تريبيلوس

مجلد 22 - 2014

مجلة جمعية الامارات للتاريخ الطبيعي

Volume 22 - 2014

Journal of the Emirates Natural History Group

TRIBULUS

Volume 22 - 2014

Journal of the Emirates Natural History Group

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Cover Illustrations:

Front: Tarantula spider (Araneae, Theraphosidae) by Priscilla van Andel

Back: Sand cat, *Felis margarita,* by Beverly McKay

Beverly McKay

Beverly McKay, the Canadian-born artist who painted our back cover illustration of a Sand cat, *Felis margarita*, is an illustrator specialising in paintings of living plants, fungi, animals or their bones, shells and related subjects. With an academic degree in biology and chemistry and a postgraduate qualification in Natural History and Scientific Illustration, she has previously worked as a teacher and as a laboratory assistant. A resident of Ra's al-Khaimah, where her husband teaches at the Higher Colleges of Technology, for over ten years, she has amassed a collection of thousands of images of UAE landscapes and wildlife, some of which are now being turned into paintings. She is currently working on a series of fine art paintings of birds that will have conservation of their habitats as the main theme.
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Published by the Emirates Natural History Group. P.O. Box 45553, Abu Dhabi, United Arab Emirates

Designed by Ginny dela Fuente

International Standard Serial Number (ISSN): 1019 - 6919

Printed by Al Amal Printing Press, P.O. Box 38738, Abu Dhabi, UAE

Editorial

Regular readers of **Tribulus** will be aware that, since the journal was first published over 20 years ago, a continuing theme, and message for readers, is that the United Arab Emirates remains a country that is still under-studied.

Much has been discovered for the first time during that period, whether in terms of the country's environment, fauna and flora or in terms of its archaeology, but new discoveries aplenty are made every year, with many more, surely, to be made in the years ahead.

This issue contains two papers that are, in our view, of great significance. Both report on aspects of the country that were previously unknown.

The first, by Priscilla van Andel, reports on the identification in the UAE, for the first time, of spiders from the Theraphosidae family, known to the general public as tarantulas. The UAE's spiders, as a group, have received little attention in the past, even from specialists. Van Andel, a photographer rather than a natural historian, shows not only that tarantulas can be found here but also, thanks to consultations with leading specialists overseas, that the species she has found is new to science. Her work has already prompted others to go into the field, to find that the species is by no means rare – it has simply been overlooked. That's proof enough, yet again, that there are new finds to be made, not just related to the UAE but to the world of science as a whole, for those who care to look for them.

The second paper, by frequent contributor Gary Feulner, underlines the importance of regular survey work in a particular area that looks at a wide range of fauna and flora. His study, over a twenty year period, of the area of high mountains south-west of Fujairah that he calls the 'Olive Highlands' has proven conclusively that they contain a unique assemblage of flora and fauna, some not known from anywhere else in the country. He proposes, convincingly, that they are relict species from a time when the climate was markedly different from what it is today and that they have, effectively, 'retreated' uphill, hanging on in a changed world.

The Olive Highlands, therefore, represent an area of enormous importance in terms of the UAE's ecological diversity, one that deserves both wider recognition and proper protection. Lying, as they do, within the territory of three of the emirates, Fujairah, Sharjah and Ra's al- Khaimah, they can best be protected through an inter-emirate agreement, and, by means of this paper, the attention of the government of Fujairah has already been drawn to them.

It is well-known that there has been a change in the UAE's climate over the last few thousand years, for a variety of reasons, with the relict species of the Olive Highlands providing clear evidence of that from a biological perspective. The nature of that change, however, in terms of rainfall and other factors, has as yet been little studied. How has rainfall fluctuated? At what periods have there been episodes of severe drought?

Another paper, by Adrian Parker, seeks to establish a chronology for climate and environmental change during the Holocene period, the last 10,000 years or so, based on studies in the Mleiha area of Sharjah. The results of his studies, partly funded by a grant from the ENHG's Conservation Fund, are of considerable value in terms of interpreting the patterns of historic and pre-historic settlement in the area of the Madam Plain, just west of the Hajar Mountains, but also contribute to our understanding of the country's environment on a wider scale.

A wide range of other papers are more narrowly focussed, reporting, for example, on the discovery of two new plant species for the UAE, a butterfly previously unknown anywhere in Arabia that has evidently arrived along with imported plants used in horticulture, observations of a tiger beetle once thought to be very rare, but evidently more widely spread than was previously recognised, and a first record for the UAE of a little known and extremely unusual species of mollusc.

Another paper, from nearby Oman, suggests, convincingly, that the only species of waterscorpion present in Arabia does fly, after all – contrary to the information contained in earlier studies.

These and other papers, along with the two papers on the UAE's first tarantula and on the Olive Highlands, provide the usual range of diverse contributions to knowledge of the UAE's environment, flora and fauna. They show, once again, that there is much still to be discovered, both in well-studied groups and in others that have, until now, received little attention.

We look forward to publishing further papers that will continue to shed new light on this aspect of the Emirates.

First distribution record of a tarantula spider (Araneae, Theraphosidae) found in the United Arab Emirates

by Priscilla van Andel

On 8th April 2013, the author's husband, Hans Raaijmakers, found an unidentifiable species of spider under a rock while hiking in the Hajar Mountains, United Arab Emirates.

Photographs of the spider and habitat were made and GPS co-ordinates were recorded. Photographs of the spider were sent to naturalists and arachnologists, both nationally and internationally. The arachnologists came to the conclusion this was a tarantula in the mygalomorph family Theraphosidae.

Spiders in the Family Theraphosidae are distinguished from other spiders by the presence of two pair of booklungs; cheliceral fangs open paraxial; maxillae and labial cuspules present; distinct lobe on the anterior maxillae; two pairs of spinnerets; posterior lateral spinnerets are digitiform (finger-like); eight eyes in two close rectangular rows on a small anterior tubercle on the carapace; the legs and body are hirsute (hairy) and the tarsi (feet) are scopulated (padded) with retractable claw tufts (Raven, 1985). To date, there are approximately 947 species of theraphosid spider found throughout the more tropical and desert regions of the world (Platnick, 2014). Although some theraphosid species have been recorded from parts of the Middle East, including the Arabian Peninsula, there are no published and confirmed records of theraphosid spider from the United Arab Emirates (Guadanucci *et al.* 2008, 2014).

More specimens were found, mainly during the rainy season, between the months of December and June in loosely webbed retreats under large rocks lying on the ground. A few specimens were found in unwebbed retreats. All specimens were found in wadi systems, close to the beds of the wadis.

Further fieldwork to June 2014 has identified specimens in four different UAE locations; wadis in southern Ra's al-Khaimah, Wadi Sha'am, Wadi Chees (Shis) and the Hatta Mountains. Given the proximity of some wadis to Oman, it is important to note that there have been previous reports of theraphosid spiders found within the Sultanate (S. Huber, *unpubl. data*).

Fig 1: General theraphosid spider habitat: abandoned village in a wadi in southern Ra's al Khaimah, United Arab Emirates. (Picture: P. van Andel)

While conducting biological cave research, between 25th September and 7th October 2000, Mr. Siegfried Huber found mygalomorph spiders that were later confirmed to be theraphosid spiders. Like the UAE theraphosid spiders, these spiders were found in similar habitat under rocks and near wadis close to Salalah and Mugsail, Governorate of Dhofar, and near the caves of Al Hota and Al Fallah, Governorate of Ad Dakhiliyah, and Al Araqi, Governorate of Azzahirah, in the Sultanate of Oman. (S. Huber, *pers. comm.*)

Photographs and GPS co-ordinates have been made of all UAE specimens and their locations by the author. Voucher specimens were collected for further study and identification. (*Figures 1–5*) and cover picture.

Further investigation has revealed that similar-looking spiders had been seen and photographed in the UAE, from slopes at 500 m above Wadi Sha'am as far back as 2003 (G. Feulner, *pers. comm.* [unpubl. data]). These spiders were not examined or verified to family or genus level at that time. Images recently sent to S. Nunn by G. Feulner have, however, confirmed the spiders in question are indeed in the family Theraphosidae and are most likely species within the subfamily Ischnocolinae (R. West & S. Nunn, *pers. comm.*).

Although Mirza *et al.* (2014) referred to the presence of Theraphosidae in the U.A.E., this appears to be an erroneous interpretation of Smith (1990), who stated that the closest that Eumenophorinae are found in relation to the U.A.E. is Socotra Island (Yemen). Mirza *et al.* (2014) certainly provide no further support in the form of references, voucher specimens, known type material or even personal communication for their statement. Following historical papers on Theraphosidae (and those shorter papers that would be relevant), Pocock (1897) does not reference any of the regions now known as the U.A.E., and neither do Simon (1903), Roewer (1942), Bonnet (1959), Brignoli (1983) or Raven (1985) all of whom (with the exception of Pocock 1897, which is referenced here following Mirza *et al.* [2014]), tracked the general history of all Theraphosidae within the above works (R.West & S.Nunn, *pers. comm.*). As far as can be determined by the author through extensive and intensive background research, this paper provides the first confirmed records and images of a theraphosid spider found in the United Arab Emirates.

Although under-researched in this region and, for the most part, misunderstood by many, large arachnids are generically given the vernacular name of *'shabath'* in Arabic. The author has recently started

Fig 2: Theraphosid spider in exposed silken retreat, under a rock, Wadi Chees (Shis), UAE East Coast. (Picture: P. van Andel)

Fig 3: Microhabitat of the UAE theraphosid spider. (Picture: P. van Andel)

Fig 4: Theraphosid spider, habitus, Wadi Chees (Shis), UAE East Coast. (Picture: P. van Andel)

Fig 5: Theraphosid spider, habitus, mountains near Hatt*a.* (Picture: P. van Andel)

to look for more specific local Arabic names given to large arachnids since *shabath* may also be misused to describe the solpugid commonly known as the camel spider (which, although an arachnid, is not a true spider).

In the Gulf region and other parts of Arabia, tarantulas are generically known as *'ar-roteyla',* a common name that seems to be given to tarantulas, huntsman spider and daddy long legs. In general, most Bedouin Arabs treat most arachnids with a wary respect. An Islamic oral tradition holds that during the Hijra, the journey from Mecca to Medina, the Prophet Muhammad and his companion Abu Bakr were being pursued by Quraysh soldiers, and decided to take refuge in the Cave of Thawr. The tale goes on to say that Allah commanded a spider to weave a web across the opening of the cave. After seeing the spider's web, the Quraysh passed the cave by, since the Prophet's entry to the cave would have broken the web. Since then, it has been held in many Muslim traditions that a spider is at least to be respected.

The voucher specimens collected were presented to arachnologists Rick West and Steve Nunn, who specialise in this taxon, for further identification and study.

After careful examination, they have confirmed that the specimens were indeed mygalomorph spiders in the Family Theraphosidae, subfamily Ischnocolinae and genus *Ischnocolus*.

Representatives of the genus *Ischnocolus* can be distinguished from all other Ischnocolinae genera by the clavate (club-shaped) tarsal trichobothria, with small barbs on the surface, that are arranged in a short median apical row and by the maxillae having a lighter colour on the prolateral edge on the ventral surface than on the retrolateral edge, in both live and preserved specimens. The maxillary serrula (toothed keel) is absent, the posterior lateral spinnerets are shorter than the abdomen and an unpaired claw on the tarsi is absent. Tarsal claws are bipectinated (two rows toothed like a comb) and all tarsal scopulae are divided longitudinally by a narrow row of setae ... all characteristic of the genus *Ischnocolus* and not those of the closely related and sympatric ischnocoline genus *Chaetopelma* (R. West & S. Nunn, *pers. comm.).*

While in captivity, one of the live *Ischnocolus* specimens moulted. The shed exuvium was examined (by R. West) under a dissecting scope. From the exuvium, it was determined that the sex of the specimen was an adult female by the presence of well-

Fig 6: *Ischnocolus* sp. nov., female [freshly moult colouration], Wadi Shawka, Ra's al-Khaimah, United Arab Emirates, col. P. van Andel. Picture: Rick C. West

developed spermathecae (internal sperm receptacula). Further microscopic examination and comparison to all known female *Ischnocolus* (Guadanucci & Wendt 2014) further revealed that the UAE *Ischnocolus* species is undescribed and new to science (*Fig 6*).

At least one United Arab Emirates theraphosid spider is, therefore, an undescribed *Ischnocolus* species. Its description will appear in a future publication (West, Nunn & Guadanucci, *in prep.*). The acquisition of mature males and further field studies will be required to determine the zoogeographical distribution, diversity and fragility of this species, and, possibly, of other UAE theraphosid spiders.

It is hoped that this article will generate further reports of UAE theraphosid spider sightings, information and voucher specimens for further study.

Acknowledgements

Special thanks to my husband, Hans Raaijmakers, who brought the first specimen to my attention and for supporting me with the still continuing research project; Jonathan Ali Khan (Managing Director, Wild Planet Productions); Rick West and Steve Nunn (Arachnologists); Johannes Els (Head of Department: Herpetology and Freshwater Fishes, The Environment and Protected Areas Authority, Government of Sharjah); Sithum Jayasinghe (Herpetology and Freshwater Fishes Department, The Environment and Protected Areas Authority, Government of Sharjah), without all of whom I would not have been able to conduct this research.

Furthermore, I wish to thank those individuals that have contributed to my search for information and specimens: Ajmal Hasan (Academic Coordinator - graduate studies – Khalifa University, Abu Dhabi, UAE), Peter Roosenschoon (Al Maha Desert Resort and Hotel, Dubai Desert Conservation Reserve), Lynsey Gedman (Documentary Producer), Dr. Anitha Saji (Assistant Scientist: Entomology, Biodiversity Management Sector: Environment Agency-Abu Dhabi), Ricardo Pusey (Animal Collection Manager, Terrestrial and Marine Bio-diversity Sector: Environment Agency-Abu Dhabi), Gary Feulner (Dubai Natural History Group) and Gerry Whitehouse-Tedd. Thanks to Siegfried Huber (Germany) for supplying locality data for the theraphosid spiders he found in the Sultanate of Oman in 2000.

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The Olive Highlands: A unique "island" of biodiversity within the Hajar Mountains of the United Arab Emirates

by Gary R. Feulner

Abstract

The area that is here called the Olive Highlands is a remote and little known region of high ridges (*ca*. 1000 metres) within the Hajar Mountains of the United Arab Emirates, south-west of Fujairah city. It represents an ecologically unique 'island' of biodiversity, characterised by a distinctive high elevation flora and fauna including a number of plant species (e.g., the wild olive tree *Olea europaea*, the large shrubs *Ehretia obtusifolia* and *Grewia tenax*, and the cactus-like, yellow-flowering milkweed *Desmidorchis flavus*) as well as at least one animal species (the Arabian Grizzled Skipper butterfly *Spialia mangana*) that are not found elsewhere in the UAE, and other plant and animal species not otherwise found outside the Ru'us al-Jibal (the mountains of the Musandam peninsula).

On the basis of what was known about their flora, the Olive Highlands were identified as a discrete biological habitat and were highlighted for attention by a recent biodiversity assessment for national conservation planning. Subsequently, the area has been confirmed to be a refuge for rare fauna as well, including the Arabian Grizzled Skipper and the Persian Horned Viper *Pseudocerastes persicus*, for each of which there are no other records from the Hajar Mountains of the UAE. The Olive Highlands also host an unusual colour morph of the Blue Pansy butterfly *Junonia orythia* and a large population of the Bar-Tailed Semaphore Gecko *Pristurus celerrimus*. Most if not all of these distinctive plant and animal species probably represent relicts of more widespread populations that flourished in the more mesic climate of an earlier time, perhaps as recently as *ca.* 6,000-10,000 years ago during the so-called climatic optimum.

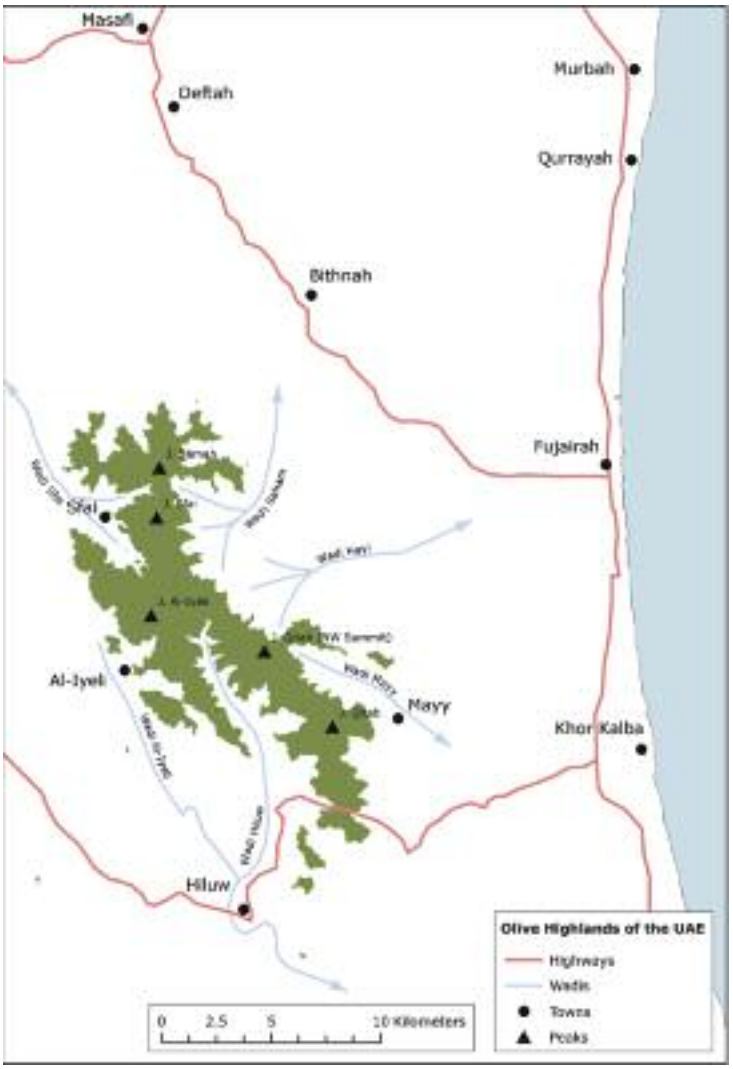

Fig. 1. The map shows the location of the area within the Hajar Mountains that is designated here as the Olive Highlands, plus selected features and locations mentioned in the text. The shaded area represents terrain at or above 600 metres elevation..

Protection of the Olive Highlands from a conservation standpoint is obviously desirable in order to preserve their unique contribution to UAE and regional biodiversity. Protection should be straightforward as a technical matter. The area remains largely unknown and unvisited, relatively inaccessible and largely undisturbed. It does not require active intervention or management; it needs only to continue to be left alone – to be earmarked for preservation and closed to development activities and other molestation.

The area in question encompasses parts of three of the seven Emirates – Fujairah, Ra's al-Khaimah and Sharjah. This means that effective preservation ultimately requires cooperation among the concerned authorities in the several Emirates, still an unproven model in the UAE, so the Olive Highlands present an opportunity that is unique not only in terms of biodiversity but in a political sense as well.

Introduction

This report is intended to describe, for further scientific and public policy attention, a remote and little known high elevation area of the Hajar Mountains that has been identified as an environmental refuge for rare plant and animal species and recommended as a conservation priority on biodiversity grounds.

The area that is here called the Olive Highlands, after its most distinctive species, is shown in *Fig. 1*. It comprises an area of high elevation terrain (600 to 1050 metres) in the south-east of the Hajar Mountains of the UAE. To the south-east, it corresponds to the Jebel Qitab ridge (*Figs. 2* and *3*), which forms the south-west flank of Wadi Mayy, south-west of Fujairah city. To the north and west, it encompasses the mountain ridges which separate Wadi Hiluw (to the south), Wadi Sfai (to the north-west), and Wadi Saham and Wadi Hayl (to the north-east). The northern extent of the area is marked by Jebel Samah, east-north-east of the village of Sfai, which now overlooks the new Sheikh Khalifah bin Zayed Freeway (not shown in *Fig. 1*).

Jebel Qitab itself, *ca.* 1030 metres high, lies near the south-eastern end of a *ca*. 6 km ridge, overlooking the village of Mayy. Near the other end of the ridge, *ca.* 4 km to the north-west, is a second summit, unnamed, also *ca*. 1030 metres. In between, the ridge rises and falls gently, with intermittent exposures of its rocky spine, but is never lower than *ca.* 900 metres. Further to the north-west, the summits of Jebel Al-Iyeli and Jebel Sfai both approach 1050 metres, and Jebel Samah is *ca*. 950 metres. [The elevations given here are those shown on the 1982 topographic map of Fujairah produced under the direction of the U.K. Director of Military Survey (Director of Military Survey 1982).]

