and Asian species *Ipomoea hochstetteri* is recorded.

Open shrubland

The arid plain of the NW plateau on Farasan Al-Kabir is sparsely vegetated. A largely ancient reef pavement, covered in places with sands, this zone is barren except where cracks and gullies in the limestone collect silt and water. The most common shrubs are *Capparis spinosa*, *Euphorbia collenetteae*, *Indigofera oblongifolia*, with occasional small trees of *Salvadora persica* and *Acacia ehrenbergiana*. *Abutilon pannosum* is dominant on silt and is especially evident in western Farasan and southern As-Saqid islands. In some areas, such as the raised coral platform near Seir, the thickets of *Capparis spinosa* and *Euphorbia collenetteae* can become very dense (see Fig. 3). In sandy areas *Tetraena simplex*, and *Aerva javanica*, occur, along with *Cyperus conglomeratus*. After winter rains this area of arid plain is flush with annuals such as *Justicia flava*.

Rare species

Khallah Bay on Farasan Al-Kabir is the only Saudi Arabian locality for *Cleome noeana* subsp. *brachystyla*, which is also recorded from Yemen in Arabia (Miller & Cope, 1996) and Somalia and Djibouti in NE Africa (Thulin, 1993).

Dumsuk Island is the only locality in the Arabian region for *Commiphora erythraea*, which is distributed across NE Africa from Tanzania to Eritrea. Surveys on part of the island in February 2009 recorded more than 20 individuals, with an estimated population of 200 trees when extrapolated across Dumsuk. These trees occur in areas of relatively well-developed soils within the raised coral platform and often form a sparse open scrub.

Coastal halophyte vegetation

Coastal halophyte vegetation occurs on the silty sands of SE and NE Farasan as well as on large areas of As-Saqid and the coastal areas of Dumsuk. This relatively dense vegetation cover, near the shore (see Fig. 4), is primarily dominated by *Limonium axillare*, along with *Halopeplis perfoliata*, *Arthrocnemum macrostachyum*, *Aeluropus lagopoides*, *Suaeda monoica* and *Suaeda fruticosa*. A *Limonium*-dominated dwarf

FIG. 3. The succulent shrublands on the raised coral areas of Farasan Al-Kabir and As-Saqid are the only Arabian localities for the Red Sea endemic *Euphorbia collenetteae*.

shrubland also extends further inland on the sands and rocks of Jabal Kandarah on Farasan Al-Kabir, and in the northern interior of As-Saqid. In areas of sand blown up against the raised coral, *Limonium axillare* occurs with *Cyperus conglomeratus*, *Tetraena simplex* and *Polycarpaea spicata*. In the Seir district of Farasan Al-Kabir and on the small uninhabited Dawshak Island, *Limonium cylindrifolium* occurs in the saline sand communities of the sea shore (Alwelaie *et al.*, 1993).

Beds of perennial seagrasses grow on sandy or muddy bottoms usually in sheltered waters between 2.5 and 10 m deep. The associated epiphytic algae and nitrogen-fixing ecosystem results in high productivity, and this seagrass ecosystem is very important for a great variety of marine life. Eight species of seagrass have been recorded: *Cymodocea rotundata*, *Cymodocea serrulata*, *Halodule uninervis*, *Halophila ovalis*, *Halophila stipulacea*, *Syringodium isoetifolium*, *Thalassia hemprichii* and *Thalassodendron ciliatum*. The most common seagrass species are *Thalassia hemprichii* and *Halophila ovalis* in shallower areas on clean sands. The widespread Asian-Australasian seagrass *Halodule uninervis* is favoured by oyster spat.

FIG. 4. Low coastal shrubland on the north coast of Farasan Al-Kabir, dominated by halophytic species such as *Limonium axillare*, *Halopeplis perfoliata* and *Arthrocnemum macrostachyum*.

Palm groves

Large groves of date palm *Phoenix dactylifera* occur at As-Saqid and Al-Qisar/Al-Muharraq, and small groves at Qummah and at Khutib beside a group of old *Hyphaene thebaica*. Among the associated fields *Acacia ehrenbergiana* is common, some trees being unusually large, with *Salvadora persica* and occasional *Ziziphus spina-christi*. At Seir on Farasan Al-Kabir, groves of *Hyphaene thebaica* form a prominent part of the vegetation in areas of sandy soils. At Al-Faqwah on Khawr al-Ma'adi there is a thicket of date palms along with *Ficus populifolia*, *Acacia tortilis* and *Acacia ehrenbergiana*.