A number of inter-related factors contribute to the ecological distinctiveness of the Olive Highlands. Foremost are probably its size and elevation. The nearly continuous chain of 800 to 1050 metre ridgetops in most of this area encompasses an estimated 13 km^2, making it, by far, the largest such high area in the UAE, outside the Ru'us al-Jibal (the mountains of the Musandam peninsula). The contiguous area above 600 metres (shown in *Fig. 1*) is estimated at *ca*. 78 km^2; above 500 metres it is *ca*. 132 km^2. (By way of comparison, the Shimayliyah area to the north, between Masafi and the Gulf of Oman coast, includes three individual peaks that exceed 1100 metres, but otherwise the ridges in the Shimayliyah area are generally much lower, reaching 900 metres at only a few points, and they are invariably narrower and more precipitous, often knifelike.) At these elevations there are no roads and no present day agriculture, although intermittent cultivated areas extend up to nearly 500 metres in Wadi Hiluw, Wadi Al-Iyeli and Wadi Sfai, and a graded road on the western margin of the designated area rises to *ca*. 550 metres and connects the villages of Sfai and Al-Iyeli (*Fig. 4*).

Geologically, the Olive Highlands consist almost entirely of gabbro (British Geological Survey 2006a, 2006b), a coarse grained igneous rock. Geologists classify igneous rocks as acid, intermediate, basic or ultrabasic on the basis of their (decreasing) content of silica (SiO_2), the fundamental building block of igneous rocks. Gabbro, with a relatively low silica content, is said to have a "basic" composition. In this respect the Olive Highlands are geologically and geochemically distinct from most of the Hajar Mountains to the north (e.g., Wadi Wurayah National

Fig. 2. Jebel Qitab (right of centre) and the Olive Highlands, viewed from Khor Kalba

Fig. 3. The summit ridge of Jebel Qitab on a clear day, looking south-east, showing the broad summit and relatively gentle southerly slopes, as well as a hint of the more rugged north-easterly slopes.

Fig. 4. The view south-west from Jebel Al-Iyeli, overlooking upper Wadi Al-Iyeli and the graded road between the villages of Al-Iyeli and Sfai. Here the descent to the road is only *ca.* 500 metres.

Fig. 5. Clouds from the Gulf of Oman coast pile up along the north-east face of the summit ridge of Jebel Qitab, where they are met by westerly winds prevailing across the UAE. This view looks north-west. Compare this photo with Fig. 3, which shows a panoramic view of the same area from the other end of the ridge.

Fig. 6. The summit cliffs and the steep but moist and sheltering north-east facing slopes and ravines of the Olive Highlands feature large species such as *Olea europaea* (top right) and *Ehretia obtusifolia* (lower left), as well as many other distinctive species discussed in the text.

Park and surrounding areas) and to the south (e.g., the Hatta area southward to Wadi Jizzi and beyond), which are composed primarily of a rock called harzburgite. Harzburgite is extremely low in silica and is therefore classified as "ultrabasic".

Ultrabasic bedrock is typically associated with the development of poor soils that are deficient in important nutrients (e.g., calcium, nitrogen and phosphorus) and high in toxic heavy metals (e.g., chromium and nickel), so this distinction is potentially significant for plant life (Harrison & Kruckeberg 2008). Moreover, in arid climates, groundwater in ultrabasic bedrock can become extremely "basic" in the traditional chemical sense as well (i.e., high alkalinity), with groundwater pH in excess of 11, adding to the potential difficulties of the ultrabasic environment.

Within and adjacent to the Olive Highlands, ultrabasic bedrock (harzburgite) is found only just outside the periphery in the north-east, in upper Wadi Hayl and Wadi Saham, at elevations well below the main ridges, but some ultrabasic rock types can be found within what is mapped as a mixed unit, along the short ridge west of the Jebel Qitab summit ridge (separating uppermost Wadi Hiluw from Wadi Hayl) and continuing north along the lower slopes of the Olive Highlands, east of Jebel Sfai and Jebel Samah (British Geological Survey 2006a, Thomas *et al.* 2006).

Physiographically, weathering of the gabbro bedrock produces gentler slopes and broader summit ridges than weathering of the harzburgite, resulting in relatively greater physical area at high elevations and facilitating soil development, creating a more hospitable and diverse edaphic environment for most plant species. (See, e.g., *Figs. 3*, *4* and *6*.)

Climatically, the elevation of the Olive Highlands offers relief from the worst of the region's high temperatures. But in addition, the Olive Highlands, and the Jebel Qitab ridge in particular, have the ability to make their own weather. They are high enough, and oriented at a sufficient angle to the coast, that they can and do trap and precipitate moisture from Indian Ocean (Gulf of Oman) air as cloud or fog (*Figs. 5* and *6*). The development of easterly clouds against the summits in this region can frequently be seen from the west flank of the Hajar Mountains. This additional moisture undoubtedly contributes to the support of a distinctive floral community.

Fig. 7. Dwarf shrubs dominate the ridgetop plateau. The predominant plant in the picture is *Gymnocarpos decandrus*. Also distinguishable are *Convolvulus acanthocladus*, *Ochradenus arabicus* (at extreme right) and *Aristida adscensionis*.

Fig. 8. Uppermost Wadi Hiluw, looking south from the divide with Wadi Sfai. The relatively gentle slopes are indicative of gabbro bedrock versus harzburgite.

Fig. 9. A view of Jebel Qitab (at left) and the adjacent ridgetop, summit cliffs and upper ravine slopes, seen from the north-west.

As in any mountain plant community, many individual species are selective in their choice of habitat, in terms of substrate, slope, exposure, orientation and other factors. Within the Olive Highlands, north-facing slopes and wadis generally have a more abundant and more diverse flora than south-facing ones. This can be seen very well along the Jebel Qitab ridge, where the more moist and sheltering north-east facing slopes and ravines feature large species such as *Olea europaea*, *Ehretia obtusifolia* and *Grewia tenax* (*Fig. 6),* as well as many of the other characteristic species discussed below, whereas even at higher elevations the south-west facing slopes tend to have a more typical Hajar Mountain flora. The north-east slopes of the Jebel Qitab ridge also have a steeper profile and a greater descent to base level than other areas of the Olive Highlands, descending *ca*. 800 metres to Wadi Mayy (at *ca*. 200 metres) in only about 2.5 kilometres horizontal distance.

The Jebel Qitab ridge, more than six kilometres long, can be thought of as the core of the Olive Highlands, because it constitutes by far the largest contiguous area at 900 metres or more elevation and because the summit of the ridge and its north-east facing slopes have been found to contain the densest concentrations of most (but not all) of the plant and animal species that make the area unique from the standpoint of biodiversity, as further discussed below.

The distinctive flora of the Olive Highlands was first reported nearly two decades ago (Feulner 1997), but the area remains largely unheralded and unexplored to this day. There are still no major roads in the immediately surrounding areas and (with the recent exception of rough tracks to three communications towers) the summit areas are accessible only on foot. Even among generally knowledgeable UAE naturalists, few know anything about the area, as evidenced, for example, at habitat mapping sessions held in the course of the Local, National Regional Biodiversity Rapid Assessment exercise conducted by Abu Dhabi Global Environmental Data Initiative in 2012 (AGEDI 2013).

Major Habitats

Mountain environments are typically diversified on a relatively fine scale, and the Olive Highlands are no exception. It may nevertheless be helpful to attempt to categorise the area in terms of five major habitats, which, however, grade into each other at the margins.

Ridgetops. At first glance, the rounded summit ridges of the Olive Highlands appear to be almost barren (*Figs. 3* to *5*). The ridgetops themselves are all but devoid of trees and are dominated by dwarf shrubs and annuals (in season) (*Fig. 7*). The largest shrubs are *Ochradenus arabicus* and *Ephedra pachyclada*. Other common shrubs include *Convolvulus acanthocladus*, *Fagonia schimperi*, *Glossonema varians*, *Gymnocarpos decandrus*, *Helianthemum*

lippii, *Leucas inflata*, *Melhania muricata* and *Trichodesma enetotrichum*. Ridgetop annuals include *Asphodelus tenuifolius*, *Cuscuta planifora*, *Oligomeris linifolia*, *Pallenis hierochunticus* (syn. *Asteriscus hierochunticus*), *Plantago amplexicaulis*, *Senecio breviflorus* (formerly considered *S. flavus*), *Viola cinerea* and *Volutaria sinaica*.

Subsidiary ridges. From the summit ridges, subsidiary ridges descend to wadi level. On the north-east slope of the Jebel Qitab ridge, and to a lesser extent on the slopes east of upper Wadi Sfai, the subsidiary ridges are arranged in parallel, like ribs along the summit spine. Elsewhere, the pattern of subsidiary ridges and the ravines between them is more dendritic (*Fig. 8*). The subsidiary ridges are moderately steep and rocky, featuring blocky weathering of the gabbro bedrock and large boulders. Plant life thrives in the shelter of the rocks and boulders, where thin soil can accumulate. A broad range of characteristic Hajar Mountain species can be found in this environment, as well as some of the rarer species described separately below. A representative sampling includes: *Abutilon fruticosum*, *Aristida adscensionis*, *Cenchrus ciliaris*, *Desmidorchis arabicus* (syn. *Caralluma arabica*), *Echiochilon persicum*, *Erodium neuradifolium*, *Euphorbia larica*, *Fagonia brugueri*, *Filago desertorum*, *Iphiona scabra*, *Lavandula subnuda*, *Leucas inflata*, *Periploca aphylla*, *Phagnalon schweinfurthii*, *Plantago afra*, *Pulicaria glutinosa*, *Reichardia tingitana*, *Rumex vesicarius*, *Salvia aegyptiaca* and *Senecio breviflorus*.

Fig. 10. A closer view of the summit cliffs and upper ravine habitat on the north-east slopes of the Jebel Qitab ridge. The base of the moribund olive tree at the centre is surrounded by leafy *Abutilon fruticosum* and flanked by ground cover of *Sisymbrium erysimoides*. Recognisable on the slopes beyond are, *inter alia*, *Aerva javanica*, *Convolvulus acanthocladus*, *Leucas inflata*, *Ochradenus aucheri* and *Salvia macrosiphon*.

Upper ravines & summit cliffs. The subsidiary ridges are separated by ravines. The ravines are typically steepest at their heads, which sometimes end in blocky cliffs, especially on north and north-east facing slopes (*Figs. 9* and *10*). These cliffs provide shelter from the sun, they trap moisture from the sea (see above) and they allow soil accumulation. This environment hosts a mix of trees and large shrubs (*Olea europaea*, *Ehretia obtusifolia*, *Ephedra pachyclada*, *Grewia tenax* and *Ochradenus arabicus*), dwarf shrubs (e.g., *Abutilon fruticosum*, *Aerva javanica*, *Convolvulus acanthocladus*, *Geranium* sp., *Gymnocarpos decandrus*, *Launaea bornmuelleri* (formerly considered *L. spinosa*) and *Lavandula subnuda*) and small annuals (e.g., *Erodium neuradifolium*, *Plantago afra*, *Senecio breviflorus*, *Sisymbrium erysimoides* and *Spergula fallax*). Where the upper slopes of a ravine are made of loose rubble or scree, the flora may resemble what is described below for the lower slopes. Where the ravines are fed by more gentle channels from the ridgetop, accumulations of stunted *Dodonaea viscosa* shrubs may be found along the channel banks.

Lower slopes of ravines. The lower slopes of the ravines are typically less steep than the upper slopes, and are more likely to have a cover of rubble or scree. They are home to diverse species (*Fig. 11*) including, e.g., *Aerva javanica*, *Anagallis arvensis*, *Echinops erinaceus*, *Forsskaolea tenacissima*, *Launaea bornmuelleri*, *Leucas inflata*, *Moringa peregrina*, *Nanorrhinum hastatum* (syn. *Kickxia hastata*), *Rumex vesicarius*, *Salvia aegyptiaca*, *Salvia macrosiphon* (syn. *S. spinosa*) and *Teucrium stocksianum*.

Ravine beds. In the centre of the main watercourses gabbro bedrock is often exposed, but the central wadis may also consist of large, rounded to sub-rounded boulders in a bed of well rounded cobbles and pebbles. Plants in this environment must be able either to withstand periodic torrents or to grow, flower and reproduce in between them. So it is primarily a realm of annual herbs and grasses (e.g., *Anagallis arvensis*, *Campanula erinus*, *Castellia tuberculosa*, *Geranium mascatense*, *Misopates orontium* and *Spergula fallax*) and larger, more deeply rooted shrubs, trees and tussock grasses (e.g., *Dodonaea viscosa*, *Grewia*

Fig. 11. Dwarf shrubs and annuals abound in a rubble-filled gulley on the north-east slopes of Jebel Qitab, at ca. 800 metres in mid-February 2014. The large-leafed prostrate plant is *Salvia macrosiphon*. The dense, erect, round-leafed plant at the left, right and bottom margins is *Forsskaolea tenacissima*.

Fig. 12. A ravine on the north-east slopes of the Jebel Qitab ridge, in late afternoon. In this photo, taken from ca. 300 metres, the 600 metre elevation contour used in this paper to delineate the Olive Highlands is situated approximately three-quarters of the distance from the bottom of the picture to the ridgetop horizon.

tenax, *Lycium shawii*, *Olea europaea*, *Pennisetum divisum* and *Ziziphus spina-christi*). Trees are sometimes draped with the climber *Cocculus pendulus*. Soil may accumulate in or around boulders and debris above the lowest level of the bed, and will support species more typically found on wadi banks or the lower slopes of the ravines, e.g., *Acacia tortilis*, *Echinops erinaceus*, *Lavandula subnuda* and *Physorrhynchus chamaerapistrum* (*Fig. 12*).

Other habitats. One major habitat found in UAE mountain wadis generally that is not well represented within the Olive Highlands is the lower wadi environment, characterised by a relatively broad, flat wadi with a bed of stones, cobbles and small boulders, usually with subterranean water flow, flanked by thick terraces of alluvial gravel. The 600 metre contour, chosen here to define the Olive Highlands for discussion, excludes most such environments except for small areas in the upper reaches of Wadi Hiluw and Wadi Sfai. Species primarily associated with that environment, such as *Chrozophora oblongifolia*, *Ficus cordata salicifolia*, *Rhazya stricta*, *Saccharum griffithii* and *Tephrosia apollinea*, are correspondingly rare within the Olive Highlands, although Wadi Sfai is broad enough at some points in its upper reaches that the *ghaf* tree, *Prosopis cineraria*, can be found there up to *ca*. 700 metres.

A few plant species generally common in the Hajar Mountains of the UAE may be rare or absent in the Olive Highlands because they have evolved to thrive best in areas of ultrabasic bedrock rather than gabbro. Among the species suspected to be in that category are, e.g., *Diplotaxis harra*, *Pteropyrum scoparium* and *Salvia macilenta*. Conversely, some of the species found in the Olive Highlands appear to be intolerant of ultrabasic bedrock. Three well supported examples are *Dicoma schimperi*, *Echiochilon persicum* and *Lycium shawii* (the Desert Thorn). The relationship between plant biogeography and bedrock geology within the Hajar Mountains is a focus of the author's current research (e.g., Feulner, *in prep.*).

Biodiversity

In visits to areas within the Olive Highlands on more than 30 occasions over the past 20 years, at intervals of two years or less, the author has recorded at least 162 plant species there. (For this purpose, all plants recorded on mountain slopes or in wadis at elevations greater than *ca*. 600 metres have been included.) This figure compares respectably with figures from dedicated botanical surveys of Wadi Wurayah National Park (200+ species) (Feulner, *in prep.*) and of natural habitats within the Wadi Helo (a/k/a Wadi Hiluw) Protected Area (147 species) (El-Keblawy 2011). Both of the latter surveys included terrain at all elevations, and therefore lower wadi environments as well.

But more important than the number of species recorded is the fact that the Olive Highlands constitute an ecologically unique 'island' of biodiversity, characterised by a distinctive high elevation flora and fauna that includes a number of plant species and at least one animal species that are not found elsewhere in the UAE, as well as other plant and animal species that are not found outside the Ru'us al-Jibal.

Fig. 13. *Abutilon fruticosum* has been found in the UAE only on the north-east slopes of the Jebel Qitab ridge.

The following is an annotated list of many of the plant and animal species that make the Olive Highlands a unique environment within the Hajar Mountains of the UAE.

Flora

Abutilon fruticosum (Malvaceae) (*Fig. 13*): The north-east slopes of Jebel Qitab are the only known UAE locality for this species with relatively large and showy flowers. Specimens were found at various elevations, including just below the summit.

Arenaria serpyllifolia (Caryophyllaceae): This "chickweed" species is locally common at higher elevations in the Ru'us al-Jibal (Feulner 2011). It has been considered very rare elsewhere in the UAE (Jongbloed 2003, Karim & Fawzi 2007) but in the Olive Highlands it is at least occasional on stony slopes at elevations of *ca*. 800 metres and above.

Astragalus fasciculifolius (Fabaceae): This large shrub. one of the UAE's most attractive when in flower, is common on slopes and wadi banks in the Ru'us al-Jibal but very rare in the Hajar Mountains. Small numbers have been found in uppermost Wadi Zikt, within Wadi Wurayah National Park. A few specimens have been recorded in the Olive Highlands, in the vicinity of Jebel Sfai (*pers. obs.*) and in upper Wadi Hiluw (El-Keblawy 2011).

Bromus pectinatus (Poaceae): This coarse grass was recorded by the author not far below the summt of Jebel Al-Iyeli, at *ca*. 1000 metres, and by El-Keblawy (2011) from Wadi Hiluw, also on upper slopes. Otherwise it is known in Eastern Arabia only from a single collection in the UAE and several in Northern Oman (Cope 2007).

Fig. 14. *Campanula erinus* is an uncommon mountain plant best known from the Ru'us al-Jibal. This plant, from a ravine draining Jebel Qitab, is one of only three Hajar Mountain records.

Campanula erinus (Campanulaceae) (*Fig. 14*): This small annual was found in a steep wadi bed on the north-east flank of Jebel Qitab. It is locally common in the Ru'us al-Jibal, but there are only two other Hajar Mountain records, from different locations in Wadi Wurayah National Park.

Castellia tuberculosa (Poaceae) (*Fig. 15*): This rarely recorded grass was found at various elevations in the bed of a major ravine draining the north-east flank of Jebel Qitab. Only two other UAE records are known, both from areas now within Wadi Wurayah National Park.

Convolvulus acanthocladus (Convolvulaceae): This intricately twisted, spiny *Convolvulus* is one of the most common plants of the Ru'us al-Jibal, above *ca*. 1000 metres (Feulner 2011), but it is otherwise unknown in the UAE, except at higher elevations in the Olive Highlands, where it is found as occasional scattered plants. On the other hand, *C. virgatus*, a less robust spiny *Convolvulus* that is one of the most common species of lower slopes in much of the Hajar Mountains of the UAE (e.g., Wadi Wurayah and neighbouring wadis), is virtually absent within the Olive Highlands. [NB: *C. acanthocladus* as discussed here should not be conflated with the spiny but rectilinear form of *Convolvulus*, also professionally identified to date as *C. acanthocladus* but readily distinguishable in the field by appearance and habitat, and limited geographically to the west flank of the Hajar Mountains in northernmost Oman. See also Feulner (2011) at Sec. 14.]

Desmidorchis flavus (Asclepiadaceae) (*Fig. 16*): This yellow-flowering, cactus-like succulent (formerly *Caralluma flava*) is found occasionally in the northern part of the Olive Highlands, from upper Wadi Hiluw to Jebel Samah, including the slopes of the ridge that separates Wadi Sfai (to the west) from Wadi Saham (to the east). It is otherwise unknown in the UAE, although it is a close relative of the more widespread, purple-flowering *Desmidorchis arabicus* (formerly *Caralluma arabica*). The Olive Highlands population may represent the northernmost extent of its global range.

Dicoma schimperi (Asteraceae): This small shrub (formerly *Hochstetteria schimperi*) can be identified by its erect, ribbed stems. Western (1989) first recognised that its local distribution is limited to the south-eastern portion of the mountains of the UAE. This suggests that it is intolerant of the ultrabasic bedrock that prevails elsewhere. It is locally common in Wadi Hiluw, on

Fig. 15. *Castellia tuberculosa*: Multiple specimens of this grass were encountered in coarse gravel in the bed of the ravine shown in Fig. 12, but only two prior records are known.

Fig. 16. *Desmidorchis flavus*: The only UAE records of this cactus-like, yellow-flowering succulent are from the north-western part of the Olive Highlands.

Fig. 17. *Ehretia obtusifolia:* The north-east slopes of the Jebel Qitab ridge, and particularly the summit cliffs, are the only known UAE locality for this large, characteristically drooping shrub. Note the characteristic spoon-shaped leaves, occasionally with a notched apex. See also Fig. 5.

gentle slopes at relatively low elevation (*ca.* 500-600 metres), but it has also been recorded from near the summit of Jebel Jabsah (*ca*. 900 metres), north of Wadi Ham on the outskirts of Fujairah city.

Echiochilon callianthum (Boraginaceae): This is the pink-purple flowering species described in Jongbloed (2003) as *E. thesigeri* (see Feulner 2011, Appendix at *Echiochilon persicum*). It has been recorded in the UAE only from the Olive Highlands and the outlying carbonate massif of Jebel Hafit in Al-Ain.

Ehretia obtusifolia (Boraginaceae) (Figs. 6, 17): This large, drooping shrub is often found splayed out beneath other large shrubs or trees on slopes or cliffs. Its only known UAE locality is among the olive trees on the north-east facing slopes of the Jebel Qitab ridge, where on several occasions it has been observed in flower and fruit in January and February. A single erect, tree-sized specimen was found in a ravine below, at *ca.* 650 metres. Both the olive trees and *E. obtusifolia* appeared to suffer from extended drought during the 2000s but when seen most recently, in February 2014, *E. obtusifolia* appeared refreshed and was flowering and fruiting.

Ephedra pachyclada (Ephedraceae): One of the UAE's only two gymnosperms (both *Ephedra* spp.), this leafless shrub is otherwise found in Eastern Arabia only in the Ru'us al-Jibal (where it appears at *ca*. 900 metres and becomes more common above *ca*. 1200 metres) and in the high Jebel Akhdar (above *ca*. 2000 metres) (Ghazanfar 1992).

Fagonia schimperi (Zygophyllaceae) (*Fig. 18*): This species is occasional and locally common on the upper north-east facing slopes of Jebel Qitab. Scattered individual specimens have been found elsewhere within the Olive Highlands. It is otherwise known in Eastern Arabia only from higher elevations in the Ru'us al-Jibal (Feulner 2011). The author has also observed a probable specimen near the summit of the 1800-metre carbonate peak of Jebel Ra'is in Northern Oman, above upper Wadi Hawasina.

Grewia tenax (Tiliaceae) (Figs. 19a, b): The Olive Highlands are the only known UAE site for this species. It has been found in small numbers in company with the wild olive and *Ehretia obtusifolia* on the north-east facing cliffs and ravines of Jebel Qitab. *G. tenax* closely resembles its more common congener, *G. erythraea*, but unlike *G. erythraea*, which is often browsed to a cushion, *G. tenax* usually achieves the size of a large shrub or small tree. Scattered specimens are known from Northern Oman, including the Ru'us al-Jibal (Jongbloed 2003).

Launaea omanensis (Asteraceae): This uncommon daisy is endemic to the Hajar Mountains of the UAE and Northern Oman. It was first recorded from the UAE in early 2014, in the course of a botanical survey of Wadi Wurayah National Park, commissioned by Emirates Wildlife Society-WWF and sponsored by HSBC. It is recognisable by its very thin, profusely toothed basal rosette of leaves, its rubbery, leafless stems and its grey-green colour (N. Kilian, *pers. comm.*). In the Olive Highlands, several specimens have been found on the rocky ridges on the north-east slopes of the Jebel Qitab ridge.

Melhania muricata (Sterculiaceae) (*Fig. 20*): This distinctive species is the UAE's only representative of the Sterculiaceae (the cacao family). It is occasional at higher elevations in the Olive Highlands, especially along the summit ridge of Jebel Qitab, but it is otherwise unknown in the UAE and northernmost Oman, with the exception of a single record from Jazirat al-Ghanem in the Strait of Hormuz. Circumstantial evidence suggests that *M. muricata* may be the larval foodplant of the Arabian Grizzled Skipper butterfly, another species so far known in the UAE only from Jebel Qitab (Feulner & Roobas 2014).

Monsonia cf. *heliotropioides* (Geraniaceae) (*Fig. 21*): *M. heliotropioides* is widespread but rare along the west flank of the Hajar Mountains in the UAE and is also recorded from the hills of the Batinah coast and the Dhofar region of Oman. The species found on the north-east slopes of Jebel Qitab in the Olive Highlands (and also recorded from Wadi Wurayah to the north) resembles *M. heliotropioides* in having sepals tipped with a purple mucro and relatively short petals, but the mericarp does not resemble either *M. heliotropioides* or *M. nivea* as shown in *Flora of Egypt* (Boulos 2000). Instead, the mericarp features a pit and furrow resembling that of *Erodium neuradifolium*, but with a weak septum dividing the pit.

Olea europaea (Oleaceae) (Figs. 22a to h): The north and east facing slopes of the Olive Highlands, principally those drained by Wadi Mayy, Wadi Hayl and Wadi Saham, are home to the UAE's only population of wild olives, which the author estimated in the late 1990s to number *ca*. 500 trees. The olive trees are concentrated along the north and east-facing rocky cliffs and in the steep ravines below. A small number of trees grow in the shelter of north-facing cliffs on Jebel Al-Iyeli and on the north slopes and ravines of Jebel Sfai. Single small specimens have been found at wadi level in Wadi Hayl (M.A.R. Khan, *pers. comm.*) and Wadi Mayy. Outside this area, only two wild olives have been found in the UAE, a pair of very small trees (<1.5 metres tall) situated high on the north slope of Jebel Jabsah, north of Wadi Ham on the outskirts of Fujairah city.

Fig. 18. *Fagonia schimperi:* This high elevation species is otherwise limited in Eastern Arabia to the Ru'us al-Jibal and a single site in Northern Oman.

Pennisetum orientale (Poaceae): Large clumps of this grass (syn. *Pennisetum setaceum*) were recorded below the north-east facing cliffs along the summit ridge of Jebel Qitab. Only a single other UAE record is known, from Jebel Masafi. *P. orientale* is similarly rare in the Ru'us al-Jibal, where it was recorded only on a damp cliff face at a major spring (Feulner 2011).

Phagnalon schweinfurthii (Asteraceae) (*Fig. 23*): This distinctive composite favours higher elevation. It features erect white stems, bright green leaves and compact, dull pinkish-purple flowerheads on long stalks. It is occasional in the high Ru'us al-Jibal, where it may be suppressed due to preferential browsing. To the south, however, it has been recorded only from Jebel Masafi and Jebel Qitab, each at elevations above *ca*. 600 metres, and at elevations above 1000 metres in the mountains south of Hatta. *P. viridifolium* has recently been synonymised with *P. schweinfurthii* (Feulner 2011).

Volutaria sinaica (Asteraceae): This generally rare but unpredictable ruderal species (syn. *Amberboa lippii*) was locally common on the Jebel Qitab summit plateau in March 2014, especially in silt accumulations, although it had not been recorded on previous visits to the same locality.

Fig. 19a. *Grewia tenax*: The north-east facing slopes of Jebel Qitab in the Olive Highlands are the only known UAE site for this species. The gangly shrub in the foreground photo shows the typical habit. The denser shrub in the background is the Desert Thorn *Lycium shawii*.

Fig. 19b. *Grewia tenax*: A close-up showing leaves and fruit. The growth form and the relatively long leaf stems (petioles) can be used to distinguish *G. tenax* from the more common *G. erythraea*.

Fig. 20. *Melhania muricata*: The UAE's only representative of the Sterculiaceae (cacao family), found only at higher elevations within the Olive Highlands. It is suspected to be the larval foodplant of the Arabian Grizzled Skipper butterfly *Spialia mangana*.

Fig. 21. *Monsonia* cf. *heliotropioides*: A few specimens of this uncommon species were found on a subsidiary ridge within the Olive Highlands.

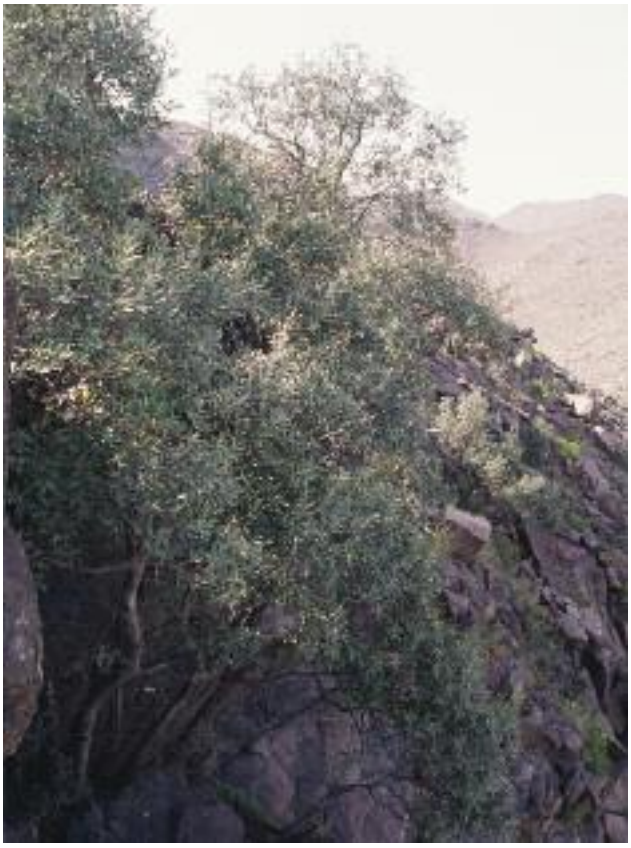

Fig. 22a. *Olea europaea*: A 'typical' wild olive tree in the Olive Highlands.

Fig. 22b. When they were first recognised in the wet mid-1990s, the olive trees along the summit cliffs of Jebel Qitab displayed lush foliage.

Fig. 22c. Olive trees growing in shallow, exposed gulleys (here on the east-facing slopes of Jebel Sfai) tend to be smaller than those on cliffs or in deeper ravines, but can be numerous. Note the browsing of lower branches in both Figs. 22b and 22c.

Fig. 22d. An olive tree stunted by browsing, growing on a slope of mixed basic and ultrabasic bedrock above Wadi Saham.

Fig. 22e. Since 2003, following the turn-of-the-century drought, the olive trees along the summit cliffs of Jebel Qitab have been largely barren. This 2006 photo shows new growth concentrated in the centre of a large tree.

Fig. 22f. This photo taken in March 2014 shows some of the same olive trees as in Fig. 22b. The three large trees in the centre of the picture remain barren, even after above average rainfall in the winters of 2012-13 and 2013-14, but *Ehretia obtusifolia* (the shrub at uppermost right) is thriving.

Fig. 22g. This tree is believed to be the largest (by girth), and presumably the oldest, in the Jebel Qitab summit population; in this March 2014 picture it appears all but lifeless. However, Fig. 22b shows the same tree (at right), revealing that it featured a major "dead" trunk even when it was first photographed, otherwise in full leaf, in 1996. The olive trees of the Hajar Mountains may be prepared by evolution to cope with substantial climatic vicissitudes.

Fig. 22h. Hope for the future? The wild olive tree is a slow-growing but resilient tree. New growth was seen in the interior of some moribund older trees in 2014.

Fig. 23. *Phagnalon schweinfurthii*: The Olive Highlands are the principal Hajar Mountain site for this species in the UAE; with rare exceptions, it is otherwise found only in the Ru'us al-Jibal.

Fauna – Invertebrates

Spialia mangana (Arabian Grizzled Skipper) (*Fig. 24*): *S. mangana* is an uncommon and little known butterfly having its principal range from south-west Arabia to East Africa (Yemen through Ethiopia and Somalia to Uganda and Kenya) with two localities reported from the Dhofar region of Oman (T.B. Larsen, *pers. comm.*). In 2006-2007, *S. mangana* was found in the mountains of Northern Oman as well, on the middle slopes of the Jebel Akhdar and Jebel Kawr at elevations of *ca.* 1000-1400 metres. In February 2014 it was recorded on the summit ridge of Jebel Qitab by a team led by the author. Circumstantial evidence suggests that its preferred larval foodplant may be the similarly restricted *Melhania muricata* (Sterculiaceae). A full account is published separately in this volume of *Tribulus* (Feulner & Roobas 2014).

Pseudophilotes vicrama (Baton Blue butterfly) (*Fig. 25*): Once thought to be limited in Arabia to the Ru'us al-Jibal, local populations of this Lycaenid or "Little Blue" butterfly have been discovered in Wadi Sfai (Feulner 2008) and Wadi Hiluw (Kh. Rafeek, *pers. comm.* 2011), more than 80

Fig. 24. The Arabian Grizzled Skipper *Spialia mangana* has its main population in Yemen and the Horn of Africa. Isolated relict populations were found in the Jebel Akhdar of Oman in 2006-2007 and on Jebel Qitab in the Olive Highlands in February 2014.

Fig. 25. The Baton Blue butterfly *Pseudophilotes vicrama* was long thought to be restricted in Eastern Arabia to higher elevations in the Musandam range, but localised populations of this sedentary butterfly were found in upper Wadi Sfai in 2008 and in upper Wadi Hiluw in 2011.

Fig. 26a. The Blue Pansy butterfly *Junonia orythia* is a common denizen of the UAE mountains, where it frequently basks on open ground. The local subspecies is *J.o. here*, of which a pair is shown in copula in lower Wadi Hiluw (ca. 200 metres). The female has opened her wings, showing the blue colouration typical of UAE specimens.
(Photo by Binish Roobas)

Fig. 26b. The Jebel Qitab ridge may harbour a distinctive population of the Blue Pansy featuring females having brown hindwings without blue colour. This specimen is one of hundreds that were migrating downslope throughout the course of a sunny day in early March 2014.

kilometres south of the southernmost previous records, and at lower elevations (*ca*. 500-550 metres in Wadi Sfai and *ca*. 350-375 metres in Wadi Hiluw). Because of the sedentary character of this species, the Olive Highlands records are believed to represent long-term resident populations (T.B. Larsen, *pers. comm.*).

Junonia orythia (Blue Pansy butterfly) (*Figs. 26a*, *b*): The widespread Blue Pansy butterfly is generally considered to be represented in the UAE by the subspecies *J.o. here*. Local populations are somewhat variable but with only very rare exceptions the ground colour of the dorsal hindwing of females is blue, nearly but not quite as blue as the males (*Fig. 26a*). However, in a major ravine on the north-east slopes of Jebel Qitab, on a sunny day in March 2014, the author and Binish Roobas observed the phenomenon of a steady migration of hundreds of individual Blue Pansy butterflies down the ravine. Many of these stopped briefly to bask on large boulders and, although they were difficult to approach, they were reasonably easy to observe with ready binoculars. In all of the two dozen or so females observed, the ground colour was brown, without any hint of blue (*Fig. 26b*). These observations suggest that the Olive Highlands may harbour some secrets in this regard as well.

Targeted investigation can reasonably be expected to reveal at least a small number of additional invertebrate species that are localised in the Olive Highlands, particularly sedentary ones (e.g., burrowing species) that are sensitive to climate and/or elevation, and others, especially insect species, that may be associated with the wild olive trees. The author has looked specifically, but so far without success, for the land snail *Pseudonapaeus jousseaumei*, which replaces the more common and widespread *Zootecus insularis* at higher elevations in the Hajar Mountains to the south.

Fauna – Vertebrates – Herptiles

Duttaphrynus dhufarensis (Dhofar Toad): This toad species is the rarer of two found in the UAE. It is primarily nocturnal and is sometimes found far from permanent water, including high on mountain slopes in the Ru'us al-Jibal (Cunningham & Feulner 2001). It was recorded once from Jebel Qitab, at *ca*. 700-800 metres in a wadi draining the summit ridge, where it was flushed during a late afternoon descent. A second individual was encountered by night, crossing the vehicle track at the base of the mountain, along Wadi Mayy. At a dam *ca*. 5 kilometres downstream in Wadi Mayy, a juvenile was observed and adults were heard calling in late fall. A juvenile was also identified in upper Wadi Sfai. Its occurrence in mountain slope environments suggests that *D. dhufarensis* must be able to breed successfully in ephemeral pools in steep, boulder-filled mountain wadis.

Pristurus celerrimus (Bar-Tailed Semaphore Gecko) (*Fig. 27*): The Jebel Qitab summit ridge supports a relatively large and conspicuous community of this diurnal species, similar to what can be seen on plateaux in the high Ru'us al-Jibal. It seems likely that this gecko is a major prey species for the Persian Horned Viper.

Pseudocerastes persicus (Persian Horned Viper) (*Fig. 28*): A specimen was observed in mid-afternoon on the ridge near the summit of Jebel Qitab, on open ground among scattered boulders. It retreated to shelter under a nearby boulder when approached but was subsequently exposed and observed more closely. This is understood to be the only confirmed sighting of *P. persicus* within the Hajar Mountains of the UAE. Other UAE sightings have been either from the Ru'us al-Jibal or from Jebel Hafit (Cunningham 2002, Gardner 2013, J. Els, *pers. comm.*, Feulner, *pers. obs.*). Because this species has generally been found only at elevations above *ca*. 700 metres, the possibility should be investigated that the Jebel Qitab summit ridge supports a self-sustaining population. The relative abundance of the gecko *Pristurus celerrimus* could constitute a major food source, although this would require the viper to feed at least in part diurnally.

It was the impression of the observers that the distinctive black, wormlike tip of this viper's tail was very likely to be used as a lure to attract prey, as has been speculated by others (e.g., Cunningham 2002). In addition to the closely similar appearance of the tail tip to images of other species known to use tail luring (e.g., Dressler, showing Peringuey's Adder), that inference is further supported both by the coiling posture adopted by the snake, which left the tail positioned to the fore, and by the recent recognition of an even more elaborate caudal lure in a close Iranian congener, the Spider-Tailed Horned Viper *P. urarachnoides* (Bostanchi *et al.* 2006).

Fig. 27. The Banded Semaphore Lizard is typically very boldly coloured in the Olive Highlands.

Fig. 28. The Persian Horned Viper *Pseudocerastes persicus*. This picture shows the only confirmed record from the Hajar Mountains of the UAE, but it now seems likely that the Olive Highlands is home to a small but self-sustaining population. (Picture by Binish Roobas)

A shed snakeskin was collected from *ca.* 1000 metres on the ridge above uppermost Wadi Sfai, not far from Jebel Al-Iyeli. The shedding was examined by Johannes Els, Head of Department, Herpetology and Freshwater Fish, at the Breeding Centre for Endangered Arabian Wildlife in Sharjah. particularly to determine whether it might constitute an additional record of *P. persicus*. His examination of the dorsolateral scales indicates that it probably represents *Echis omanensis*, but DNA confirmation will be sought (J. Els, *pers. comm.*). The site is atypical for *E. omanensis*, on an open ridge and distant from water. Subsequently, a second, similar shed skin was collected adjacent to a gulley in the same area, at *ca*. 900 metres.

The only other snake so far confirmed from the Olive Highlands is the Sand Snake *Psammophis schokari*, which was recorded once at 700-800 metres and suspected at *ca*. 1000 metres on Jebel Qitab, among vegetated boulders below cliffs along the summit ridge. A "racer" was also recorded on the summit ridge of Jebel Sfai, which was probably either *P. schokari* or *Platyceps rhodorachis*.

The best explanation for the presence of most of the above species of plants, invertebrates and herptiles in relative isolation in the Olive Highlands is that they represent relicts of more widespread populations that flourished in the more mesic climate of an earlier time, perhaps as recently as *ca*. 6,000-10,000 years ago during the so-called climatic optimum, and that the Olive Highlands has served as a biological refuge.

The situation is somewhat different for birds and for larger mammalian species, which can migrate more easily. These are discussed below.

Fauna – Vertebrates – Birds

The author's records include some 30 bird species from visits to the Olive Highlands – all of them typical Hajar Mountain residents or visitors – including several species that are more common below the 500 metre contour (e.g., Green Sandpiper, Grey Francolin and Indian Roller).

Human observers are well exposed in the open terrain of the summit ridges, which probably diminishes the number of bird records from that environment, but it is reasonable to suppose that the overall lack of human disturbance and the shelter of the north-east facing cliffs and ravines which harbour the wild olive trees could make the upper slope areas potential breeding sites for raptors such as Short-Toed Snake Eagle, Bonelli's Eagle and Booted Eagle (R.J. Hornby, *pers. comm.*), and for other species as well.

Many more birds were typically recorded during visits to the Olive Highlands in the wet mid-1990s than in the drier 2000s. It is tempting to speculate that the difference might be due not only to the more congenial mountain environment of the mid-1990s, but also to

the relative absence of alternative "green" sites for avian visitors to the UAE at that time. It may, however, reflect in equal or greater measure the author's increasing attention over time to non-avian fauna, at the expense of avian records.

The most dramatic avian record was a close encounter, at eye level, with an oncoming Griffon Vulture, which appeared suddenly around the corner of a summit cliff on Jebel Samah, aimed directly towards the observer. It was difficult to grasp immediately what this large but silent, unfamiliar silhouette could be. For its part, the bird displayed no emotion as it glided past, changing course almost imperceptibly to follow the trend of the ridge. It could be identified only at a distance, when it had descended slightly, making visible its distinctive mantle.

Fauna – Vertebrates – Mammals

No wild mammals have yet been observed in the summit regions within the Olive Highlands, but there are limited records from the surrounding slopes and wadis.

Gazella gazella cora (Mountain Gazelle): Sightings or traces of the Mountain Gazelle *G. gazella cora* are known from at least three areas on the periphery and lower slopes of the Olive Highlands. On New Year's Day 1992, a group of four animals was observed on upper slopes above the head of Wadi Hayl (Hellyer 1992), at elevations estimated to be *ca*. 700 metres or more. This is the same area where Arabian Tahr were reported later in the decade (see below). In the mid-1990s and the early 2000s, then-recent gazelle droppings were observed at several places along the upper reaches of Wadi Hiluw, on the south-west slopes of the Jebel Qitab ridge, both on lower slopes and on long-abandoned agricultural terraces adjacent to the upper wadi, all at elevations of *ca*. 550-700 metres. Gazelle droppings were also observed in a tributary wadi to the west of Jebel Samah.