Rare species

The Seir area of Farasan Al-Kabir is the only location in Saudi Arabia from which the widespread afro-tropical fig species *Ficus populifolia* is recorded. This species is known in Arabia from Yemen, and the most northerly records in Yemen are approximately 200 km south of Farasan (Jabal Melhan) (Wood, 1997).

IPA Assessment

The Farasan Islands are an important site for conservation in Arabia. They are an established protected area in Saudi Arabia, administered by SWC, and are listed as an Important Bird Area (Evans, 1994). Scott (1995) considers the archipelago to be a site of international significance as a potential RAMSAR wetland. It is also an important site for wild plant conservation and, using the adapted Arabian criteria (Al-Abbasi *et al.*, 2010), the Farasan Archipelago qualifies as an Important Plant Area (see Table 2). This paper marks the second in a series of papers on Important Plant Areas in the region (Llewellyn *et al.*, 2010).

TABLE 2. The Farasan Archipelago qualifies as an IPA under criteria A (2–4), B (1 & 2) and C

Criterion A	
A2/A3 – Regionally/nationally threatened taxa	The mangrove *Avicennia marina* is a threatened species in Saudi Arabia. The Farasan Archipelago is the only recorded locality in Saudi Arabia for *Nothosaerva brachiata*, *Basilicum polystachyon*, *Ficus populifolia*, *Ipomoea hochstetteri* and *Cleome noeana* subsp. *brachystyla*, and the only recorded Arabian locality for *Commiphora erythraea*, *Drake-Brockmania somalensis*, *Flueggea leucopyrus* and *Euphorbia collenetteae*.
A4 – National endemic, near endemic, regional endemic and/or regional range-restricted taxa	The Saudi Arabian endemic *Kickxia corallicola* is found on Farasan. Atiqur Rahman *et al.* (2002) also record the Arabian endemic *Ajuga arabica* from the islands, but this unlikely record needs confirmation.
Criterion B	
B1 – Species-rich example of a defined habitat type in Arabia	The *Avicennia* and *Rhizophora* stands on Farasan are some of the best examples of mangrove habitat in Saudi Arabia.
B2 – Biogeographic and bioclimatic refuge	The Farasan Islands are an important bioclimatic refuge for Somalia-Masai species such as *Commiphora erythraea*, *Ficus populifolia* and *Grewia tenax*.
Criterion C	
C1 – Outstanding example of a globally or regionally threatened habitat type	*Rhizophora* and *Avicennia* mangrove vegetation is both rare and threatened in the Arabian Red Sea region.

Socio-economic Issues

The present population of the Farasan Islands is approximately 12,000, the majority of whom live in Farasan town and the neighbouring Al-Masilah village. Until recently, the local population subsisted mainly by artisanal fishing, pearling and small-scale grazing (mainly goats) and subsistence farming (dates and sorghum). The principal occupation is now fishing, both commercial and small scale, along with some clamming and pearling. Government employment and private services provide income for the remainder of the population.

There are no known *himas* in the Farasan Islands (Llewellyn, 2003), but from SWC consultation with local people it is believed that local people support the establishment of the archipelago as a protected area and the SWC initiatives to restore mangrove habitats on the islands. The Farasan Islands have long been a popular holiday destination for local people from Jazan who come to camp on Farasan Al-Kabir's long sandy beaches. Whilst there are only a handful of hotels on Farasan Al-Kabir, nature-based tourism is expanding, and it is important to ensure that it remains sustainable. There is great potential for well-managed eco-tourism and wildlife viewing led by SWC rangers and trained local people. This has the potential to provide income for people on the islands, as well as increasing environmental awareness and providing environmental education. Currently, however, there are few visitor services on the islands and there is no interpretation/education centre for visitors to the archipelago.

Threats to Conservation

There are a number of threats to plant conservation on the Farasan Archipelago, including the cutting of mangroves, off-road driving and the expansion of agricultural and mining operations. Development of the islands for tourism is also another potential threat to plant biodiversity conservation. Tourist developments should not be located on important sites for plant and animal biodiversity. It is proposed that these sites (e.g. areas of rare vegetation or the habitat of rare species) should be protected as core biodiversity zones within the SWC protected area. These areas should prohibit development from agriculture, mining and tourism as well as small-scale disturbances such as off-road driving and wood collection.