For the Mountain Gazelle, the Olive Highlands may represent marginal habitat to which it has been driven by human encroachment and hunting pressure. The 1992 account referenced above quotes a senior Fujairah government official to the effect that there were still a substantial number of this elusive species in the remoter parts of the Hajar Mountains, and that they were still subject to a limited amount of hunting, despite Emiri instructions to the contrary (Hellyer 1992).

Arabitragus jayakari (Arabian Tahr) (formerly *Hemitragus jayakari*): Because the gabbro terrain is relatively easy for both humans and larger quadrupeds to access and navigate (the presence of feral donkeys, discussed below, is indicative), and because there is no permanent surface water within most of the Olive Highlands (the only known permanent surface water is at *ca.* 550 metres in upper Wadi Sfai), this area was probably never prime habitat for the Arabian Tahr. In the late 1990s, surveys by the Arabian Leopard Trust revealed Arabian Tahr on the upper slopes of Wadi Hayl (M. Sawaf *pers. comm.*), at the edge of the Olive Highlands, in the mixed harzburgite/gabbro unit, from where permanent water feeds plantations below, but Arabian Tahr have not yet been recorded from areas of gabbro bedrock.

Feral donkeys: Feral donkeys were conspicuous on the Jebel Qitab summit ridge on the author's first visit in late 1994. Live sightings included groups of 5 and 3 donkeys, including juveniles. There were also many fresh trails, droppings and dust baths, as well as recent bones. The observed donkeys, however, were possibly sufficient to account for all such circumstantial evidence. On subsequent visits in the wet mid-1990s, donkeys were less conspicuous although droppings were seen and smaller numbers (2 to 7) were observed. A group of 4 donkeys was also seen at high elevation on Jebel Sfai during the same period. Numbers apparently dwindled during the turn-of-the-century drought (1999-2003) (see Feulner 2006) but a single donkey was seen on the Jebel Qitab summit ridge in early 2003. However, on a subsequent visit in late 2006, the donkey droppings and dustbaths looked old, and by 2014 a visit to the same area did not record evidence of mammals, except some silt patches that may have originated as dusting baths.

Feral donkeys have always been more common in the lower, flatter reaches of Wadi Hiluw and Wadi Sfai, not far from the traditional plantations from which they or their ancestors were probably released. In upper Wadi Sfai, small numbers of feral donkeys continue to range up to 700 metres and more, probably due to the regular presence of surface water at that elevation. Evidence of their presence can also be found higher, along the summit ridge of Jebel Al-Iyeli, but as of late 2014, the existing donkey trails there appeared to have fallen into disuse, and donkey droppings were both scarce and old.

Feral goats: Feral goats and goat droppings have always been scarce in most of the Olive Highlands, and particularly on the summit ridges and upper slopes. The author's only record of a goat above 600 metres was of a large, heavy-chested male on the Jebel Qitab summit ridge in early 2003. Before that time, the wild olive trees in the summit regions showed evidence of heavy browsing, but that could be accounted for by the donkey population. In the ravines, where donkeys could not easily reach, browsing was less evident. The absence of feral goats at higher elevations in the Olive Highlands may be due primarily to local animal husbandry practices, specifically the failure to release domestic goats to forage in the wild for extended periods, as has been suggested for the

distinction between the mountains of the Musandam peninsula, where feral goats are common, and the environmentally similar Jebel Akhdar, where they are rare (R. Wood, *pers. comm.*).

Carnivores: Field evidence of mammalian carnivores in the Olive Highlands is scarce. Fox droppings are rare and mostly found at lower elevations. They have appeared to be droppings of Red Fox *Vulpes vulpes arabica* as opposed to the typically insect-rich droppings of Blanford's Fox *Vulpes cana*. The droppings of a large carnivore were observed only once, along the summit ridge south of Jebel Sfai. The most likely candidate is the Caracal *Caracal caracal*, which is undoubtedly present and may be ecologically significant (R.J. Hornby, *pers. comm.*). A caracal was killed by farmers in Wadi Mayy in *ca*. 2005 (M. Ziolkowski, *pers. comm.*).

Small Mammals: Small mammals such as Egyptian Spiny Mouse *Acomys cahirinus*, Wagner's Gerbil *Gerbillus dasyurus* and Brandt's Hedgehog *Paraechinus hypomelas* are likely to be present throughout the Olive Highlands. All are nocturnal. A single Wagner's Gerbil was observed at length during a nighttime investigation on the slopes of a low hill in upper Wadi Sfai, at *ca*. 550 metres, but otherwise no evidence of tracks, skeletons or skins of small mammals has yet been encountered.

Status and Threats

The Olive Highlands have seen changes over the two decades since they were first recognised, but for the most part those changes appear to have been wrought by nature, not by man – a somewhat unusual situation in the UAE. One of the most noteworthy characteristics of the Olive Highlands environment, apart from its unique biodiversity, is the absence of significant human encroachment.

The author's visits to areas within the Olive Highlands have spanned the period from late 1994 through 2014, at irregular intervals of several weeks to almost two years, amounting to more than 30 visits and including two traverses of the length of the Jebel Qitab summit ridge, the core of the area. On early visits, in the wet mid-1990s, the olive trees on the north-east slope of the Jebel Qitab ridgetop appeared to be thriving (*Figs. 22a & b*). However, no saplings could be found and browsing of lower branches was evident (*Figs. 22b & c*), and even of some whole shrubs (*Fig. 22d*), leading to uncertainty whether the population could be said to be self-sustaining under those conditions.

In many UAE mountain and wadi environments, donkeys have been reflexively blamed for environmental damage more plausibly attributable to goats and camels – perhaps because, unlike goats and camels, donkeys have no economically vested constituency – but in the case of the wild olives on Jebel Qitab, the conclusion is inescapable that donkeys were the culprits and that the browsing levels seen in the mid-1990s were a threat to continued regeneration of the olive population.

The extreme drought of the early 2000s (see Feulner 2006, see especially *Figs. 1* and *5* therein), which persisted in a less extreme form through most of the decade, appeared to take its toll of the donkey population, but also of the highest and most exposed olive trees. In early 2003, the olive trees on the summit cliffs of Jebel Qitab had only sparse leaves, and when visited thereafter, in late 2006, the older branches were barren (*Fig. 22e*). Recovery has yet to come; in March 2014 whole trees were barren, despite two consecutive rainy winters (*Fig. 22f*).

Within limits, these climatic vicissitudes may represent a contingency for which the wild olives are evolutionarily prepared. *Fig. 22g* shows the largest (by girth) and presumably oldest tree in the Jebel Qitab summit population; in this March 2014 photo it appears all but lifeless. However, *Fig. 22b* shows the same tree, revealing that it featured a major "dead" trunk even when it was first photographed, otherwise in full leaf, in 1996.

Downslope, olive trees continue in or adjacent to the wadis that drain the summit, down to an elevation of *ca*. 550 metres, and most have appeared to remain in good condition.

Not surprisingly, different species have reacted somewhat differently to the changing environmental conditions over the past two decades. For example, when seen in the early and mid-2000s, the score of drooping *Ehretia obtusifolia* shrubs associated with the cliff-top olive trees looked equally dismal, but in March 2014, unlike the olives, they appeared very much refreshed (after two consecutive rainy winters) and were in flower and fruit (*Figs. 17*, *22e*). On the other hand, it was the author's impression that *Ephedra pachyclada* is much less in evidence currently, in 2014, than it was in the 1990s, suggesting a failure to thrive.

What is certain, in any case, is that plant and animal species such as those localised in the Olive Highlands are among the species at greatest risk from broader global or regional climate change in the form of increasing temperatures and decreasing rainfall. These species have already "retreated" uphill and have no place else to go. To that extent, their fate may ultimately be independent of any local conservation efforts. But at the moment there appear to be no *other* immediate threats to the environment of the Olive Highlands. Specifically, the feral donkeys of the 1990s have not returned, so over-browsing is not a problem, and the level of human encroachment, although incipient, remains extremely low by UAE standards.

This arguably imposes an added responsibility on the human stewards of the area not to tip the balance. The current situation is positive in that regard. There is almost no evidence of either historical or recent human visitation or exploitation anywhere within the Olive Highlands, except the construction in the past decade of three communication towers. The earliest of

Fig. 29. The newest of three communications towers erected in the Olive Highlands, above the village of Mayy in Wadi Mayy. It is extremely fortunate from a conservation standpoint that this lower elevation site was chosen, rather than the neighbouring summit of Jebel Qitab.

the three was at the north-western extremity of the Jebel Qitab ridge; a rough service road now ascends to the tower from Wadi Hiluw. The road had been allowed to fall into disrepair when it was investigated in 2008 but it has subsequently been gated at the bottom (reportedly by military, not communications, authorities) and is evidently still used for maintenance or other official purposes. Unfortunately the road was constructed with little attention to environmental considerations. In the kilometre or so before it reaches the summit ridge, the steep road cuts on the uphill side create an extended barrier to access or passage by humans or large quadrupeds. A more recent tower constructed on the ridge north of Wadi Mayy, apparently a standard microwave installation, is shown in *Fig. 29*.

The low pass (*ca*. 700 metres) from Wadi Sfai to Wadi Saham, east of the village of Sfai, was a historical route from the interior of the mountains to the East Coast, but it has become obsolete in the modern era. A single instance of boulder art has been found along that route. No examples of stone structures or other human artifacts are known from the ridgetops or from other passes in the Olive Highlands, although the 900-metre pass from Wadi Sfai to Wadi Hiluw is a relatively straightforward walking route and small, disused terraced fields are found as high as *ca*. 700 metres on the Wadi Sfai side. Those fields, however, are located near an area where water collects in a chain of pools after rain, and the presence there of mineral water bottles, plastic bags and other litter indicates that local residents know the site and visit at least occasionally. Other instances of human use are trivial. Once, in March 1998, the author encountered a middle-aged local couple from Wadi Mayy on the slopes of Jebel Qitab, collecting a favoured plant (or possibly the local 'truffle', *shahmateen*). On another occasion, in 2001, greetings were exchanged near the summit of Jebel Samah with two European ladies, both volunteers at Fujairah's maternity clinic, who had hiked up from Wadi Saham for exercise and diversion.

Geological prospecting has revealed no mineral deposits of economic value within the Olive Highlands and their surrounding areas, although minor excavation for chromite was undertaken in the ultrabasic rocks of upper Wadi Hayl (Thomas *et al.* 2006), in *ca*. 2000. These areas have also been spared, so far, from the depredation of quarrying for crushed stone. Small scale exploitation of minor copper-bearing veins may have occurred in pre-modern times on the fringes of the Olive Highlands, e.g., in upper Wadi Hiluw, near the 500 metre contour (M. Ziolkowski, *pers. comm.*), and at slightly higher elevation in upper Wadi Sfai (*pers. obs.*), but there is as yet no evidence of significant mineralisation, excavation, or milling or smelting operations in these areas. However, the nearby archaeological site at Harrah, in Wadi Hiluw at *ca*. 350-375 metres, was a major copper mining locality from which large quantities of metal were extracted over an extended period of time, from mineralised veins that spanned the wadi (J. Kuetterer, *pers. comm.*).

Fig. 30. Since the mid-2000s, the old vehicle track in upper Wadi Hiluw, which fell into disrepair in the wet years of the mid-1990s, has been improved and maintained, perhaps partly in conjunction with the construction of an access road to the new communications tower near the north-west summit of Jebel Qitab. The view shown here looks south south-east from the ascent to the tower.

Conservation

In view of the extensive list of distinctive flora (and to a lesser extent, fauna) set out above, it should not be necessary to say more to make the case that the Olive Highlands deserve high priority from a conservation standpoint, in order to preserve their unique array of high elevation species. It is difficult to identify a mountain area in the UAE (other than the high Ru'us al-Jibal) that is more distinctive in terms of its contribution to the biodiversity of the UAE.

Moreover, it is equally difficult to identify a mountain area in the UAE that is easier and simpler to preserve. The Olive Highlands are today largely in their natural state. Human visitation and use remain almost non-existent. All that is required to preserve the area is to ensure that it continues be left alone, free of 'development' – roads, quarrying, construction, landscaping or other exploitation or molestation. Fences are not required: the habitat itself constrains resident species, and remoteness has protected them effectively to date. Active 'management' is also not required, only a modest regime of monitoring and supervision, including monitoring for the possible return of feral donkeys or the advent of feral goats to the high areas in significant numbers. This function could be performed in part by local residents in the surrounding villages. The expense of simply leaving the area undisturbed is almost negligible; it would be hard to get more biodiversity bang for the buck.

It was for many years the author's personal opinion that the best way to protect the Olive Highlands (and many other areas of natural history importance in the UAE) was through benign neglect – including minimal publicity. However, the pace and unpredictability of development in recent years, e.g., the rapid and all but uncontrolled expansion of quarrying, the discussion and implementation of potentially intrusive conservation-themed projects in nearby areas, and the temptations that could arise from the existence of access roads to the three communications towers, all make it important now to ensure public and official recognition of the special nature of the Olive Highlands.

That process has been initiated by identifying and prioritising the Olive Highlands as part of the Local, National Regional Biodiversity Rapid Assessment exercise conducted in 2012 by the Abu Dhabi Global Environmental Data Initiative, in conjunction with Hyder Consulting (AGEDI 2013), and thereafter by informal communication with representatives of the Government of Fujairah, where long-term strategic land use planning is currently underway. However, the Olive Highlands also include substantial territory within the Emirates of Ra's al-Khaimah (the Wadi Sfai watershed) and Sharjah (the Wadi Hiluw watershed), so it is important to raise the awareness of the concerned authorities in those Emirates as well, independent of the AGEDI initiative.

In Fujairah and Ras al-Khaimah, extensive quarrying has destroyed many mountain front areas, but the interior, including the Olive Highlands, remains all but untouched. The recent pipeline and highway routes across the mountains have sensibly followed lower terrain to the north. The upper watershed of Wadi Sfai was among a dozen or so areas recommended informally in the mid-2000s to an adviser to the Ra's al-Khaimah Department of Industrial Development and Environmental Protection, as deserving of special protection for natural history reasons, but the focus of concern for that office at the time was on areas in the periphery of urban Ra's al-Khaimah.

Sharjah's record of environmental awareness is excellent, and much of upper Wadi Hiluw (a/k/a Wadi Helo or Helow) was declared a protected area in 2007, for the stated purpose of protecting the mountain and wadi environment. As elsewhere in the UAE, however, development has often outpaced conservation efforts, with the result that most of Wadi Hiluw below 400 metres elevation is almost unrecognisable from what it was just two decades ago. In addition, a number of farms in Wadi Hiluw up to *ca*. 500 metres, disused during the wet 1990s due to inaccessibility, have been re-vitalised in the 2000s following the construction and maintenance of an improved vehicle track (*Fig. 30*).

Inter-governmental conservation cooperation has proven to be a challenge within Arabia generally, just as it has elsewhere. But where there is challenge there is also opportunity. Here, the case for conservation is clear and the solution is straightforward and inexpensive, but the devil is in the details. The most important priorities are that the Olive Highlands be recognised for their unique status as an island of biodiversity and that they be treated accordingly by all concerned.

Given that the relevant inter-Emirate borders essentially bisect the main summit ridges within the Olive Highlands, including the critical summit ridge of Jebel Qitab, a provincial approach, or worse, a turf war, would be disastrous for a satisfactory conservation result. It would destroy the integrity of the very habitat most in need of protection, effectively cutting the baby in half.

Perhaps in these circumstances a supportive role can be played by federal authorities as well; to the extent that military jurisdiction exists over the area of the communications tower at the north-western end of the Jebel Qitab ridge, the involvement and cooperation of federal authorities may be not only appropriate but necessary.

A more hopeful prognosis is that preservation of the Olive Highlands can serve as an opportunity to establish fruitful cooperation among Emirates in the service of an unquestionably worthwhile conservation goal.

Acknowledgements

The author wishes to thank the individuals who have accompanied him on field excursions to various locations in the Olive Highlands over the years, and who contributed their own valuable observations, including particularly the late Martin Parker, John Martin and Binish Roobas. Binish Roobas deserves special acknowledgment since he was responsible for the record of *Pseudocerastes persicus* atop the Jebel Qitab summit ridge, which would almost certainly have gone unnoticed without him, and he freely shared his thinking and subsequent research about *P. persicus*. Johannes Els provided an authoritative examination of a shed snakeskin suspected to represent *P. persicus*. Dr. Richard Hornby read and commented thoughtfully on a draft of this paper, as he has on others in the past. Richard Flemmings very kindly prepared the map of the Olive Highlands presented here as *Fig. 1*.

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Bosk's fringe-toed lizard *Acanthodactylus boskianus*: Follow-up study of a population in the Hajar Mountain foothills of the UAE

by Binish Roobas, Gary R. Feulner and Yusuf Thakur

Fig. 1. The male lizard shown here stationed itself under this sparse annual (*Farsetia stylosa*) for more than an hour. At least twice it leapt up to and into the plant to seize small insects. (Picture by GRF)

Abstract

Follow-up observation of a UAE study population of *Acanthodactylus boskianus* in the foothills of the Hajar Mountains has confirmed that this species does not hibernate in the UAE and that it breeds over an extended period, but possibly not during the UAE summer. We have also observed prey capture by lizards leaping into low shrubs and from rocks, predation on a large grasshopper and a medium-sized wasp, intra-specific aggression among males and females (including a dramatic and vicious encounter between two females), and burrowing by a gravid female. Video footage greatly enhanced our ability to observe and understand many of these behaviours.
We also recorded, unexpectedly, a number of additional reptile species within the study area, including Spiny-Tailed Agamas (*Uromastyx aegyptia leptieni*) and the rarely observed Diadem Snake (*Spalerosophis diadema cliffordii*), a likely predator on *A. boskianus*.

Introduction

In **Tribulus** Vol. 21, authors BR and GRF described a population of *Acanthodactylus boskianus* (Daudin, 1802) at a site in the foothills of the Hajar Mountains of the UAE (Roobas & Feulner 2013). Subsequent follow-up observations have resolved certain points left open in the original paper and have added additional interesting information. Those observations included a particularly fruitful visit by BR and YT, a naturalist and wildlife filmmaker, on 12 March 2014, when experience, skill and luck combined to produce video footage of several of the phenomena reported here.

Because *A. boskianus* remains a very rarely encountered species in the UAE and Northern Oman, a summary of our additional observations is presented.

Hibernation

We can now confirm that *A. boskianus* in the UAE does not hibernate in winter, as it does in Egypt (El-Masry & Hussein 2001). We had surmised this from the presence of young juvenile lizards in early December 2012, just prior to the hibernation period. Subsequently, young juveniles were observed (along with adults) on 1 February 2014, in the heart of the south Arabian 'winter'.

Prey Capture

In the course of our original study, we observed lizards lunging to snap up ground prey, principally ants. We also learned inadvertently that *A. boskianus* can track the trajectory of incoming aerial objects, including grasshopper-sized ones, and pounce on them when they land.

In additional field visits in winter and spring 2013-14, we discovered another unexpected talent. *A. boskianus* sometimes waits in ambush under a plant *(Fig. 1),* and can leap up to the lower branches to snatch an insect meal, or even leap into the lower branches with all four feet, jumping a vertical distance roughly equivalent to its own body length. In the most ambitious such attempt, an actively foraging female leapt that distance into a dense *Pulicaria glutinosa* shrub to seize a big green grasshopper. The problem then was to swallow the prey, which it did only very slowly, bit by bit, and apparently with great difficulty.
[In North Africa, *A. boskianus* is known to climb into shrubs (Sahara-Nature). Some other desert lizards also do this, including at least one UAE species, but this behaviour is generally considered to be for cooling purposes, not for hunting. We have not observed plant climbing by *A. boskianus*, independent of the immediate goal of prey capture.]

We have also observed lizards jumping horizontally from low stones *(Fig. 2)* for a distance of up to two body lengths, to catch low-flying small insects in mid-air. One juvenile, in particular, climbed purposefully onto a dark stone and waited for some time, keeping watch. Suddenly it leapt into the air towards a small flying insect passing rapidly nearby. Speed, energy and accuracy won it a good meal. The heights involved in each case were no more than *ca*. 8 cm, but given the physics of jumping, it is possible that this behaviour is more characteristic of juvenile lizards than adults.

Although we had recognised that *A. boskianus* was prepared to tackle large prey, it was still a surprise to see one pounce on a medium-sized, long-waisted wasp (believed to be a digger or potter wasp). The wasp was already on the ground only *ca*. 5 cm in front of a female lizard we were watching, when we saw the lizard lunge. The lizard seized the wasp by the head and neck *(Fig. 3),* shook it, and tapped it against the ground, then dropped it on its back, obviously injured. During this initial grappling, the wasp had curved its long abdomen back towards the lizard's snout, as if to sting it. After only a second or so, the lizard picked the wasp up again, shook it, and tossed it *ca*. 10 cm to one side. The lizard then retrieved the wasp, positioned it head first for swallowing and, after a pause, downed the entire wasp in a few gulps. (Experienced naturalists will recognise that it would have been extremely difficult to observe this level of detail in the absence of video footage that could be examined at leisure, and in slow motion or by individual frames.)