One of the most pressing threats is from the invasive species *Prosopis juliflora*, a large thicket of which has established on Farasan Al-Kabir near the Al-Muharraq junction (see Fig. 5). This area of *Prosopis* has established at the expense of the native *Acacia* woodland and is spreading into the densest areas of *Acacia ehrenbergiana* woodland in the Al-Muharraq area. Studies in the United Arab Emirates (El-Keblawy & Al-Rawai, 2007) have demonstrated that *Prosopis juliflora* decreases the richness, density and frequency of native plant species. Field observations on Farasan indicate that *Prosopis juliflora* kills the native *Acacia ehrenbergiana* woodland. Possible mechanisms for this suppression include the

FIG. 5. Widely invasive in the Arabian Peninsula, *Prosopis juliflora* is one of the main threats to plant biodiversity conservation on Farasan.

production of allelopathic chemicals (Al-Humaid & Warrag, 1998) and the ability of *Prosopis* to compete aggressively for scarce water resources.

If no action is taken to halt its spread, *Prosopis* will likely invade very rapidly (as elsewhere in Arabia) and this will impact the *Acacia* woodland which is the habitat of Idmi gazelle.

Conservation action must focus on removing the *Prosopis* which has already begun to invade the *Acacia* woodland in Al-Muharraq. Unlike in other parts of Arabia, and in East Africa (Mwangi & Swallow, 2008), *Prosopis juliflora* is not used by the local people and its removal will not cause conflict with the local population. In terms of control methods, biological control using seed-eating Bruchids has been attempted in South Africa with only partial success (Zimmerman, 1991; Coetzer & Hoffmann, 1997). As there are native species of *Prosopis* in Arabia, for example *Prosopis cineraria* (L.) Druce, biological control would be a risky strategy for the Farasan Islands. Instead it is recommended that *Prosopis juliflora* is controlled by cutting back established trees and by uprooting seedlings before they mature. Following cutting, application of herbicide (either a single herbicide or a combination) is necessary to prevent regrowth. These techniques have been used with success on other weedy *Prosopis* species in Jordan (Qasem, 2006) and for controlling

Prosopis juliflora in Australia (Parsons & Cuthbertson, 2001) and on Socotra (A. G. Miller, pers. comm.).

Further Research

Although the flora of Farasan is relatively well known, further floristic work is needed to determine and map the major vegetation types on the islands. The stands of mangrove on the Farasan Archipelago are perhaps the most important plant habitats on the islands, and these require careful monitoring programmes to detect any decline in their quality and extent. Further work is necessary to map the distribution of *Rhizophora mucronata* in Arabia, particularly in the southern Red Sea and Gulf of Aqaba.

Further research is also needed to determine the biogeographic status of the regionally rare species on the islands, particularly the tree species *Commiphora erythraea* and *Ficus populifolia*. Population genetics studies to compare the Farasan populations with those from East Africa (including the Dhalak Islands) would be of great value for ascertaining the genetic divergence of the African and Arabian populations. This would give an indication of the importance of the genetic diversity found in the Farasan populations and would provide evidence on the duration of separation between these populations and also on plant colonisation events in the Red Sea region.

In view of the threat of *Prosopis juliflora* to the plant biodiversity of the Farasan Islands, a targeted programme to monitor the effects of this species on the local vegetation should be established as a matter of priority. This should coincide with research aimed at determining the most effective method of *Prosopis* removal from Farasan. Lastly, as there are few individuals capable of identifying plants on the Farasan Islands, a photographic field guide to the plants of Farasan would be a very valuable tool for conducting future surveying and monitoring work (Hall & Miller, in press). It would also be a valuable resource for environmental education and for tourists to use when visiting the islands. Future botanical work should be directed towards photographic documentation of the plants of Farasan and towards compiling a practical field identification guide for the area.

Acknowledgements

We are grateful to an anonymous reviewer for highlighting the new combination necessary for *Tetraena boulosii*. We also thank a second anonymous reviewer for their helpful comments on earlier drafts of this manuscript.

References

Al-Abbasi, T. M., Al-Farhan, A., Al-Khulaidi, A. W., Hall, M., Llewellyn, O. A., Miller, A. G. & Patzelt, A. (2010). Important Plant Areas in the Arabian Peninsula. *Edinburgh J. Bot.* 67: 25–35.

AL-HUMAID, A. I. & WARRAG, M. O. (1998). Allelopathic effects of mesquite (*Prosopis juliflora*) foliage on seed germination and seedling growth of Bermuda grass (*Cynodon dactylon*). *J. Arid Environ.* 38: 237–243.