Fig. 2. A lizard perched on a stone, from which moments later it launched itself to catch a passing insect in flight. (Picture by GRF)

Intra-specific interactions and aggression

We observed only about half a dozen interactions between individual lizards, and these were diverse and unpredictable. Most involved aggression and none involved mating. On one occasion we witnessed no more than a simple nose kiss between a foraging male and a foraging female whose paths brought them in close proximity; then each went on their way. On another occasion, a male, who proved to be patrolling a small area over the course of an hour or more, darted some two metres to chase an interloping female, who turned and fled without contact. We tentatively interpreted this as territorial defence of a feeding area, although possibly only a temporary one. The female returned to the general area after about ten minutes, but took the precaution of staying outside the male's line of sight, behind a clump of shrubs. We also observed a foraging juvenile retreat from a foraging male who was approaching, obliquely, at a distance of *ca*. 1 metre; the male showed no reaction.

The tables were turned on yet another occasion, when a foraging female and a foraging male from some distance away found themselves face-to-face. They performed a brief nose kiss but the female seemed aggressive and made a hissing noise with her mouth open, at which the male retreated.

In the only male/male encounter we observed, a male that we had followed while foraging for *ca*. 35 metres found itself in a silty hollow ringed by small shrubs, when a second male of similar size appeared and approached. The two circled, facing one another side-to-side, but with torsos curved away from each other. Then the second lizard lunged at the first, making hostile contact and driving it away.

By far the most dramatic encounter we witnessed was a vicious battle between two females. The combat began suddenly and lasted only five seconds. In the field, the spectacle appeared to be a blur of tumbling lizards, but we are able to describe it thanks to analysis of a video taken by YT, a tribute to his sense for his animal subjects.

The sequence of events of that encounter was as follows:

- A female lizard foraging near a small, dry shrub suddenly became agitated — and the photographer focused his attention.
- The lizard stepped into the open and directed herself, head up and mouth open, towards what proved to be an oncoming attacker.
- The attacker, a noticeably larger female, charged at high speed, at an angle from the left.
- The attacker rounded in front of the defender without a pause (*Fig. 4*) and attacked from the right flank, seizing the defender's right thigh in its jaws.
- Using its hold as leverage, the attacker rolled and flipped the defender through the air, in an arc (*Fig. 5*).
- These flips continued, and may have generated their own momentum. We counted at least six flips, each one sending one of the lizards more or less perpendicular to the ground, followed by three or four lower rolls.
- The video discloses that the defender was not simply a passive victim during the struggle. She twisted her torso backwards and was able to bite the attacker three times on the head and snout – first on the snout, second on the skull behind the eyes, and the third time over the left eye (*Fig. 6*).
- It may have been this last maneuver that finally discouraged the attacker. In any case, she released her hold on the defender and fled the scene as quickly as she had arrived.
- The victorious defender had obviously paid a price. She attempted to continue foraging but walked slowly and unsteadily at first, dragging her right hind leg. Raw flesh showed that she had also been bitten behind the left shoulder. Her heart beat strongly and rapidly and her tail shivered.
- Over the course of a few minutes, however, the defender seemed to recover much of her normal mobility.

In lizard studies, aggression among females has generally been associated with competition for preferred home ranges, including easy access to food and shelter. A possible motivation that suggests itself in our circumstances is competition for access to preferred sites for excavation of a nesting burrow – behaviour which was observed later the same day (see below). It is also worth remarking that the defender was successful – (as in the majority of territorial disputes in the animal world) – notwithstanding that she was obviously the smaller of the two combatants.

Fig. 3 This *A. boskianus* has caught a large wasp on the ground and has grasped it by the head and neck, with wings and abdomen visible. (Picture by YT)

Fig. 4. The battle commences: The attacking lizard darts past the defender's open jaws, aiming to strike on the right flank and seize the defender's right thigh. (Picture by YT)

Fig. 5. Pyrotechnics: As the combatants flip and roll, one lizard is spun perpendicular to the ground. (Picture by YT)

Fig. 6. Counterattack: The defender has turned to bite the attacker on the head, covering and perhaps contacting the attacker's left eye. This image also shows the size discrepancy between the two combatants. (Picture by YT)

Burrow excavation for egg-laying

An unattributed account from North Africa states that *A. boskianus* females dig a burrow *ca*. 30-40 cm deep in which to deposit their eggs (Sahara-Nature). During our visits to the study site in 2012 and 2013, we saw only a small number of relatively conspicuous burrows that might have been nesting burrows. On 12 March 2014, however, we observed an obviously gravid female lizard excavating what can only have been a nesting burrow.

The excavation site was in relatively soft soil (a former agricultural field) under a harder surface crust. The process was stereotyped. The female would emerge cautiously from the underground portion, body hunched low, perhaps recognising that the fresh burrow and digging activity made her relatively conspicuous. Then she would turn in the entrance apron (in this case, always in a clockwise direction) and commence digging *(Fig. 7).* We watched her do this more than twenty times. The front limbs were used to excavate new material; the hind limbs were used primarily to sweep loose material backwards and out of the hole, assisted by sinuous movements of the hips and torso. Even while digging, the lizard remained wary, raising her head periodically to survey her surroundings.

Occasionally, after exiting the hole and before turning to dig again, the lizard would lie in the loose soil of the entrance apron and raise one or both forelimbs *(Fig. 8).* We had seen similar behaviour previously in an *A. boskianus* digging in loose soil while foraging for small insect prey. We continue to interpret this as thermoregulatory behaviour intended to cool the forepaws after the frictional heat of digging, and/or to cool the animal generally after physical activity (Roobas & Feulner 2013). One observational test of the "cooling" hypothesis might be to determine whether these behaviours are more common in hotter weather. Our two observations of lizards lying in dug soil with both forelimbs raised were in mid-March and mid-August.

Fig 7a

Fig 7b

A gravid female excavates her nesting burrow, using her forelimbs to dig (left) and her hind limbs to clear (right). (Pictures by BR)

Fig. 8 Returning to the surface after a bout of excavation, the female lizard lays out in the loose dirt and raises both forelimbs. (Picture by YT)

Fig. 9. Gallagher's Leaf-Toed Gecko, a nocturnal rock-climbing species. (Pictures by GRF)

Breeding period

The reproductive period for *A. boskianus* in North Africa is said to be in late spring and summer, with hatching occurring in August after a 75-day incubation period (Sahara-Nature). Mating and egg-laying would therefore occur from roughly mid-May to mid-June. The burrow excavation we observed on 12th March 2014 is inconsistent with the North African timetable, but our earlier observations of the population structure at the UAE study site led us to infer an extended breeding season in the UAE, with mating and egg-laying estimated to occur from late summer through mid-winter. Nest excavation in early March falls just after the end of that estimated cycle.

Other reptile species present

During field work for the initial paper we did not observe any other reptiles within the area of the study site, a circumstance which we considered to be unusual. However, during several follow-up visits in 2014, including one evening visit, we recorded six additional reptile species within or adjacent to the study area.

Fig. 10. The Diadem Snake *Spalersophis diadema cliffordi*, a likely diurnal predator on *A. boskianus*. (Pictures by BR)

These include:

- Leptien's Spiny-Tailed Agama (Arabic *dhub*) *Uromastyx aegyptia leptieni* (Agamidae): A juvenile was found in an inconspicuous burrow adjacent to the core zone of the study area and several larger burrows were observed on the stony lower slopes of the wadi. The dried tail of a small dhub was found up a tributary wadi. A few kilometres to the north, a small community of *ca*. 20+ dhubs has been recognised for a number of years. It seems likely that dhubs may be somewhat more common in this area of mountain front than has previously been recognised.
- Sinai Agama (a/k/a Blue Rock Agama) *Pseudotrapelus sinaitus* (Agamidae): A single individual was observed on a stony slope immediately adjacent to the core zone of the study area.
- Dwarf Semaphore Gecko *Pristurus rupestris* (Gekkonidae): Only two specimens of this normally common diurnal gecko were observed, one on a small *Acacia* tree and one on soil, but the latter uncharacteristically at dusk. These are sites and times at which *A. boskianus* would not normally be present. For this reason we are inclined to repeat our suspicion that *P. rupestris* may be preyed on by *A. boskianus*. If so, then within the study site it may have modified its normal habits to minimise the risk of predation.
- Banded Ground Gecko *Bunopus spatalarus* (Gekkonidae): A number of specimens of this normally phlegmatic species were found on stony ground after dark.
- Gallagher's Leaf-Toed Gecko *Asaccus gallagheri* (Gekkonidae) (*Fig. 9*): Several specimens of this nocturnal, rock-climbing species were observed in a gorge in a small tributary wadi that debouches into the study area.

- Diadem Snake *Spalerosophis diadema cliffordii* (Colubridae) (*Fig. 10*): The observation of this diurnal hunter was exceptional; Gardner (2013) plots only two prior UAE records. The snake was moving along open ground when it was first sighted in mid-morning on 11 April 2014, but it withdrew to the shelter of a rock when observers gathered. Exposed, it made several threatening lunges with the forepart of its body raised. This behaviour is consistent with Gardner's (2013) advice that the Diadem Snake will strike readily if cornered, but Gardner also states that most prey is killed by constriction and that no serious effects of bites on man have been recorded. The Diadem Snake is a potential predator on *A. boskianus*, which appears to be the most abundant diurnal prey species at the site.It would not be unreasonable, based on the authors' experience, to expect at least a small number of additional reptile species to be present within the site or in the surrounding area, for example the Baluch Ground Gecko *Bunopus tuberculatus*, the Hadramaut Sand Lizard *Mesalina adramitana* and any of several snakes, including the Wadi Racer *Platyceps rhodorachis*, the Sand Snake *Psammophis schokari* and either of the UAE's two *Echis* species vipers.

In addition to the above-listed reptiles, on a nocturnal visit to the site we observed a single small mammal, believed to be Cheesman's Gerbil *Gerbillus cheesmani*, in a thicket of brush at the base of a medium-sized shrub (*Acacia ehrenbergiana*).

Conservation considerations

Even apart from the exceptional population of *A. boskianus*, the reptile fauna of the study site reflects considerable diversity within a relatively small area. Moreover, as noted in the original paper, that fauna exists in conjunction with light but regular use by local residents. It does not seem either feasible or necessary to restrict current use, but in order to try to preserve the area as a microcosm of the UAE's native mountain front fauna, the authors propose to bring the site to the attention of local authorities as one deserving of protection in the form of non-destruction (no quarrying, power lines, road expansion, 'farm' construction, etc.) as well as culturally sensitive monitoring to prevent potentially abusive practices e.g., by weekend picnickers.

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[NB: *Tribulus* is available online at: http://www.enhg.org/trib/]

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An unexpected resident butterfly of the United Arab Emirates – the Arabian Grizzled Skipper *Spialia mangana* (Lepidoptera: Hesperiidae)

by Gary R. Feulner and Binish Roobas

Abstract

A relict population of the Arabian Grizzled Skipper *Spialia mangana*, otherwise known principally from south-western Arabia and the Horn of Africa, has been found in the Hajar Mountains of the United Arab Emirates (UAE) at a remote high elevation site long recognised as a refuge for rare plant species. Circumstantial evidence suggests that its preferred larval foodplant may be *Melhania muricata* (Sterculiaceae). If so, the distribution of *S. mangana* in the UAE and Northern Oman may be controlled, at least in part, by the distribution of that plant.

Fig. 1: The Arabian Grizzled Skipper *Spialia mangana* atop Jebel Qitab, Fujairah, United Arab Emirates. This is a rare, full top view showing clearly the complete absence of small marginal white spots on all four wings. This butterfly is feeding on *Viola cinerea*. (Picture by Maral K. Chreiki)

Fig. 2: A view of the underside of an Arabian Grizzled Skipper atop Jebel Qitab, showing the well-defined pale band on the hind wing that characterises this species. (Picture by GRF)

In mid-February 2014, the Arabian Grizzled Skipper *Spialia mangana* (Rebel) 1899 was recorded at *ca.* 1000 metres elevation on the summit ridge of Jebel Qitab, south-west of Fujairah city, overlooking the Gulf of Oman. *Figures 1* and *2* show the butterfly and highlight its diagnostic features.

S. mangana is an uncommon and little known species having its principal range from south-west Arabia to East Africa (Yemen through Ethiopia and Somalia to Uganda and Kenya) with two localities reported from the Dhofar region of Oman (Larsen 1980, 1983, 1984a, 1984b and *pers. comm.*; Larsen & Larsen 1982). In December 2007, *S. mangana* was found in the mountains of Northern Oman as well, on the middle slopes of Jebel Kawr, an exotic limestone massif at the south-west corner of the Jebel Akhdar (Feulner 2007). The Jebel Kawr records were later supplemented by earlier unpublished observations by Tim Roberts (*pers. comm.*), made in late October 2006, from the nearby slopes of the Jebel Akhdar, above Wadi Ghul. All of the Northern Oman records were from similar elevations, *ca.* 1000-1400 metres. They extended the known range of *S. mangana*, disjunctively, by some 725 kilometres, from central Dhofar to the Jebel Akhdar.

The new UAE record represents an additional range extension of *ca.* 225 kilometres. Because *S. mangana* is a sedentary (i.e., non-migratory) species (Larsen, *pers. comm.*), the new record is considered (as at Jebel Kawr and Jebdel Akhdar) to represent a relict population persisting from an era of more mesic (but probably still eremic) conditions.

The intervening Jebel Kawr and Jebel Akhdar reports make the UAE record somewhat less surprising, but no less significant from the standpoint of regional biogeography. The summit ridge of Jebel Qitab (*Fig. 3*) and neighbouring high ridges to the north-west, from elevations of *ca.* 600-1050 metres, collectively called the Olive Highlands (Feulner 2014), have previously been identified as a high elevation refuge for relict plant species within the Hajar Mountains of the UAE (Feulner 1997, 2014; AGEDI 2013). The presence of *S. mangana* provides faunal evidence to the same effect.

Fig. 3: Typical ridgetop habitat in the Olive Highlands, a refuge for rare plant and animal species. (Picture by GRF)

The authors had been attentive to skipper butterflies (Family Hesperiidae) in the UAE over the preceding year, but it was partly their recognition of the Jebel Qitab summit ridge as a biodiversity 'hotspot' that encouraged them to persist in their efforts to obtain a range of potentially diagnostic photographic views of the few skippers they observed there.

The butterflies were seen at midday on a sunny but relatively cool day. They remained in the area of the observers, generally within a radius of about 10-15 metres. They made periodic short sorties and were observed to feed on flowering *Asphodelus tenuifolius* and *Viola cinerea* (*Fig. 1*), two widespread annuals, but they returned regularly to alight in an open area of flat, silty and stony ground among boulders, either on the ground or on low but erect basal rosettes of *Pallenia* (formerly *Asteriscus*) *hierochunticus*. Typically they perched with their wings relatively wide open, but a photograph of the upper side alone would not necessarily permit a conclusive identification from among the five congeneric skippers found in the UAE and Northern Oman (Larsen & Larsen 1982; Gillett 1995; Feulner 2007).

The fact that they perched repeatedly and conspicuously within the same small, open area, suggests they were probably 'hilltopping', i.e., following the terrain to a topographic high point for the purpose of meeting and mating with other conspecifics. Larsen (*pers. comm.*) regards the behaviour described as typical of hilltopping for sexual purposes. Two other butterfly species were present in the vicinity at the same time – a single Common Swallowtail *Papilio machaon* and one or more Pea Blue *Lampides boeticus*. Both of those species are known for hilltopping (Larsen 1984b) and they were almost certainly also doing exactly that.

As in the case of Jebel Kawr, only a small number of individuals of *S. mangana*, perhaps only two or three, were seen at Jebel Qitab, and little more can be said directly from these observations about the ecology of *S. mangana* in the UAE or Northern Oman, except that the species appears to be found at medium to high elevations (*ca.* 1000-1400 metres) and is active through the fall and winter seasons, including late October, December and February.

The larval foodplant of *S. mangana* remains unknown (Larsen, *pers. comm.*), but the presence of *S. mangana* only in the botanical refuge of the Olive Highlands suggests the possibility that its distribution maybe controlled, at least in part, by the presence of a preferred foodplant among the dozen or so species that are locally restricted to the Olive Highlands. Those include the following species (Feulner 2014):

Abutilon fruticosum (Malvaceae)
Convolvulus acanthocladus (Convolvulaceae)
Desmidorchis flavus (Asclepiadaceae)
Ehretia obtusifolia (Boraginaceae)
Ephedra pachyclada (Ephedraceae)
Fagonia schimperi (Zygophyllaceae)
Grewia tenax (Tiliaceae)
Melhania muricata (Sterculiaceae)
Monsonia cf. *heliotropioides* (Geraniaceae)
Olea europaea (Oleaceae)
Pennisetum orientale (Poaceae)
Phagnalon schweinfurthii (Asteraceae)

Fig. 4: *Melhania muricata*, the suspected larval foodplant of the Arabian Grizzled Skipper. (Picture by GRF)

Other Grizzled Skippers (*Spialia* spp.) found in Arabia are known to be polyphagous on various low Malvaceae (mallow family) and Sterculiaceae (cacao family), and to a lesser degree Tiliaceae (linden family), although they may also use other plants (Walker & Pittaway 1987; Kehimkar 2008; Larsen *pers. comm*.).

In the case of *S. mangana* at Jebel Qitab, circumstantial evidence points most strongly towards *Melhania muricata* (*Fig. 4*), which is also present at the Jebel Kawr site (Feulner 2007). *M. muricata* is a known foodplant of the Zebra Grizzled Skipper *S. zebra*, which ranges from East Africa through Southern Arabia to Baluchistan and the Punjab (Larsen & Larsen 1982; Larsen 1983). It is also the UAE's only representative of the Sterculiaceae and is reasonably common along the Jebel Qitab summit ridge. However, the list of Olive Highlands local endemics also includes a medium-sized Malvaceae, *Abutilon fruticosum*, and a large Tiliaceae, *Grewia tenax*, both of which can be found on the slopes and/or summit cliffs of Jebel Qitab.

Larsen (*pers. comm.*) advises that the larvae of *S. mangana*, like other *Spialia* larvae, probably shelter in little envelopes made from the leaves of the foodplant and would not be easily seen, except by using the envelopes as a proxy.

It is difficult to test more rigorously the hypothesis that the distribution of *S. mangana* is controlled by the distribution of *M. muricata*, since both the butterfly and the plant are rare and have been found only at relatively remote locations. It is not clear that any records of *M. muricata* exist from the Hajar Mountains between the Jebel Akhdar and the Olive Highlands. Thus, in addition to favouring higher elevations, *M. muricata* may also be limited by geology, avoiding the ultrabasic rocks (harzburgite) of the Semail nappe (a/k/a the Oman ophiolite), which comprise most of the mountainous area between the existing records. But that area is also extremely rugged and very poorly explored at higher elevations (900 to 1500+ metres), so the plant could simply have been overlooked.

Jebel Rais, in Oman, is an isolated promontory of carbonate sediments within that intervening area of ultrabasic rock (rising to 1800+ metres above uppermost Wadi Hawasina) and for that reason was the subject of a botanical reconnaissance in by the senior author (GRF) in December 2005. *M. muricata* was not recorded at Jebel Rais, although several other Olive Highlands local endemics were found there: *Convolvulus acanthocladus*, *Ephedra pachyclada*, *Fagonia schimperi* and *Olea europaea*. Of those four species, three are otherwise unrecorded in the intervening area, but *O. europaea* is the most common tree species at higher elevations within the ophiolite mountains, from Jebel Hatta in the UAE south to the Jebel Akhdar.

A second species of Sterculiaceae, *M. phillipsae*, has been recorded from Northern Oman (Ghazanfar 1992; Jongbloed 2003); it appears to be equally uncommon. The senior author (GRF) has encountered it at only a single locality, at *ca.* 1200-1300 metres on the upper slopes of Jebel Muqayleet, a gabbro massif like Jebel Qitab (i.e., basic, not ultrabasic rock), some 15-20 kilometres south of Wadi Jizzi. Neither *M.*

muricata nor *M. phillipsae* has yet been recorded from the several outlying carbonate (limestone and dolomite) ridges along the mountain front from Al-Ain/Buraimi to the north, i.e., Jebel Hafit, Jebel Ghaweel and Jebel Sumayni, each of which reaches 1100-1200 metres.

As emphasised in connection with the Jebel Kawr records, the discovery of *S. mangana* continues the progressive recognition in Northern Oman (and now in the UAE) of small populations of arid Afro-tropical butterfly species previously known in Arabia only from Yemen and Dhofar, e.g. Brown Playboy *Deudorix antalus*, African Cupid *Euchrysops osiris* (Gillett 1997) and Somali Cupid *Euchrysops lois* (Gillett 1999). Moreover, it seems that *S. mangana*, like *E. lois*, cannot be satisfactorily accounted for by the possibility of recent immigration in response to favourable conditions and/or human intervention, but must be considered a previously unrecognised relict species.