ALWELAIE, A. N., CHAUDARY, S. A. & ALWETAID, Y. (1993). Vegetation of some Red Sea islands of the Kingdom of Saudi Arabia. *J. Arid Environ.* 24: 287–296.

ANGIOSPERM PHYLOGENY GROUP (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. *Bot. J. Linn. Soc.* 141: 399–436.

ATIQUR RAHMAN, M., AL-SAID, M. S., MOSSA, J. S., AL-YAHYA, M. A. & AL-HEMAID, M. A. F. (2002). A check list of angiosperm flora of Farasan Islands, Kingdom of Saudi Arabia. *Pakistan J. Biol. Sci.* 11: 1162–1166.

COETZER, W. & HOFFMANN, J. H. (1997). Establishment of *Neltumius arizonensis* (Coleoptera: Bruchidae) on Mesquite (*Prosopis* species: Mimosaceae) in South Africa. *Biol. Control* 10: 187–192.

COLLENETTE, S. (1999). *Wildflowers of Saudi Arabia*. Riyadh: National Commission for Wildlife Conservation and Development.

COLLENETTE, S. & TSAGARAKIS, C. (2001). *Some Regional Botanical Lists from Saudi Arabia*. Taif, Saudi Arabia: National Wildlife Research Centre.

DABBAGH, A., HOTZL, H. & SCHNIER, H. (1984). Farasan Islands: General considerations and geological structure. In: JADO, A. R. & ZOTL, J. G. (eds) *Quaternary Period in Saudi Arabia*, Vol. 2, pp. 212–220. New York: Springer-Verlag.

EL-JUHANY, L. I. (2009). Present status and degradation trends of mangrove forests on the southern Red Sea coast of Saudi Arabia. *American-Eurasian J. Agric. Environ. Sci.* 6(3): 328–340.

EL-KEBLAWY, A. & AL-RAWAI, A. (2007). Impacts of the invasive exotic *Prosopis juliflora* (Sw.) DC. on the native flora and soils of the UAE. *Plant Ecol.* 190: 23–35.

EVANS, M. I. (ed.) (1994). *Important Bird Areas in the Middle East*. Cambridge: Birdlife International.

GHAZANFAR, S. A. & FISHER, M. (1998). *Vegetation of the Arabian Peninsula.* London: Kluwer.

HALL, M. & MILLER, A. G. (In press). Documenting plants in a changing climate: a case study from Arabia. In: HODKINSON, T. R., JONES, M. B., WALDREN, S. & PARNELL, J. A. N. (eds) *Climate Change, Ecology and Systematics*. Cambridge: Cambridge University Press.

HASSAN, H. M. & AL-HEMAID, F. M. (1996). Composition, origin and migration trends of perennial vegetation in the Farasan El-Kabir Island (Red Sea, Saudi Arabia). *Saudi J. Biol. Sci.* 4: 5–15.

LLEWELLYN, O. A. (2003). The basis for a discipline of Islamic environmental law. In: FOLTZ, R. C., DENNY, F. M. & BAHARUDDIN, A. (eds) *Islam and Ecology*, pp. 185–247. Cambridge, MA: Harvard University Press.

LLEWELLYN, O. A., HALL, M., MILLER, A. G., AL-ABBASI, T. M., AL-WETAID, A. H., AL-HARBI, R. J., AL-SHAMMARI, K. F. & AL-FARHAN, A. (2010). Important Plant Areas in the Arabian Peninsula: 1. Jabal Qaraqir. *Edinburgh J. Bot.* 67: 37–56.

MANDURA, A. S. & KHAFAJII, A. K. (1993). Human impact on the mangrove of Khor Farasan Island, southern Red Sea coast of Saudi Arabia. In: LEITH, H. & AL-MASSOM, A. (eds) *Towards the Rational Use of High Salinity Tolerant Plants*, Vol. 1, pp. 353–361. Dordrecht: Kluwer Academic Publishers.

MILLER, A. G. & COPE, T. A. (1996). *The Flora of the Arabian Peninsula and Socotra*, Vol. 1. Edinburgh: Edinburgh University Press.