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Observations on migrant Caper White *Belenois aurota* (Fabricus 1793) and Painted Lady *Cynthia cardui* (Linnaeus 1758) butterflies passing through the UAE, spring 2014

by Oscar Campbell

Most springs in the UAE witness at least a small arrival of north-bound, migrant butterflies, with the large, strikingly coloured Caper White *Belenois aurota* and Painted Lady *Cynthia cardui* amongst the most obvious. These species are both well-known migrants over their very large world ranges (Larsen, 1984) and are often common and conspicuous across Arabia (Walker & Pittaway, 1987). In spring 2014 (mainly from mid-March to mid-April), Abu Dhabi island saw a very marked influx of migrant butterflies, predominately *B. aurota*, although other well-known migrant species, including *C. cardui*, also featured. Observations by the author, made annually since 2007 whilst searching for migrant birds on Abu Dhabi Island, indicate that 2014 was certainly the best spring in (at least) eight years for *B. aurota.* This may have been a local phenomenon as observers at Jebel Hafit, Al Ain reported 2014 to be a 'fairly normal' year for the species (H. Roberts *in litt*.) This short note, in two parts, first summarises an observation of egg laying by *B. aurota* on a potentially novel foodplant on Abu Dhabi Island and then discusses a dramatic and highly concentrated arrival of butterflies, mainly *C. cardui*, in Dibba, Fujairah Emirate.

Belenois aurota egg-laying on *Salvadora persica*, Abu Dhabi island

Lulu Island is a sandy island, just off the Corniche of Abu Dhabi island, formed over several years in the 1990s by the dumping of dredged mud and sand, protected on its outer side, facing the Arabian Gulf, by rocks quarried from the Hajar Mountains. It now has extensive strips of planted trees and shrubs such as *Eucalyptus* sp., *Zizyphus spina-christii* and *Salvadora persica*. During a visit by the author on 27th March 2014, a marked passage of *B. aurota* was noted, with more than 100 being seen. Almost all were observed flying and a good majority of the insects were heading obviously on a north-east trajectory, following the leading line formed naturally by the island's orientation. A repeat visit on 29th March produced just 25 butterflies but on 11th April 100 were again recorded. On this latter date, whilst most butterflies were again noted flying, a cluster of ten, at the most north-eastern part of the island and obvious from some distance, demanded closer inspection.

They proved to be females egg-laying on *S. persica*. A short search revealed nine egg batches of which eight (containing between five to 50 eggs; mean 31) were deposited on the upperside of the leaves and one batch (containing 40 eggs) was placed on the underside of a leaf. One female was watched laying a batch of 11 eggs in a two minute period, before flying again. All butterflies concentrated egg-laying on the same small section of a rather large, straggly and mature *S. persica* (estimated to be about 12 feet tall); all clutches found were within three feet of each other. Egg-laying occurred mainly on the terminal leaflet (or, sometimes, a leaflet near the terminus) and favoured positions were approximately 6 feet above the ground and fully exposed to bright, strong sunlight. Other leaves nearby had obvious feeding damage (a few had been consumed in their entirety) but no larvae could be found. Simultaneously, another four butterflies were observed flying around an adjacent and similar *S. persica* but were not observed actually egg-laying. Many other *S. persica* bushes were in close proximity but butterflies were not noted in close attendance of any, despite many being in apparently identical situations with regard to exposure to sun, height above ground etc. A follow-up visit made on 18th April revealed just 15 *B. aurota*, scattered over the island as a whole, none being in evidence anywhere around the *S. persica* shrub that had been so favoured one week earlier. All eggs noted on 11th had gone, although two tiny larvae were found nearby. These closely matched internet images of early instar *B. aurota*.

S. persica, including horticultural plantings, is a well-known foodplant for the Blue-spotted Arab, *Colotis phisadia*. This species has been observed on Lulu Island, often in the presence of *S. persica* but never (at least by the author) in unusual concentrations. However, as far as is known, larvae of *B. aurota*, as implied by the English name, are known to feed exclusively on members of the Capparaceae family, particularly *Capparis cartilagenia* and *Maerua crassifolia*. (Larsen, 1975).The former is a scattered plant on calcareous cliffs in the Hajar mountains of the UAE, but is rather commoner in Ru'us al-Jibal, Musandam whilst the latter is rare, recorded on low mountain slopes from Jebal Qatar and Ra's al-Khaimah (Jongbloed, 2003). Egg-laying on the former has been observed and the butterfly has also been observed in the vicinity of the congeneric *C. spinosa* at Wadi Wurrayah, Fujairah Emirate (G.R. Feulner, *in litt*), which is also the foodplant on which it has been recorded from Jordan (Katbeh-Bader *et al*, 1998). Egg-laying on *C. cartilagenia* was also noted in Wadi Tarabat, Jebel Hafit on 28th March 2014 (S. Parr *in litt*).

Large and marked influxes of *B. aurota* occur with some frequency in the UAE. For example, Gillett (1997) describes an observation from March 1996 when *Maerua* trees in the hills of Al Madhah / Buraimi

region, Sultanate of Oman, and close to Al Ain, were found to be almost completely defoliated and covered in thousands of chrysalids of *B. aurota*. The species is also a well-known migrant in Africa with, for example, an enormous movement (estimated to involve one billion individuals, witnessed moving en-masse through northern Tanzania in January – February 2012 (Anon, 2012). However there appears to be no reports of the species using foodplants other than members of the Capparaceae family during that movement. Reference to several published guides to Indian butterflies, and to Larsen (1983) confirms that recognised larval foodplants of *B. aurota* on the sub-continent (where the species is generally referred to as the "Pioneer") are all Capparaceae; the genera *Cadaba*, *Capparais* and *Maerua* are specifically named and no other families or genera (including *Cleome*, the principal UAE representative of Capparaceae) are mentioned (G.R. Feulner, *in litt*). T.B. Larsen, *in litt* to G.R. Feulner (October 2014) confirmed that *B. aurota* feeds mainly on Capparaceae but contended that occasional use of *S. persica* may not be too surprising. Butterfly species in Arabia using a novel foodplant are known from elsewhere; for example, in northern Oman, *Brephidium exilis* (Western Pygmy Blue), an introduced species to Arabia, was recently reported ovipositing on *Zaleya pentandra*, a member of the Aizoaceae and a novel family to its normal foodplants (although *B. exilis* had previously been suspected of utilising *Sesuvium*, another Aizoaceae, in Arabia previously; Otto, 2014). If larvae of *B. aurota* can survive and pupate successfully on *S. persica*, there may be interesting implications for its population in a region where this foodplant is highly prevalent.

In conclusion, as far can be ascertained, after an extensive search, this Abu Dhabi sighting appears to be a first record of *B. aurota* egg-laying on *S. persica* (or indeed on any species not from the Capparaceae family), not just in Arabia, but further afield.

A remarkable concentration of Painted Ladies, amongst other species, at Dibba, Fujairah Emirate

On 25th April 2014 the author, in the company of Simon Lloyd, visited Fujairah National Dairy Farm ('Wamm Farms'), situated just inland of the town of Dibba, Fujairah, on the East Coast of the United Arab Emirates. These anthropogenically-maintained grasslands have little to interest butterflies, migrant or resident, but the entire site is highly attractive to migratory birds, searching for food and shelter between the Gulf of Oman and arid Hajar mountains. The farms are fringed by stony plains dominated by *Acacia tortilis* trees which, during our visit, were flowering heavily. As the flowering season for this species is April to June (Jongbloed, 2003), flowering had presumably begun very recently prior to our visit.

On arrival soon after dawn, it was obvious that *C. cardui* were present in exceptional numbers, mainly sheltering from a moderate, blustery south-westerly wind (estimated as force 3-4) in the lee of *A. tortilis* trees. Over the course of three hours searching, some 2000 individual butterflies were counted. Since only a tiny proportion of the trees present were actually examined, the actual total present must have been many, many times larger. All *A. tortilis* checked had at least some butterflies, with over 200 individuals on a few, particularly favoured, trees. Other butterfly species clearly associated with this influx, albeit in significantly lower numbers, were Blue Pansy *Junonia orithya* (at least 200 individuals), *B. aurota* (150), Plain Tiger *Danaus chrysippus* (50) and African Emigrant *Catopsilia florella* (2). All of these are known, obligate migrants to a greater or lesser degree (Larsen, 1984).

Later on the same day, much lower numbers of a similar range of species (although mainly *B. aurota*) were observed all along the coast as far south as Kalba (65 km south of Dibba), including examples of *J. orithya* obviously migrating along the beach at Fujairah. Small numbers of migrating butterflies (again mainly *B. aurota*) were even observed at some distance during a boat trip several kilometres offshore from Kalba. Unlike earlier in the day, *C. cardui*, although present, did not dominate. Indeed, one striking feature of this *C. cardui* migration was the generally very sudden and localised nature of it. Only a handful of *C. cardui* were observed at Fujairah National Dairy Farm on 18th April (S. Lloyd *pers. comm.*) although an obvious, albeit much smaller, movement of several hundred (along with similar numbers of *B. aurota* and lesser numbers of other species) was recorded on the Sayh plateau, Musandam, Oman (60 km north of Dibba) on 20th April (OC, *pers obs*). No significant numbers of any migrant butterfly species were recorded at Al Ain (150km south of Dibba) on the weekend of 24th-25th April (H. Roberts *in litt.*) and not a single *C. cardui* was recorded anywhere on Abu Dhabi Island (210 km south west of Dibba) during 3.5 hours of searching on 26th April (OC *pers. obs.*).

C. cardui is one of the best known of migrant butterflies in many parts of its vast global range and its large scale migrations often attract widespread attention from the general public. For example, the United Kingdom saw an enormous arrival (estimated at 11 million individuals) in spring 2009, and it was established, by radar tracking, that offspring of summer arrivals returned south at high altitudes (generally 500m) in the autumn (Stefanescu *et al.*, 2013). Over six generations, the insects completed a round trip of over 14,000km between tropical Africa and the Arctic Circle. Three billion individuals were once estimated to have passed through southern California and neighbouring states during one movement (Larsen, 1984) and they are periodically exceptionally abundant in Jordan (Katbeh-Bader *et al.*, 1998) with collecting data presented therein indicating that spring (and especially April) see maximum numbers. A study based on standardised monitoring

techniques in north-east Spain (Stefanescu, 1997) found that, although maximum numbers occurred later in spring (mainly in May and June, as might be expected at a latitude greater than that of the Middle East), some years witnessed a small but definite rise in numbers in late April. The same study highlighted significant fluctuations in numbers between years and that, at a given site at a given time, most butterflies concentrated on one or a small number of preferred nectar sources, as was observed at Dibba.

Finally, migration of *C. cardui* has been shown to correlate strongly with prevailing wind direction, both at high altitudes and at ground level (Stefanescu *et al*., 2007). Insects on a north-bound flight through the UAE being blown gently downwind would presumably account for a concentration in the north-east part of the country, when insects suddenly encounter the coastline. This may be at least the proximate reason for the remarkable concentration described above.

Acknowledgements

I am very grateful to Gary Feulner for many helpful comments and additional information that have enhanced greatly this short note, particularly concerning *B. aurota* ovipositing on *S. persica*. Furthermore, Huw Roberts and Steve Parr responded to requests for information and Simon Lloyd joined me in the field on 25th April.

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First UAE and Arabian records of *Chilades pandava*, the Cycad Cupid butterfly, an introduced Oriental species (Lepidoptera: Lycaenidae) hosted by the ornamental sago plant *Cycas revoluta*

by Gary R. Feulner, Binish Roobas, Tamsin Carlisle and Helga Meyer*

Fig. 1. "Mating frenzies" on ornamental cycads, noticed by several observers in Dubai in the summer of 2014, called attention to the butterfly in the picture, which proved to be *Chilades pandava*, the Cycad or Plains Cupid. (Picture by TC)

Abstract

The Cycad Cupid butterfly *Chilades pandava*, an Indo-Southeast Asian species, has recently been observed at several sites in urban Dubai, United Arab Emirates, in each case breeding on an ornamental cycad species, the sago plant *Cycas revoluta*. *C. pandava* has greatly expanded its global range during the past 15 years through the introduction of cycads for horticultural purposes. It is expected that *C. pandava* will be found at additional sites in Dubai and probably elsewhere in the Arabian peninsula. Observers at landscaped sites in the Arabian Gulf region should be alert to this possibility and be prepared to distinguish this species from the native Small Cupid *Chilades parrhasius*, which it very closely resembles. Photographs and information are provided to facilitate field identification, but the close association with cycad host species remains the surest criterion.

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Introduction

During the Arabian summer of 2014, "mating frenzies" of a Lycaenid butterfly resembling the native Small Cupid *Chilades parrhasius* were observed on three occasions at sites in urban and suburban Dubai by the authors, all individuals associated with the Dubai Natural History Group (DNHG) (*Fig. 1*). In each case, the butterflies were mating on ornamental cycad plants.

HM was the first to notice this phenomenon, which she saw on 9th June at her apartment gardens in Jumeirah, opposite Jumeirah Beach Park, and she called attention to it in the DNHG's monthly newsletter, *Gazelle* (Meyer & Feulner 2014). She wrote, "I had the good fortune to see many butterflies in a frenzy to mate and some females were also laying eggs on [one of several potted] cycad plant[s]. They seemed to mate for ages and I observed one couple stuck together for 1.5 hours at least, while a lot of other males tried to interfere."

Fig. 2. An ornamental cycad, the sago *Cycas revoluta*, at Madinat Jumairah resort, where a mating frenzy of *C. pandava* was observed on a summer morning in 2014 when few other butterflies were flying. The plant has produced a vegetative flush of new fronds – ribs and budding leaflets (here straw-coloured due to damage from larval feeding) – which has attracted adult butterflies to mate and lay eggs.
(Photo by GRF)

The butterfly in question was identified in the *Gazelle* account as the Small Cupid *Chilades parrhasius*, a common species in diverse environments in the UAE, but also a highly variable species and one which, in the wild, is active throughout the summer. *C. parrhasius* ranges from dry parts of India and Sri Lanka across southern Afghanistan and Iran to eastern and southern Arabia (Larsen & Larsen 1982, Larsen 1983). Larsen (1983) remarked on its variability in both size and markings, and left open the possibility that *C. parrhasius* might yet be found to comprise multiple species.

Subsequently, on 6th August, in the course of a DNHG survey of the wildlife at Dubai's Madinat Jumeirah resort, GRF and BR observed a similar mating frenzy at one of a row of five cycads at a landscaped plot along a golf cart path (*Fig. 2*). This was especially noteworthy because, with just two exceptions, these were the only butterflies seen flying on a muggy morning in the resort's environment of largely introduced plant species.

After seeing the report in *Gazelle*, TC remarked to GRF that she, too, had noticed mating frenzies of "Small Cupids" on several occasions during the summer, around potted cycads on the grounds of her apartment complex, the Jumeirah Beach Residence (JBR). In previous years she had noticed and photographed only smaller numbers of similar butterflies, feeding on several species of introduced ornamental flowers. TC's area of JBR, the Murjan area, also has a number of established cycads in some of its flower beds, which are much larger than the ones in the planters and have been there for at least the past three years. Due to ease of access, however, she has closely monitored only the potted cycads. Like HM, TC found the butterflies copulating while perched on the cycad fronds and budding leaves. She also found eggs glued to fronds, mainly on the central ribs near the base of fronds at the centre of the cycad, near where new foliage would emerge.

The cycad plant involved in each of the above instances appears to be *Cycas revoluta*, a native of Japan (Marler *et al.* 2012) that is now widespread as an agricultural and ornamental species, marketed as "sago", "sago palm" or "King Sago". In each case as well, the plant was undergoing a vegetative "flush", sending up new ribs from the centre of the plant, each flanked by the buds of new leaflets (see *Figs. 2, 5*). [NB: Although sago plants are often called "sago palms", they belong to the cycads, a primitive gymnosperm plant lineage dating back to the Jurassic (Wikipedia, "Cycad".) They are unrelated to true palms, which are a specialised group of angiosperms, i.e., flowering plants. Sago and most other ornamental cycads belong to the largest subgroup of cycads, the family Cycadaceae, a monogeneric family consisting

of *ca*. 100 species, all classified in genus *Cycas* (Marler *et al.* 2012, Wikipedia, "Cycadaceae").]

Another *Gazelle* reader was lepidopterist Torben Larsen, the author of numerous professional and popular works on the butterflies of Arabia, the Levant, West Africa and elsewhere. He immediately appreciated the real significance of HM's observations and wrote to comment that what the DNHG authors had treated as *C. parrhasius* "seems, in fact, to be *Chilades pandava*, which has extended its Asian range as shown in [Fric *et al*. (2014), a first report from Egypt]. It[s larvae] feed exclusively in cycads."

The appearance and behaviour of the butterfly, and the circumstances of its occurrence, leave no doubt that Larsen's inference is correct and that *C. pandava* has reached Dubai. Moreover, there can be little doubt that it will also be found at other landscaped sites in Dubai, and perhaps at other sites in the UAE and elsewhere in Arabia, where ornamental cycads are present. Confirming that prediction, as this report was being finalised in late October 2014, BR noticed several healthy landscaped cycads on a broad sidewalk outside his place of employment in Dubai's Media City. He immediately went out to investigate and found a handful of *C. pandava* there, plus evidence that they were breeding, undaunted by the movement of vehicles at an adjacent pick-up and drop-off ramp. However, the introduction of *C. pandava* in Dubai may be fairly recent. TC's photos from JBR in 2012 and 2013 do not appear to show *C. pandava*, but only *C. parrhasius*, on plants other than cycads. Two DNHG members involved in commercial landscaping were consulted, and were not aware of any recent problems or complaints involving damage to ornamental cycads.

As is the case for many plant and animal species, there is no agreed common name in English for *C. pandava*. In its native India and Southeast Asia, it has generally been called the Plains Cupid (Kehimkar 2008, Marler *et al.* 2012, Singh 2011). Other authors, mainly working in the Western Pacific (where there is no other "Cupid"), have also called it the Cycad Blue (LaRosa 2008, Fric *et al*. 2014, Wu *et al*. 2009, 2010, Moore online). We have suggested the alternative of Cycad Cupid, to emphasise not only its preferred larval foodplant but also its close resemblance and kinship to the sympatric Small Cupid *C. parrhasius*, recognised in the Indian English vernacular. We believe that choice has advantages for lay butterfly enthusiasts, but of course it is always desirable to encourage use of the scientific nomenclature, *Chilades pandava*, to avoid possible confusion. The Latin epithet *pandava* (pronounced PAN-da-va) is an Indian classical reference; it is the name given to five brothers, sons of Pandu and warriors who prevailed in the internecine Battle of Kurukshetra recounted in the Mahabharata, a Hindu epic.

Discussion

What are the implications of the introduction of *C. pandava* to the UAE? *C. pandava* has proven to be a successful coloniser, using both native and ornamental cycads. Within the past fifteen years it has spread from its native India and Southeast Asia to various other regions including temperate East Asia (Korea and Japan) (Wu *et al*. 2009, 2010), islands of the western Pacific (Guam and Rota) (La Rosa 2008), islands in the Indian Ocean (Mauritius, Réunion and Madagascar) (Wu *et al*. 2009, 2010), and Mediterranean North Africa (the Nile delta) (Fric *et al.* 2014).

In areas where it is not native, *C.pandava* is considered a serious invasive pest of indigenous *Cycas* species (La Rosa 2008, Marler *et al.* 2012), many of which are on the IUCN Red List (Wikipedia, "Cycadaceae"). These include threatened endemic species in Guam (LaRosa 2008, Moore) and Taiwan (Tavou *et al*., *in prep.*). Even where *C. pandava* is native, the introduction of non-native horticultural cycads has been blamed for an increase in butterfly predation on native cycads (Wu *et al*. 2010). (NB: A second and equally important pest of ornamental and native cycads in Southeast Asia and the Western Pacific is the Asian cycad scale insect *Autocapsis yasumatsui* (LaRosa 2008, Marler *et al.* 2012, Moore online). The scale insect is considered the more important of the two in the Western Pacific (LaRosa 2008, Moore online).)

There are no native cycads in the UAE, or in Arabia, so *C. pandava* has almost certainly arrived with ornamental plants, most likely *C. revoluta*. Its record of establishment elsewhere suggests that it is unlikely to disappear from the UAE unless the larval host plants themselves are eliminated, which seems improbable given current fashion in real estate development and landscaping. Tony Pittaway, co-author of the venerable *Insects of Eastern Arabia*, describes the expansion of *C. pandava* in urban China: "This has become a very common butterfly in the concrete jungles of eastern China, where it feeds on the ornamental potted cycads which seem to adorn the front entrances of almost every large building, especially hotels, restaurants, government centres, hospitals etc." (A.R. Pittaway, *pers. comm.*)

C. revoluta has been shown to be one of the most susceptible cycad species to damage by *C. pandava*, which lays its eggs in the soft, expanding tissue of the leaf buds and new leaves, which are eaten by its caterpillar larvae (Marler *et al.* 2012). Different cycad species produce new leaves on different schedules and some species produce new leaves throughout the year (Marler *et al.* 2012). These vegetative flushes, when new fronds are produced, attract *C. pandava* adults to mate and oviposit. *C. revoluta* is known to

Fig. 3. An early instar of the larva (caterpillar) of *C. pandava* on leaf buds along a cycad frond at Jumeirah Beach Residence. The early instars are red-purple. Later instars are greenish. Only a few larvae, and no later instars, were observed at this site. (Picture by TC)

have relatively prolonged vegetative flushes (Tavou *et al*., *in prep*.). Thus there exists the potential for *C. pandava* to become a "pest" species in the UAE as well, although not in natural environments. Moreover, although its primary foodplant is invariably given as *Cycas* spp., alternative foodplants have been mentioned for *C. pandava*, including other common landscaping species found in the UAE, e.g. *Acacia* spp. and *Albizzia lebbeck* (Kehimkar 2008, Tiple *et al*. 2009) as well as cultivated varieties of gram and beans (Fabaceae) and other Mimosaceae (Kehimkar 2008).