MWANGI, E. & SWALLOW, B. (2008). *Prosopis juliflora* invasion and rural livelihoods in the Lake Baringo area of Kenya. *Conserv. Society* 6: 130–140.
PARSONS, W. T. & CUTHBERTSON, E. G. (2001). *Noxious Weeds of Australia*. Collingwood, Victoria: CSIRO Publishing.
QASEM, J. R. (2006). Chemical control of *Prosopis farcta* (Banks and Sol.) Macbride in the Jordan Valley. *Crop Prot*. 26: 572–575.
SCOTT, D. (1995). *A Directory of Wetlands in the Middle East*. Gland, Switzerland: IUCN.
THULIN, M. (1993). *Flora of Somalia*, Vol. 1. Kew: Royal Botanic Gardens.
WILDE, W. J. J. O. DE & DUYFJES, B. E. E. (2008). The edible Cucurbitaceae of Thailand and Malesia and the wild forms of the cultivated ones. *Sandakania* 17: 43–91.
WOOD, J. R. I. (1997). *A Handbook of the Yemen Flora.* Kew: Royal Botanic Gardens.
ZIMMERMAN, H. G. (1991). Biological control of mesquite, *Prosopis* spp. (Fabaceae), in South Africa. *Agr., Ecosyst. Environ*. 37: 175–186.

Received 11 August 2009; accepted for publication 10 February 2010

APPENDIX 1

Checklist of plant taxa from the Farasan Archipelago. Family delimitation follows APG II (Angiosperm Phylogeny Group, 2003)

This checklist is compiled from survey data, literature sources and herbarium specimens. The principal source for each record is noted in superscript next to each name, listed in order of importance in compiling the list. Taxa known only from herbarium specimens also have the herbarium specimen listed. Synonyms are given where these are still in common usage in the Arabian Peninsula.

1 – IPA survey data
2 – Collenette (1999)
3 – Collenette & Tsagarakis (2001)
4 – Alwelaie *et al.* (1993)
5 – Hassan & Al-Hemaid (1996)
6 – Atiqur Rahman *et al.* (2002)
7 – SWC field records

Acanthaceae
Avicennia marina (Forssk.) Vierh.[1]
Barleria hochstetteri Nees ex DC.[3]
Blepharis ciliaris (L.) B.L.Burtt[1]
Ecbolium viride (Forssk.) Alston[2]
Justicia flava (Vahl) Vahl[3]

Aizoaceae
Trianthema portulacastrum L.[6]
Trianthema sheilae A.G.Mill. & J.A.Nyberg[2]
Zaleya pentandra (L.) C.Jeffrey [*B. Lanza* s.n. (BM)]

Amaranthaceae
Aerva javanica (Burm.f.) Juss. ex Schult.[1]
Amaranthus graecizans L.[3]

Amaranthus viridis L.[6]
Arthrocnemum macrostachyum (Moric.) K.Koch[1]
Atriplex farinosa Forssk.[3]
Atriplex halimus L.[2]
Cornulaca ehrenbergii Asch.[3]
Digera muricata (L.) Mart.[3]
Halopeplis perfoliata (Forssk.) Bunge ex Asch. & Schweinf.[1]
Nothosaerva brachiata (L.) Wight[2]
Suaeda aegyptiaca (Hasselq.) Zohary[2]
Suaeda fruticosa Forssk. ex J.F.Gmel.[1]
Suaeda monoica Forssk. ex J.F.Gmel.[1]
Suaeda vermiculata Forssk. ex J.F.Gmel.[6]

Amaryllidaceae
Pancratium maximum Forssk. [*I.S. Collenette* 5827 (RIY)]

Apocynaceae
Calotropis procera (Ait.) Ait.f.[5]
Caralluma acutangula (Decne.) N.E.Br.[1]
Caralluma adscendens (Roxb.) Haw.[3]
Caralluma edulis (Edgew.) Benth. ex Hook.f.[2]
Glossonema boveanum (Decne.) Decne.[2]
Leptadenia pyrotechnica (Forssk.) Decne.[5]
Pentatropis nivalis (J.F.Gmel.) D.V.Field & J.R.I.Wood[1]

Aristolochiaceae
Aristolochia bracteolata Lam.[3]

Asparagaceae
Asparagus flagellaris (Kunth) Baker[4]

Asteraceae (Compositae)
Launaea intybacea (Jacq.) Beauverd[3]
Launaea procumbens (Roxb.) Ramayya & Rajagopal[2]
Pluchea dioscoridis (L.) DC.[3]
Pulicaria jaubertii E.Gamal-Eldin[3]

Boraginaceae
Heliotropium longiflorum (A.DC.) Jaub. & Spach[3]
Heliotropium ramosissimum (Lehm.) DC.[3]
Heliotropium strigosum Willd.[2]
Heliotropium zeylanicum (Burm.f.) Lam.[2]

Burseraceae
Commiphora erythraea (Ehrenb.) Engl.[1]
Commiphora gileadensis (L.) C.Chr.[1]

Capparaceae
Cadaba farinosa Forssk.[3]
Cadaba glandulosa Forssk.[3]
Cadaba longifolia DC.[1]
Cadaba rotundifolia Forssk.[3]
Capparis cartilaginea Decne.[1]
Capparis decidua (Forssk.) Edgew. (syn. *Capparis aphylla* Hayne ex Roth)[1]

Capparis spinosa L.[6]
Cleome brachycarpa Vahl ex DC.[1]
Cleome gynandra L. (syn. *Gynandropsis gynandra* (L.) Briq.)[3]
Cleome noeana Boiss. & Popov. subsp. *brachystyla* (Deflers) D.F.Chamb. & Lamond[2]
Cleome tenella L.f. [Unknown 1597 (RIY)]
Dipterygium glaucum Decne. [*B. Lanza* s.n. (BM)]
Maerua oblongifolia (Forssk.) A.Rich.[3]

Caryophyllaceae
Polycarpaea repens (Forssk.) Asch. & Schweinf.[3]
Polycarpaea spicata Arn.[1]

Celastraceae
Maytenus parviflora (Vahl) Sebsebe[1]

Commelinaceae
Commelina benghalensis L.[3]
Commelina forsskalii Vahl[3]

Convolvulaceae
Convolvulus arvensis L.[3]
Convolvulus glomeratus Choisy[1]
Convolvulus pilosellifolius Desr.[2]
Convolvulus rhyniospermus Hochst. ex Choisy [*I.S. Collenette* 9269 (E)]
Cressa cretica L.[3]
Cuscuta planiflora Ten. [*V.P. Dickson* 759 (K)]
Evolvulus alsinoides (L.) L.[3]
Ipomoea eriocarpa R.Br. [*I.S. Collenette* 9267 (E)]
Ipomoea hochstetteri House[2]
Ipomoea obscura (L.) Ker Gawl.[3]
Seddera latifolia Hochst. & Steud.[3]
Seddera virgata Hochst. & Steud. [*I.S. Collenette* 5844 (K)]

Cucurbitaceae
Citrullus colocynthis (L.) Schrad.[6]
Cucumis melo L.[3] (Collenette & Tsagarakis (2001) list this as *Cucumis melo* L. subsp. *agrestis* (Naudin) Pangalo, but de Wilde & Duyfjes (2008) reduced this to a forma)
Cucumis prophetarum L.[1]
Kedrostis gijef (Forssk. ex J.F.Gmel.) C.Jeffrey[3]
Zehneria anomala C.Jeffrey[3]

Cymodoceaceae
Cymodocea rotundata Asch. & Schweinf.[7]
Cymodocea serrulata (R.Br.) Asch. & Magnus[7]
Halodule uninervis (Forssk.) Boiss.[7]
Syringodium isoetifolium (Asch.) Dandy[7]
Thalassodendron ciliatum (Forssk.) Hartog[7]

Cyperaceae
Cyperus bulbosus Vahl[3]
Cyperus conglomeratus Rottb.[1]
Cyperus rubicundus Vahl[3]

Euphorbiaceae
Acalypha indica L.[3]
Chrozophora oblongifolia (Delile) A.Juss. ex Spreng.[1]
Dalechampia scandens L. var. *cordofana* (Hochst. ex Webb) Müll.Arg.[2]
Euphorbia collenetteae Al-Zahrani & El-Karemy (syn. *Euphorbia* sp. aff. *fractiflexa* S.Carter & J.R.I.Wood)[1]
Euphorbia granulata Forssk.[3]
Jatropha glauca Vahl[6]
Micrococca mercurialis (L.) Benth.[2]

Hyacinthaceae
Dipcadi Medik. sp.[1]

Hydrocharitaceae
Enhalus acoroides (L.f.) Royle[7]
Halophila ovalis (R.Br.) Hook.f.[7]
Halophila stipulacea (Forssk.) Asch.[7]
Thalassia hemprichii Ehrenb. ex Solms[7]

Juncaceae
Juncus rigidus Desf.[5]

Lamiaceae (Labiatae)
Basilicum polystachyon (L.) Moench[2]
Leucas urticifolia (Vahl) R.Br. ex Sm.[3]
Orthosiphon pallidus Royle ex Benth.[3]
Premna resinosa (Hochst.) Schauer[3]