TC has inspected the potted sago plants at JBR for eggs and larvae and has found both, but only a few young, reddish-purple larvae (*Fig. 3*), not later instars, which are said to be greenish and may sometimes be tended by any of several species of ants (Moore, online). At all stages, the larvae feed only on the soft tissue of younger leaves (Wu *et al.* 2010, Marler *et al*. 2012, Moore, online), causing aesthetic damage; dense populations can cause complete defoliation (*Figs. 2, 4*), killing the plant (Moore, online). From her observations, TC queries whether some factor, possibly an avian or other predator, may be "controlling" this new butterfly at JBR at the later instar

Fig. 4. *C. pandava* larvae eat the soft, expanding tissue of new cycad leaflets, leaving the tips dead and brown. *Cycas revoluta* is one of the most susceptible cycad species to damage by *C. pandava*. (Picture by GRF)

stage. HM's initial report made the point that the mating frenzy she witnessed was attended by many of the insectivorous Red-Vented Bulbul *Pycnonotus cafer*, a common garden bird in Dubai, trying to catch the butterflies, but she also noted that the birds appeared to be attacking the false eye spots on the hindwings of the butterfly, presumably mistaking these for the insect's head, with the result that the targets were able to avoid mortal damage.

Establishment of *C. pandava* in the UAE and Arabia would not be unprecedented. Another small Lycaenid butterfly, the Western Pygmy Blue *Brephidium exilis*, a native of arid south-western North America, has established itself in the Arabian Gulf region, from Northern Oman to Kuwait, apparently over the past 25 years (see, e.g., Pittaway *et al.* 2006). In the UAE, *B. exilis* thrives primarily on low, spreading, succulent *Sesuvium* spp. (Aizooaceae), widely used as a landscaping element. *B. exilis* has also been found in association with other Aizooaceae (Otto 2014) and other halophytes, but almost always in anthropogenic or perianthropic environments.

Only a single individual of *B. exilis* has been recorded in the UAE from an indisputably natural environment, the wadi bed of a third order tributary of Wadi Zikt, within Wadi Wurayah National Park, in the mountains of Fujairah emirate on the East Coast of the UAE (G.R. Feulner and J. Judas, unpublished observation). That individual was flying with several Grass Jewel butterflies *Chilades trochylus* (syn. *Freyeria trochylus*) feeding on flowering *Lavandula subnuda* and *Convolvulus virgatus*. As there were none of its customary succulent or halophyte associates in the area, it had almost certainly lost its way. Thus even the relative success of *B. exilis* highlights the rigours of the UAE environment: despite more than four and a half decades of introductions of large numbers of exotic plants, and to a lesser extent animals, no animals and only one species of plant (the mesquite tree *Prosopis juliflora*) can be said to have proved to be "invasive" in natural habitats in the UAE.

GRF and BR returned to Madinat Jumeirah on 19th October 2014 to review the situation of *C. pandava* there. They found modest numbers of *C. pandava* perched on cycads at each of a number of locations where cycads were planted, and several females were ovipositing. Moreover, *C. pandava* was the *only* butterfly that they saw, and it could be found not only

Fig. 5. The tiny white eggs of *C. pandava* are laid in the centre of the cycad plant, on the ribs bearing the buds of new leaflets. Nearly 100 eggs, new and old, can be counted in this photo. (NB:The female butterfly in this photo, although evidently *C. pandava*, does not show the diagnostic sub-basal wing spots discussed in the text.) (Picture by BR)

on the cycads and immediately adjacent plants, but in hedges and cultivated beds up to 10-15 metres away. Even very small cycads in a planted area seemed able to attract these butterflies. In one instance, they observed two *C. pandava* in a treed courtyard where no cycads could be seen.

It was also possible to observe the egg-laying process (*Fig. 5*) and the tiny white eggs, disk-shaped and ornamented, but with depressed centres on one surface (*Fig. 6*). Many eggs could be found on the stunted and drying remains of moribund flushes (*Figs. 5, 6*). The reason for the failure of the new growth is speculative, but there was abundant evidence of aesthetic damage to new cycad leaflets (*Fig. 4*).

It has long been recognised that landscaped sites in Dubai – resorts, parks, golf courses, etc. – however attractive they may be to the human eye, are typically greatly impoverished in butterflies and most other invertebrate species, compared to natural environments. This has generally been attributed to a combination of (i) a robust regime of pesticide application and (ii) a biota primarily consisting of exotic plants, with which native invertebrate species are unfamiliar. The success of *C. pandava* may be evidence that the role of unfamiliar plant species is greater than the role of pesticides in discouraging the presence of native species at these artificial sites, since the cycads at Madinat Jumeirah are not exempt from the pesticide regime that applies to landscaped areas generally.

Identifying characteristics

"Pest" or otherwise, it should prove instructive to monitor the status of the newly recognised Cycad Cupid *C. pandava* within the UAE, and elsewhere within the Arabian Gulf region. What should observers look for in order to be able to distinguish it from the familiar and common Small Cupid *C. parrhasius* in the field or garden?

Available descriptions and images indicate that one of the most objective characteristics is the presence in *C. pandava* of a line of four dark spots arranged in a circumferential arc near the base of the under side of the hindwing (*Figs. 1 and 7*), versus only three such spots in *C. parrhasius* (*Fig. 8*) (Kehimkar 2008). Use of this criterion depends on a good view of the hindwing, because the two inferior spots may be inconspicuous and, in both species, the lowest spot is at the basal or inner margin of the hindwing where it may be difficult to see due to posture or wear. But if it can be seen, the third spot immediately below the second that is sufficient to confirm *C. pandava;* this is the spot that is "missing" in *C. parrhasius*. In technical terms, it is a sub-basal spot in space 1c (*Fig. 9*).

The converse is not true unfortunately. The absence of the third spot is not sufficient to confirm *C. parrhasius.* In a significant number of instances, both at JBR and at Madinat Jumeirah, we have seen and photographed butterflies which were evidently *C. pandava* – perching, mating and ovipositing on cycads – but in which neither of the two inferior sub-basal spots were visible (*Fig. 5*). In such cases field discrimination between *C. pandava* and *C. parrhasius* is extremely difficult in the absence of circumstantial evidence such as habitat and behaviour; mating on vegetating cycads can probably be taken as conclusive of *C. pandava* (*Fig. 10*).

With experience, a field determination can possibly also be based on a combination of qualitative factors, including size, colour and details of patterning. Dark veins on the upperside of the male's blue wings are said to be indicative of *C. pandava* (Kehimkar 2008, Singh 2011), although those veins may appear prominent in *C. parrhasius* as well. Images of the underside of *C. pandava*, taken as a whole, are brown-hued, whereas images of the underside of *C. parrhasius* are mostly pale grey (compare *Figs. 1, 5, 7* and *9-10* with *Fig. 8*), but ground colour is not an infallible guide; exceptions are known.

Larsen (*pers. comm.*) adds two further qualitative differences signaling *C. pandava*: (i) larger size and (ii) deeper blue upperside wing colour in the male (versus pale, greyish lavender in *C. parrhasius*). As to size, at Madinat Jumeirah, most of the several dozen *C. pandava* observed closely appeared to be at the large end of the size range for C. *parrhasius*; a few were larger, although not generally rivalling the size of the Pea Blue *Lampides boeticus*. Impressionistically, most of the larger specimens were thought to be females.

As to colour, a *C. pandava* male upper side is shown in *Fig. 11*. A *C. pandava* female upper side is shown in *Fig. 12* and features a very broad but diffuse brown border on all four wings. This differs from what is shown for *C. parrhasius* in Larsen & Larsen 1982 (a modest brown border) and Larsen 1984 (a uniformly brown upperside, but with a paler interior).

It is possible that more detailed study will reveal additional consistent differences in the underside patterns of *C. pandava* and *C. parrhasius*, but if so, these are likely to be both subtle and complex. The recognised variability of *C. parrhasius*, noted by Larsen (1983), has been mentioned above. In the wild in its native India, *C. pandava* displays an exceptional diversity of dry season forms that are genetically determined but environmentally mediated, a phenomenon called seasonal polyphenism (Kunte & Tiple 2009, Tiple *et al.* 2009). The dry season forms are not seen in populations and subspecies from the wet Southeast Asian and Sri Lankan regions (Tiple *et al*. 2009). It remains to be seen to what extent such polyphenism may be found in *C. pandava* in the UAE, which subsists on plants growing in artificially maintained environments.

Fig. 6. The freshly laid eggs of *C. pandava* are disk-shaped, ornamented with tiny tubercles, and have a small central depression in one side, like an asymmetrical doughnut or rubber tyre. After the larva has emerged, the discarded "shell" of the egg appears to be splayed open like a miniature jellyfish. (Picture by BR0

Fig. 7. *C. pandava*, the Cycad Cupid: A view showing the typical (wet season) pattern of the underside. Note the brownish ground colour and the characteristic circumferential arc of *four* dark spots near the base of the hindwing. Compare with *Figs. 1*, *8* and *9*.In India, *C. pandava* also exhibits a diverse range of dry season forms. (Picture by TC)

Fig. 8. *C. parrhasius*, the Small Cupid: A view showing the typical pattern of the underside. Note the pale, greyish ground colour and the characteristic circumferential arc of *three* dark spots near the base of the hindwing. Only two conspicuous. The third is at the bottom edge of the hindwing. This individual was photographed along the Hajar Mountain front near Shawkah in summer 2013. (Picture by BR)

Fig. 9. A difficult determination: In this individual of *C. pandava*, the two lowest spots in the sub-basal arc (to the left in this photo) are inconspicuous; the lowest, along the bottom edge of the hindwing, is nearly invisible. But the presence of the third spot, immediately below the second, is diagnostic. That spot is never present in *C. parrhasius*. However, it may be absent in individuals of *C. pandava* as well (see the female in *Fig. 5*), so the absence of the spot is not diagnostic. In that case, other criteria – habitat, behaviour, size or colour – must be relied on to make a determination. (Picture by BR)

Fig. 10. These three butterflies were part of a "mating frenzy" on a vegetating potted cycad, photographed in October 2014 at Jumeirah Beach Residence. Their behaviour and brownish ground colour identifies them as *C. pandava*, although the individual at the upper left does not appear to show the diagnostic third basal spot (or the fourth, in this view). That individual is presumably a male attempting to gain access to the copulating female at the lower right. Compare the upper side of the male, with which the one shown in Fig. 11. (Picture by TC)

Fig. 11. Upper side of a male *C. pandava* from Madinat Jumeirah, mid-October 2014. Compare with the male at the upper left in *Fig. 10.* (Picture by BR)

Fig. 12. Upper side of a female *C. pandava* from Madinat Jumeirah, mid-October 2014. (Picture by GRF)

Acknowledgements

The authors wish to thank Torben Larsen for his continuing encouragement and advice to those of us attempting to better understand Arabian butterflies, and for his review of a draft of this paper. The authors, however, take full responsibility for the facts, interpretations and opinions expressed in the final paper.

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Observations on the habitat, colouration and behaviour of the tiger beetle *Callytron monalisa* (W. Horn, 1927) (Coleoptera: Cicindelidae) on the Arabian Gulf coast of the United Arab Emirates

by Gary R. Feulner and Binish Roobas

Fig. 1: The crab-burrowed upper intertidal sabkha habitat where *C. monalisa* was found at Khor al-Beidhah, Umm al-Qaiwain, in late August 2013 and mid-September 2014. (Picture by GRF)

Abstract

The tiger beetle *Callytron monalisa* was first recognised from the UAE in 2007, on the basis of specimens collected by light trapping in Abu Dhabi. It has since been encountered at several lagoons along the Arabian Gulf coast of the Northern Emirates, where it has been found to be active during mid-morning and mid-afternoon hours in late summer (late July to mid-September) on a spectrum of muddy, upper intertidal substrates.

Most individuals, including mating adults, have displayed copper and green colouration rather than the deep blue-green colour considered typical of the species (otherwise known from Iran and Pakistan). The authors' observations at two Arabian Gulf sites suggest that these colour differences may represent a developmental phenomenon, since individuals observed latest in the summer showed reduced copper colouration, including some with typical blue-green colouration, but the observations made to date do not rule out the possibility of a distinct subspecies in the UAE, occupying lagoons to the south of Ra's al-Khaimah.

Male guarding in *C. monalisa* in the UAE appears to encompass oviposition by the female.

Introduction

The tiger beetle *Callytron monalisa* (W. Horn, 1927) was first recorded from the UAE in early September 2007, when specimens were collected by Brigitte Howarth and Drew Gardner at a mercury vapour light trap on Reem Island in Abu Dhabi emirate. The next summer, in late July 2008, the senior author photographed several individuals in an arm of Khor Zawra, a coastal lagoon in Ajman emirate. *C. monalisa* thus became the 13th tiger beetle species recognised from the UAE (Cassola *et al.* 2012; Wiesner 1993, 1996).

Both of those initial sites are along the Arabian Gulf coast of the UAE. The light trap was set up on muddy ground beside a mangrove creek. The Ajman record was from an area of very fine, waterlogged mud bordering an embayment of the upper reaches of the main channel, where no mangroves were present in the immediate vicinity. The soft mud habitat is quite limited at Khor Zawra and was associated with two other species whose range at Khor Zawra is correspondingly limited: (i) a modest population of an air-breathing gastropod of the *Salinator fragilis* complex (now considered likely to represent a new genus and probably a new species) (R.

Fig. 2: A mating pair of *C. monalisa* at Khor al-Beidhah, Umm al-Qaiwain, late August 2013. The head and thorax are copper coloured, rimmed with green, consistent with earlier UAE records. (Picture by GRF)

Fig. 3: A mating pair of *C. monalisa* at Khor Hulaylah, Ra's al-Khaimah, early September 2013. The head and thorax, and the elytral markings of the male, are a uniform deep blue-green, consistent with records of this species from Iran and Pakistan. (Picture by BR)

Golding, *pers. comm.*); and (ii) at least one Echiuran (spoonworm), probably *Ikeda* sp. (Hornby 2005). These initial observations raised the possibility that *C. monalisa* might have very narrow habitat requirements.

Subsequently, in the course of other research, *C. monalisa* was found to be present and locally common at two other Arabian Gulf sites in the northern Emirates, on a variety of muddy substrates, providing some additional information about this little known species.

Colouration

On 25 August 2013, on the margin of the lagoon at Khor al-Beidhah, Umm al-Qaiwain, dozens of *C. monalisa* were active in mid-morning (0830-0930 hrs) on lumpy, crab-burrowed ground exposed in the uppermost littoral zone between cyanobacterial mats and halophyte vegetation, primarily *Arthrocnemum macrostachyum (Fig. 1).* Three or four pairs were observed in prolonged copulation, making them somewhat easier than usual to photograph *(Fig. 2).*

All of the *C. monalisa* seen at Khor al-Beidhah (including the sexually active individuals) showed colouration consistent with the two earlier UAE records: the head and thorax were mostly a metallic copper colour, rimmed with green, and the elytral markings were more or less black (*Fig. 2*; see also Cassola *et al*. (2012), *Fig. 1*). This is in contrast to the "beautiful deep blue-green colour" for which *C. monalisa* is otherwise known, and it had already been speculated that, if this colour difference proved to be a consistent characteristic of the UAE population, it could represent an undescribed subspecies (Cassola *et al*. 2012).

Two weeks later, on 7 September 2013, observations of *C. monalisa* at Khor Hulaylah, Ra's al-Khaimah, gave a broader perspective. There, *C. monalisa* was observed in mid-afternoon (ca. 1530 hrs) on glutinous mud, in somewhat smaller numbers than at Khor al-Beidhah. All individuals seen at Khor Hulaylah (including a number of mating pairs) showed the deep blue-green head and thorax typical of the species, and some showed blue-green elytral markings as well *(Fig. 3).*

Although not conclusive, the Khor Hulaylah observations cast doubt on whether the observed colour differences could best be explained by means of a distinct UAE subspecies; among other things, the geographic boundary between the two subspecies would have to lie within the *ca*. 55 kilometres of relatively uniform coastline between Khor al-Beidhah and Khor Hulaylah. Instead, it seemed at least equally plausible that the differences might be attributable to other factors such as development of the eventual blue-green colour over time, with increasing maturity in a seasonal coastal population. That hypothesis could be tested by a monitoring programme of more closely-spaced field visits, ideally to multiple adjacent *khors* (lagoons), during the period from late July to mid-September when *C. monalisa* has been found to be present locally.

It was not feasible for the authors to organise such a programme in 2014, but a single investigatory visit was made to Khor Al-Beidhah in mid-morning on 15 September 2014 to see whether *C. monalisa* could be found there again, and, if so, whether there was any change from the mostly copper colouration observed in late August 2013.

C. monalisa was successfully found again at Khor al-Beidhah, at the original location but on a somewhat broader range of substrates than before, including flat, firm, upper intertidal mud with an incipient film of cyanobacteria *(Fig. 4).* Again, dozens of individuals were observed. But this time, three weeks later in the year, the majority of the individuals seen were intermediate in colouration between the two 2013 extremes: The head was mostly green (but not blue-green), with yellowish highlights laterally, and the thorax was mostly green with only a small patch of copper colour dorsally *(Fig. 5),* although both head and

Fig. 4: Upper intertidal mudflats at Khor al-Beidhah, where *C. monalisa* was also observed in mid-September 2014. (Picture by GRF)

thorax reflected copper highlights when viewed at a broad angle to the sunlight. Three individuals appeared to have an almost fully dark green head and thorax, while a larger number were mostly copper coloured and a few were almost entirely so. We observed at least eight mating pairs, most of which were intermediate in colouration *(Fig. 6).*

We interpret these results as supporting the hypothesis of progressive colour change over time, from August through September. At a minimum, our observations argue for caution in postulating a simple subspecific dichotomy to account for colour differences. However, our observations to date do not establish a continuum that would negate the subspecies hypothesis. In particular, (i) in 2014, the Khor al-Beidhah population remained mostly 'intermediate' in mid-September, beyond the early September date by which the Khor Hulaylah population was already fully blue-green in 2013; (ii) mating took place at Khor al-Beidhah among individuals that had not yet achieved "typical" blue-green colouration; and (iii) no individuals seen at Khor al-Beidhah approached the very deep blue-green colour of those at Khor Hulaylah. Our observations did not identify any differences in the time of appearance (emergence or arrival) of *C. monalisa* at these two sites, in either 2013 or 2014.

Mating and mate guarding

As in many tiger beetle species, mating in *C. monalisa* was a prolonged affair, lasting 5-10 minutes or more and including an extended period of mate guarding by the male, beyond actual copulation. Males were slightly smaller than females, whom they clasped with their formidable-looking, specialised mandibles *(Figs. 2, 3 and 6).* Pairs often remained stationary for a minute or two if undisturbed, but the female

Fig. 5. An individual showing intermediate colouration, mostly dark green with a small copper patch on the thorax, Khor al-Beidhah, mid-September 2014. (Picture by GRF)

Fig. 6. Oviposition by *C. monalisa* in the UAE appears to occur during male guarding. The female presses the tip of her abdomen into the soft mud while still in the embrace of the male. (Picture by GRF)

Fig. 7. *Hypaetha schmidti* at Khor al-Beidhah, Umm al-Qaiwain, late August 2013. (Picture by BR)

Fig. 8. *Salpingophora hanseatica* at Khor Zawra, Ajman, mid-August 2013. (Picture by BR)

Fig. 9. *Calomera aulica,* the most common of the UAE's diurnal coastal tiger beetles, Khor Zawra, Ajman, mid-August 2013. (Picture by BR*)*

nevertheless moved intermittently, with the male still draped astride her abdomen, in copulatory embrace (amplexus) but no longer in copula. The mating female, while stationary, was frequently observed to press the tip of her abdomen lightly into the mud surface, then flick it backwards a few times, making a slight depression *(Fig. 6).* This behaviour almost certainly represented oviposition, with the male still on board – an example of very thorough mate guarding.

Other sympatric tiger beetle species

If the observations reported here are representative, and in particular if *C. monalisa* is most active on upper sabkha in daylight hours at the height of the Arabian summer, this may help to explain why it was not recorded sooner.

Three other diurnal tiger beetle species were recorded at Khor al-Beidhah, Khor Hulaylah and neighbouring UAE lagoon sites during the time period of the above observations of *C. monalisa,* and are illustrated here. None, however, were present in association with *C. monalisa*:

Hypaetha schmidti W. Horn, 1927 (*Fig. 7*): The largest of the UAE's diurnal tiger beetles, a single individual was observed at Khor al-Beidhah, where it scoured an emergent sand bank featuring burrows and pellets of a pellet-rolling crab (probably *Scopimera crabricauda*), occasionally entering the crab burrows. It has been reported to feed on smaller crabs in Saudi Arabia (M.P.T. Gillett *pers. comm.*). At Khor Kalba, on the East Coat of the UAE, *H. schmidti* has been observed to forage along the line of the retreating tide, and also to enter small crab burrows.