Leguminosae
Acacia ehrenbergiana Hayne[1]
Acacia tortilis Hayne[5]
Alysicarpus glumaceus (Vahl) DC.[1]
Argyrolobium sp. aff. *arabicum* (Decne.) Jaub. & Spach[3]
Crotalaria microphylla Vahl[3]
Indigofera caerulea Roxb.[3]
Indigofera hochstetteri Baker[1]
Indigofera linifolia (L.f.) Retz.[1]
Indigofera oblongifolia Forssk.[1]
Indigofera semitrijuga Forssk.[2]
Indigofera spinosa Forssk.[1]
Prosopis juliflora (Sw.) DC.[1]
Rhynchosia minima (L.) DC.[1]
Rhynchosia sp. aff. *minima* (L.) DC.[3]
Senna alexandrina Mill.[3]
Senna holosericea (Fresen.) Greuter[3]
Senna italica Mill.[1]
Taverniera cuneifolia (Roth) Arn.[2]
Taverniera lappacea (Forssk.) DC.[2]
Tephrosia purpurea (L.) Pers.[4]
Tephrosia subtriflora Hochst. ex Baker[1]
Tephrosia uniflora Pers. [*Collenette* 6012 (10065-RIY)]

Lythraceae
Ammannia baccifera L.[4]

Malvaceae
Abutilon bidentatum Hochst. ex A.Rich.[3]
Abutilon figarianum Webb[2]
Abutilon fruticosum Guill. & Perr.[1]
Abutilon pannosum (G.Forst.) Schltdl.[1]
Corchorus depressus (L.) Stocks[1]
Corchorus olitorius L.[3]
Corchorus trilocularis L.[1]
Fioria dictyocarpa (Webb) Mattei[2]
Gossypium hirsutum L.[6]
Grewia erythraea Schweinf.[3]
Grewia tenax (Forssk.) Fiori[1]
Hibiscus micranthus L.f.[3]
Pavonia arabica Hochst. ex Steud.[2]
Senra incana Cav.[3]

Menispermaceae
Cocculus pendulus (J.R.Forst. & G.Forst.) Diels[3]

Molluginaceae
Mollugo nudicaulis Lam.[3]

Moraceae
Ficus cordata Thunb. subsp. *salicifolia* (Vahl) C.C.Berg[3]
Ficus glumosa Delile[2]
Ficus populifolia Vahl[2]

Nyctaginaceae
Boerhavia diffusa L.[2]
Commicarpus helenae (Roem. & Schult.) Meikle [*I.S. Collenette* 5862 (E)]

Orobanchaceae
Cistanche tubulosa (Schenk) Hook.f.[2]
Lindenbergia indica (L.) Vatke[3]
Striga sp. aff. *gesnerioides* (Willd.) Vatke[3]

Palmae
Hyphaene thebaica (L.) Mart.[1]
Phoenix dactylifera L.[1]

Phyllanthaceae
Andrachne aspera Spreng. var. *glandulosa* Hochst. ex A.Rich.[3]
Flueggea leucopyrus Willd. (syn. *Phyllanthus leucopyrus* (Willd.) D.Koenig ex Roxb.)[2]
Flueggea virosa (Roxb. ex Willd.) Royle[3]
Phyllanthus fraternus G.L.Webster [*I.S. Collenette* 6001 (RIY)]
Phyllanthus maderaspatensis L.[3]
Phyllanthus rotundifolius Klein ex. Willd.[3]

Plantaginaceae
Kickxia corallicola D.A.Sutton[1]
Nanorrhinum hastatum (R.Br. ex Benth.) Ghebr. (syn. *Kickxia hastata* (R.Br. ex Benth.) Dandy)[3]
Schweinfurthia pedicellata Benth. & Hook.f.[1]

Plumbaginaceae
Limonium axillare (Forssk.) Kuntze[1]
Limonium cylindrifolium (Forssk.) Verdc. ex Cufod.[3]

Poaceae (Gramineae)
Aeluropus lagopoides (L.) Trin. ex Thwaites[1]
Aristida adscensionis L.[3]
Aristida funiculata Trin. & Rupr.[3]
Brachiaria ramosa (L.) Stapf[3]
Cenchrus ciliaris L.[3]
Chloris barbata (L.) Sw.[3]
Chrysopogon plumulosus Hochst.[3]
Cynodon dactylon (L.) Pers.[5]
Dactyloctenium aegyptium (L.) Willd.[3]
Dactyloctenium aristatum Link[3]
Dactyloctenium scindicum Boiss.[3]
Desmostachya bipinnata (L.) Stapf[1]
Dichanthium foveolatum (Delile) Roberty[4]
Digitaria ciliaris (Retz.) Koeler [*I.S. Collenette* 5872 (K)]
Dinebra retroflexa (Vahl) Panz[2]
Drake-Brockmania somalensis (Hack.) Stapf[2]
Elionurus royleanus Nees ex A.Rich. [*I.S. Collenette* 6010 (K)]
Eragrostis ciliaris (L.) R.Br. [*I.S. Collenette* 5178 (E)]
Eragrostis lepida (A.Rich.) Hochst. ex Steud.[2]
Eragrostis minor Host[3]
Eriochloa fatmensis (Hochst. & Steud.) Clayton[3]
Halopyrum mucronatum (L.) Stapf[3]
Hyparrhenia hirta (L.) Stapf[4]
Panicum coloratum L.[3]
Panicum turgidum Forssk.[3]
Paspalidium desertorum (A.Rich.) Stapf[2]
Pennisetum setigerum (Vahl) Wipff (syn. *Cenchrus setigerus* Vahl)[3]
Setaria verticillata (L.) P.Beauv.[3]
Setaria viridis (L.) P.Beauv.[3]
Sporobolus helvolus (Trin.) T.Durand & Schinz[3]
Sporobolus spicatus (Vahl) Kunth[3]
Tetrapogon tenellus (K.D.Koenig ex Roxb.) Chiov.[1]
Tricholaena teneriffae (L.f.) Link[3]

Polygalaceae
Polygala erioptera DC.[2]

Portulacaceae
Portulaca oleracea L.[3]

Resedaceae
Ochradenus baccatus Delile[1]

Rhamnaceae
Ziziphus spina-christi (L.) Desf.[1]

Rhizophoraceae
Rhizophora mucronata Lam.[1]

Rubiaceae
Kohautia caespitosa Schnizl.[3]
Oldenlandia corymbosa L. [*T. Abbasi* 15105-RIY (RIY)]

Salvadoraceae
Salvadora persica L.[1]

Scrophulariaceae
Anticharis glandulosa Asch.[3]

Solanaceae
Solanum forskalii Dunal [*Chaudhary* 7208 (RIY)]
Solanum thruppii C.H.Wright (syn. *Solanum coagulans* Forssk.)[3]
Solanum virginianum L. (syn. *Solanum surattense* Burm.f.)[3]

Tamaricaceae
Tamarix L. sp.[3]

Urticaceae
Forsskaolea viridis Ehrenb. ex Webb[2]

Vahliaceae
Bistella digyna (Retz.) Bullock (syn. *Vahlia digyna* (Retz.) Kuntze)[3]

Verbenaceae
Chascanum marrubiifolium Fenzl ex Walp.[3]
Priva adhaerens (Forssk.) Chiov.[3]

Vitaceae
Cissus quadrangularis L.[1]
Cissus rotundifolia (Forssk.) Vahl[1]

Xanthorrhoeaceae
Aloe vera (L.) Burm.f.[1]

Zygophyllaceae
Tetraena alba (L.f.) Beier & Thulin (syn. *Zygophyllum album* L.f.)[6]
Tetraena boulosii (A.I.Hosny) M.Hall[‡] (syn. *Zygophyllum boulosii* A.I.Hosny)[1]
Tetraena coccinea (L.) Beier & Thulin (syn. *Zygophyllum coccineum* L.)[4]
Tetraena simplex (L.) Beier & Thulin (syn. *Zygophyllum simplex* L.) [*R. Basehi* 4242 (KSU)][1]

Unconfirmed records
Ajuga arabica P.H.Davis[6]
Astragalus L. sp.[6]
Cyperus jeminicus Rottb.[7]
Erica arborea L.[6]
Indigofera volkensii Taub. [*Y. Al-Wutaid* 12705-RIY (RIY)]
Ipomoea sinensis (Desr.) Choisy subsp. *blepharosepala* (A.Rich.) Meeuse[6]
Maytenus senegalensis (Lam.) Exell[6]
Maytenus somalensis (Loes.) Cufod.[4]
Schweinfurthia pterosperma (A.Rich.) A.Braun[3]
Sporobolus ioclados (Trin.) Nees[5]

[‡] **Tetraena boulosii** (A.I.Hosny) M.Hall, **comb. nov.** – *Zygophyllum boulosii* A.I.Hosny, Taeckholmia 11: 27 (1988). – Type: *Boulos et al.* 16898 (holo KTUH; iso CAI, E).