Salpingophora hanseatica (W. Horn, 1927) (*Fig. 8*): Two individuals of this rare and relatively large species were recorded at Khor Zawra in Ajman, *ca*. 20 kilometres from Khor al-Beidhah, at mid-morning in mid-August 2013, on flat, firm, sandy mud in the uppermost intertidal zone, along with *Calomera aulica* (see below).

Calomera aulica (Dejean, 1831) (formerly *Lophyridia aulica*) (*Fig. 9*): This is the most common of the UAE's coastal tiger beetles, recorded on sandy or shelly mud at all of the Northern Emirates khors and on all of the occasions mentioned above. At Khor al-Beidhah, the populations of *Calomera aulica* and *Callytron monalisa* did not overlap. *C. aulica* frequented firmer, sandier substrate, typically with considerable gravel-size shell debris. Also *C. aulica*, unlike *C. monalisa*, remained active through the midday hours, although many individuals (including mating pairs) retired intermittently to the shade of saltbush vegetation.

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New records for the vascular flora of Jebel Hafit, Abu Dhabi Emirate

by Sabitha Sakkir and Gary Brown

Fig. 1. General view of Wadi Tarabat, where many of the new species were found. Jebel Hafit, 25/02/2007.

According to Brown & Böer (2005), the UAE and adjacent areas of Oman are home to 678 vascular plant species, of which about 400 occur in Abu Dhabi Emirate. Jebel Hafit is the most prominent landscape feature in the Emirate and a hotspot of biodiversity. A number of authors have contributed to a better understanding of the flora of this location, including Stuart & Stuart (1998), Jongbloed et al. (2000, 2003) and Western (1989). In a fairly detailed study of Jebel Hafit, based on their own experience and summarising the results of others, Brown & Sakkir (2004) listed 160 vascular plant species. This figure represents 40 % of the species known for the Emirate, underlining the conservation value of this impressive inselberg. Since this publication, the authors have conducted regular surveys on Jebel Hafit, resulting in the discovery of 46 new native plant species (Table 1). Voucher specimens of some of the species have been deposited in the herbarium at the Environment Agency, Abu Dhabi, others are available as high-quality photographic images, and some are shown below.

Eleven of the new records for Jebel Hafit are grasses (Poaceae). Many people experience problems with the identification of members of this family, although some of the species listed are quite distinctive. However, it can be challenging to distinguish *Schismus arabicus* from *S. barbatus*, and without experience, determination requires precise measurement of the minute floral structures.

Quite a number of the newly recorded species are desert annuals. As a consequence, they can be absent for many years and only appear, or are more conspicuous, in particularly wet seasons. Such species include *Astragalus eremophilus*, *Herniaria hirsuta*, *Hippocrepis constricta*, *Launaea* spp., *Lappula spinocarpos*, *Notoceras bicorne* and *Paronychia arabica* as well as the delicate grasses *Rostraria pumila*, *Schismus arabicus*, *S. barbatus* and *Tragus racemosus*.

Some of the newly recorded species are known from the vicinity of Jebel Hafit, but appear to have been overlooked on the mountain, probably because they are either rare or very local there. Typical representatives of this group are *Adiantum capillus-veneris*, *Cyperus conglomeratus*, *Dyerophytum indicum*, *Pteropyrum scoparium* and *Zilla spinosa*. Others are somewhat more remarkable because they have not been recorded from the vicinity, and are therefore of biogeographical interest. These include *Dipcadi biflorum* and *Schweinfurthia imbricata*.

A number of species listed in Table 1 have spread into the area due to increasing human encroachment,

such as *Erigeron bonariensis*, *Portulaca olereaca*, *Sonchus oleraceus*, and *Solanum nigrum*, as well as the halophytes *Bassia muricata*, *Cressa cretica*, *Salsola imbricata*, and *Suaeda aegyptiaca*. This latter group benefits in particular from disturbed irrigated areas.

The semi-succulent dwarf shrub *Tetraena qatarensis* (= *Zygophyllum q.*) is a poorly understood complex of closely related species, and is interpreted here to include *T. mandavillei*. This species occurs throughout much of the Emirate, where it is locally abundant, and has now been recorded at the base of Jebel Hafit. This species should not be confused with *Tetraena migahidii*, which is often lumped together with *T. qatarensis* even though it is a very distinct taxon (see Mandaville 1990). *T. migahidii* is locally common in rocky habitats on Jebel Hafit, especially at higher elevations, as reported by Brown & Sakkir (2004).

Launaea bornmuelleri (Hausskn. ex Bornm.) Bornm. is a new species for Jebel Hafit, but has not been included in the list, as it has been confused with the superficially similar *L. spinosa* in the past, a species that is now understood not to occur in the UAE or Oman at all (see Feulner 2011). *L. bornmuelleri* is widespread throughout the Hajar Mountains, also at higher elevations on Jebel Hafit. In the meantime, the identity of the *Echinops* species (referred to as "*Echinops* sp." in Jongbloed *et al*. (2003) and Brown & Sakkir (2004)) has been provisionally determined, and the species occurring in the area, including on Jebel Hafit, appears to be *Echinops erinaceus* Kit Tan, an endemic to the Hajar Mountains (see Feulner 2011).

Apart from the native species listed in this paper, some exotics have also gained a foothold on the mountain and are thriving, including the striking perennial *Asclepias curassavica*.

Table 1. Species recorded new for Jebel Hafit (since Brown & Sakkir 2004)

Pteridaceae (Ferns and fern allies)
Adiantum capillus-veneris L.

Asparagaceae (formerly Liliaceae)
Dipcadi biflorum Ghaz.

Cyperaceae
Cyperus conglomeratus Rottb.

Poaceae
Aeluropus lagopoides (L.) Trin.
Cenchrus setigerus Vahl.
Centropodia forsskaolii (Vahl) Cope
Cymbopogon schoenanthus (L.) Spreng.
Echinochloa colona (L.) Link
Enneapogon desvauxii P. Beauv.
Hyparrhenia hirta (L.) Stapf
Rostraria pumila (Desf.) Tzvelev
Schismus arabicus Nees
Schismus barbatus (L.) Thell.
Tragus racemosus (L.) All.

Aizoaceae
Aizoon canariense L.

Amaranthaceae (formerly Chenopodiaceae)
Bassia muricata (L.) Asch.
Salsola imbricata Forssk.
Suaeda aegyptiaca (Hasselq.) Zohary

Asteraceae
Atractylis carduus (Forssk.) C. Chr.
Centaurea pseudosinaica Czerep.
Erigeron bonariensis L.
Launaea capitata (Spreng.) Dandy
Launaea mucronata (Forssk.) Muschl.
Launaea procumbens (Roxb.) Ram. & Raj.
Pluchea arabica (Boiss.) Qaiser & Lack
Sonchus oleraceus (L.) L.

Boraginaceae
Heliotropium digynum Asch. ex C. Chr.
Lappula spinocarpos (Forssk.) Asch. ex Kuntze

Brassicaceae
Notoceras bicorne (Aiton) Amo
Zilla spinosa (L.) Prantl

Caryophyllaceae
Herniaria hirsuta L.
Paronychia arabica (L.) DC.

Convolvulaceae
Cressa cretica L.

Fabaceae
Astragalus eremophilus Boiss.
Hippocrepis constricta Kunze
Medicago laciniata (L.) Mill.

Plantaginaceae (formerly Scrophulariaceae)
Schweinfurthia imbricata A. Miller

Plumbaginaceae
Dyerophytum indicum (Gib. ex Wig.) Kun.

Polygonaceae
Pteropyrum scoparium Jaub. & Spach

Portulacaceae
Portulaca olereaca L.

Solanaceae
Solanum nigrum L.
Withania somnifera (L.) Dunal

Tamaricaceae
Tamarix aphylla (L.) H. Karst.

Zygophyllaceae
Tetraena qatarensis (Hadidi) Beier & Thulin
Tribulus pentandrus Forssk.
Tribulus terrestris L.

Fig. 2. *Lappula spinocarpos*, a small desert annual that was photographed in two separate years on Jebel Hafit. Jebel Hafit, 25/02/2007.

Fig. 3. *Dipcadi biflorum* is a particularly interesting find for Jebel Hafit. Jebel Hafit, 21/01/2010.

Fig. 4. *Schweinfurthia imbricata* is endemic to the Hajar Mountains and has only been recorded from relatively few locations there. Jebel Hafit, 26/02/2014.

Fig. 5. *Centaurea pseudosinaica* appears in small numbers in wet years. Jebel Hafit, 22/03/2005.

Fig. 6. *Tribulus pentandrus* occurs in Wadi Tarabat. Jebel Hafit, 22/02/2005.

Fig. 7. *Notoceras bicorne* is a desert annual that is otherwise fairly widespread in the Hajar Mountains. Jebel Hafit, 21/02/2010.

Fig. 8. *Hippocrepis constricta* is a small desert annual that is easily overlooked. Jebel Hafit, 21/03/2008.

Acknowledgements

SAS would like to thank Dr. Majid Sultan Al Qassimi (Director, Terrestrial Biodiversity Management Sector, Environment Agency, Abu Dhabi) and Dr. Shaikha Salem Al Dhaheri (Executive Director, Biodiversity Management Sector, Environment Agency, Abu Dhabi) for their support.

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New records of two species of Caryophyllaceae in the flora of the United Arab Emirates

by Mohammad Shahid & N. K. Rao

Silene arabica and *Vaccaria hispanica* of the family Caryophyllaceae are reported for the first time from the United Arab Emirates. The two species have been found growing on sandy soils in different parts of the country. *Silene arabica* was found in Dubai and Ra's al-Khaimah, while *Vaccaria hispanica*, the only species in its genus, was recorded in Ajman.

Caryophyllaceae, commonly known as the pink or carnation family, is a taxon of flowering plants that has about 89 genera and 3,000 species found worldwide, mainly in the temperate regions of the northern hemisphere. With around 700 species (Melzheimer, 1988), *Silene* is the largest genus of the family, which is most diverse in the Mediterranean region and the Middle East (Greuter, 1995). *Vaccaria* is a monotypic genus of Caryophyllaceae, comprised of the single species *V. hispanica*.

27 species representing 16 genera of the family have been recorded in different parts of the UAE (Western, 1993; Jongbloed, 2003, Karim and Fawzi, 2007), the majority having been recorded in the northern regions of the country. Of the 27 reported Caryophyllaceae species in the country, five belong to the genus *Silene*.

The two previously-unrecorded species from the family Caryophyllaceae, *Silene arabica* and *Vaccaria hispanica*, were documented by the authors during various surveys, with data on the plant populations and habitats based on field observations in the field. Identification and verification was undertaken through consultation of different pertinent floras (Chaudhary, 1999; Chaudhary, 2001; Daoud, 1985; Omar, 2000). Study of the relevant literature (Western, 1993; Jongbloed, 2003; Karim and Fawzi, 2007; Feulner, 2011) indicated that these two species of Caryophillaceae have not previously been reported from the UAE.

Fig. 1. *Silene arabica* plant in its natural habitat, February 2014 (Ra's al-Khaimah). In the UAE it flowers during February-April (Picture by M. Shahid).

Fig. 2. *Silene arabica* flower (Picture by M. Shahid).

Fig. 3. *Vaccaria hispanica* plant growing in sand, February 2014 (Ajman). It flowers in the UAE between February and April (Picture by M. Shahid).

Fig. 4. *Vaccaria hispanica* flower (Picture by M. Shahid).

Results

Silene arabica Boiss., Fl. Orient. 1: 593. 1867 (*Figs. 1 & 2*)

Synonyms: *S. affinis* Boiss., Diagn. Ser. 2, 1: 72. 1853; non Godr. Mem. Acad. Montp. 1: 417. 1853

Silene arabica was found in two different areas in the UAE. In Ra's al-Khaimah, three plants along a roadside (25˚37 839 N, 055˚49 162 E) were recorded, while a single plant was observed in Dubai (25˚08 055 N, 055˚22 747 E) growing under a *Prosopis cineraria* tree. Both of the areas where the species was noted had sandy soils.

The natural range of the species is considered to be West and South Asia where it is found in Sinai (Egypt), Israel, Jordan, Iraq, Iran, Afghanistan and Pakistan (Melzheimer, 1988;). In the Arabian Peninsula, it has been reported in Kuwait, Saudi Arabia and Qatar (Daoud, 1985; Chaudhary, 1999; Norton *et al*., 2009). The UAE is, therefore, the fourth country of the Peninsula where it has been found. Five different species of the genus *Silene* have previously been reported from the UAE, S. *arabica* therefore becoming the sixth.

Vaccaria hispanica (Miller) Rauschert, Feddes Repert. 73: 52. 1966 (*Figs. 3 & 4*)

Synonyms: *Saponaria hispanica* Miller, 1768, Gard. Dict. ed. 8, Saponaria no. 4 (in errata), 1768; *S. vaccaria* Linnaeus, 1753; *Vaccaria pyramidata* Medikus, 1789; *Saponaria oxydonta* Boiss., 1867

Vaccaria hispanica is found in parts of Africa, Asia and Europe. In the Arabian Peninsula, it has been reported in Saudi Arabia (Chaudhary, 2001), Kuwait (Omar, 2000), Qatar (Norton *et al*., 2009) and Yemen (Wood, 1997). A single plant of the species was recorded by the authors growing on sand along a roadside in the emirate of Ajman (25˚23 853 N, 055˚34 162434 E), a first record for the country.

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Furbelowed Watering-pots (*Brechites attrahens* Lightfoot, 1786) in Abu Dhabi

by Richard J. Hornby

Introduction

On two occasions since 2009, staff of Nautica Environmental Associates have discovered dead specimens of *Brechites attrahens* (synonym *Brechites vaginiferus*) while undertaking marine ecological surveys in the vicinity of Abu Dhabi Island. This is a very unusual bivalve mollusc that has the bizarre common name of Furbelowed Watering-pot. It is now considered to be a member of the family Penicillidae. This and the family Clavagellidae are the only two families that comprise the very unusual superfamily, Clavagelloidea, the taxonomy and evolution of which was discussed and revised by Morton (2007). The main distinguishing features of these animals is that they have lost the adductor muscles with which most bivalves open and close their shells. Instead, they grow an elongated calcareous tube which is the functional equivalent of a burrow. The anterior end develops into a rounded structure containing many holes and tubules, and which resembles the rose on a watering can. The other end grows into a series of frills or flounces, or, as used to describe features of ladies' dresses in Victorian Britain, furbelows.

Fig. 1 is a photograph of an intact specimen found in 2009 to the north of Sammaliah Island, near the Raha Beach development, east of Abu Dhabi Island.

Fig. 1. An intact Furbelowed Watering-pot

Fig. 2. The anterior end, showing the rose and, to the top-left of it, the original bivalve shell from which the tube grew.

Fig. 3. Furbelows of *Brechites attrahens*

Morphology and development

It has been established (Morton, 2002) that in normal life the animal lives vertically in soft sediment, usually in a shallow subtidal marine environment, with the anterior end (the "rose") pointing downwards, while the top of the furbelows are exposed above the surface of the sediment.

Larval forms of Clavagelloidea have never been described, but they are believed to be planktonic. After settling on a suitable surface, the animal develops into a conventional-looking bivalve with a diameter of about 4 mm. After a period of unknown length, the valves open and a calcareous "saddle" is produced. Out of this a calcareous ring grows and this then greatly elongates to form the long hollow tube in which the animal lives. Much of the length of the tube usually has a covering of sand grains and shell particles. In *Fig. 2*, the original bivalve shell is clearly visible attached to the outside, just above the 'watering-pot'. Also visible in this picture are the radiating hollow, tubules around the rose, like the petals on a daisy, and the protruding holes on the rose itself. This whole structure helps to stabilise the creature in sediment, but it also plays a very important role in feeding (*see below*).

It has been confirmed (Morton 2002) that the animal creates a hydrostatic pressure to draw in interstitial water through the holes and tubules of the watering-pot. This is pumped upwards, by regular contraction of the pedal disc, into the mantle cavity, where organic matter is extracted. The pumping also creates a reverse water movement which increases oxygenation of the sediment. Other species of benthic mollusc are able to utilise sulphur in anoxic sediments as an energy source as they contain symbiotic chemo-autotrophic sulphur-oxidising bacteria, but these are not present in members of the Penicillidae (Morton 2002). Positive hydrostatic pressure also extends the siphons which can be extended beyond the furbelows. It is also possible that hydrostatic pressure is manipulated to help maintain the animal in a vertical position.

It seems possible that the furbelows may represent annual growth periods, in which case the specimen in *Fig. 3* would have been seven or eight years old when it died.

Habitat and Status

Brechites attrahens is an Indian Ocean species with a wide distribution stretching at least from Western Australia to the Red Sea, but it is believed to be very rare wherever it occurs. Morton (2002) reports the discovery of living individuals of the species in Withnell Bay, Dampier Archipelago, Western Australia. Morton's paper describes for the first time the development, habitat and way of life of this species. Empty tubes and fragments were found mostly in coral sand at depths ranging from twenty metres to the mid-intertidal zone. Some were found living in exposed bedrock crevices but most were found in a stream riffle draining through the beach in which both temperature and salinity were above that of the ambient seawater. Tolerance of such conditions would clearly be advantageous in Abu Dhabi waters.

The only other paper we have found citing a "recent" discovery of the species was in the Gulf of Suez in 1988 (Gab-Alla, 1999). The species has not yet been evaluated for the IUCN Red List.

There seem to be no previous records of *Brechites attrahens* in the United Arab Emirates. In the most authoritative guide available, 'Seashells of Eastern Arabia' (1995), Bosch *et al*. give the distribution as being only Masirah Island, off the east coast of Oman. The species is not included in the first published lists of seashells of the region by Biggs (1973) and Smythe (1978), and nor was it present in the long but unpublished lists produced by Carolyn Lehmann (in 1994), Horst Kauch (in 1997), and the late Sandy Fowler up to about 2005. The species was recorded, however, by Stephen Green in 'Seashells of Bahrain' (1994), which states that broken shells were found at

four different locations in the north and east of Bahrain. Green gives a maximum length of 10cm. , which is about half the length of the one found near Sammaliah Island (*Fig. 1*). We have not found any records of the species in Saudi Arabia, Kuwait or Iran.

The species is so distinctive that it is not easily overlooked, so there can be no doubt that it is very rare around Arabia. It is possible that it no longer survives in the Arabian Gulf, as it is not possible to determine the age of the specimens we have found. We have never encountered a live specimen in any of the hundreds of marine ecological surveys we have conducted and none has ever been present in any of the thousands of infauna samples we have examined. On balance we feel that the species is probably still extant around Abu Dhabi, but at a very low density. There must be hundreds of square kilometres of potentially suitable habitat in Abu Dhabi, and a tiny proportion of this area has been examined by marine biologists or conchologists. The shells are too fragile to permit them to be tumbled along the seabed for long until they wash up on an accessible beach.

Smith (1976) noted that clavagelloideans are sparsely represented in museum collections, and added that they are rarely taken alive. Morton (2007) stated that "extant species are arguably, for obviously amazing shells, among the rarest of living animals. Dead specimens would normally become covered by accumulating sediment, and would be lost. Being very fragile, they would seldom survive intact when areas are disturbed by dredging or other forms of coastal development. The specimens found in Abu Dhabi in 2009 had been exposed *in situ*, and all the adhering sand and shell particles that had been present on the living animal, were still present. For these reasons, we believe that the shells are likely to be only decades old, possibly centuries, but not millennia.

Morton (2002) describes the appearance of the live 'watering-pots' in Withnell Bay. They were present at quite a high density (four to five per square metre) projecting by as much as 10 mm above the cobble surface "with bottle-green siphonal orifices sampling the stream water.

Presence in the UAE

The remains of about six dead specimens, including one intact one, were found near Sammaliah Island where they were being exposed by the meandering of a natural channel that drains water off several square kilometres of intertidal flats and mangroves. Lateral movement of the channel may have been stimulated by the dredging of a channel in 2008/2009 to improve boat access to Yas Island. When the watering pots were alive they must have been at the surface and able to filter-feed in open water, but they were subsequently buried by deposition of fine silt and sand. This is the material that was being eroded away by the flow in the channel. All the fine particles and small shells were being washed away, leaving behind debris of quite large shells. Some of the watering-pots were still vertical and half buried. It is estimated that something between 0.5 and 1 metre of sediment had been eroded away by water movement.

Some information on this discovery of *Brechites attrahens* was presented in *Focus*, the newsletter of the Emirates Natural History Group**,** ENHG, in 2010 with an appeal for further information, but none has been received. If the species still survives in the UAE, it must be very rare and possibly restricted to very inaccessible places. Discovery of a living colony would be a notable achievement, and discovery of the as-yet-unknown larval and juvenile forms would add considerably to our knowledge of these highly unusual animals.

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Records of Dhofar toads *Duttaphrynus dhufarensis* from Al Ain, Abu Dhabi Emirate, United Arab Emirates

by Pritpal S. Soorae, Arshad Toosy & Mohammed Al Mehairbi

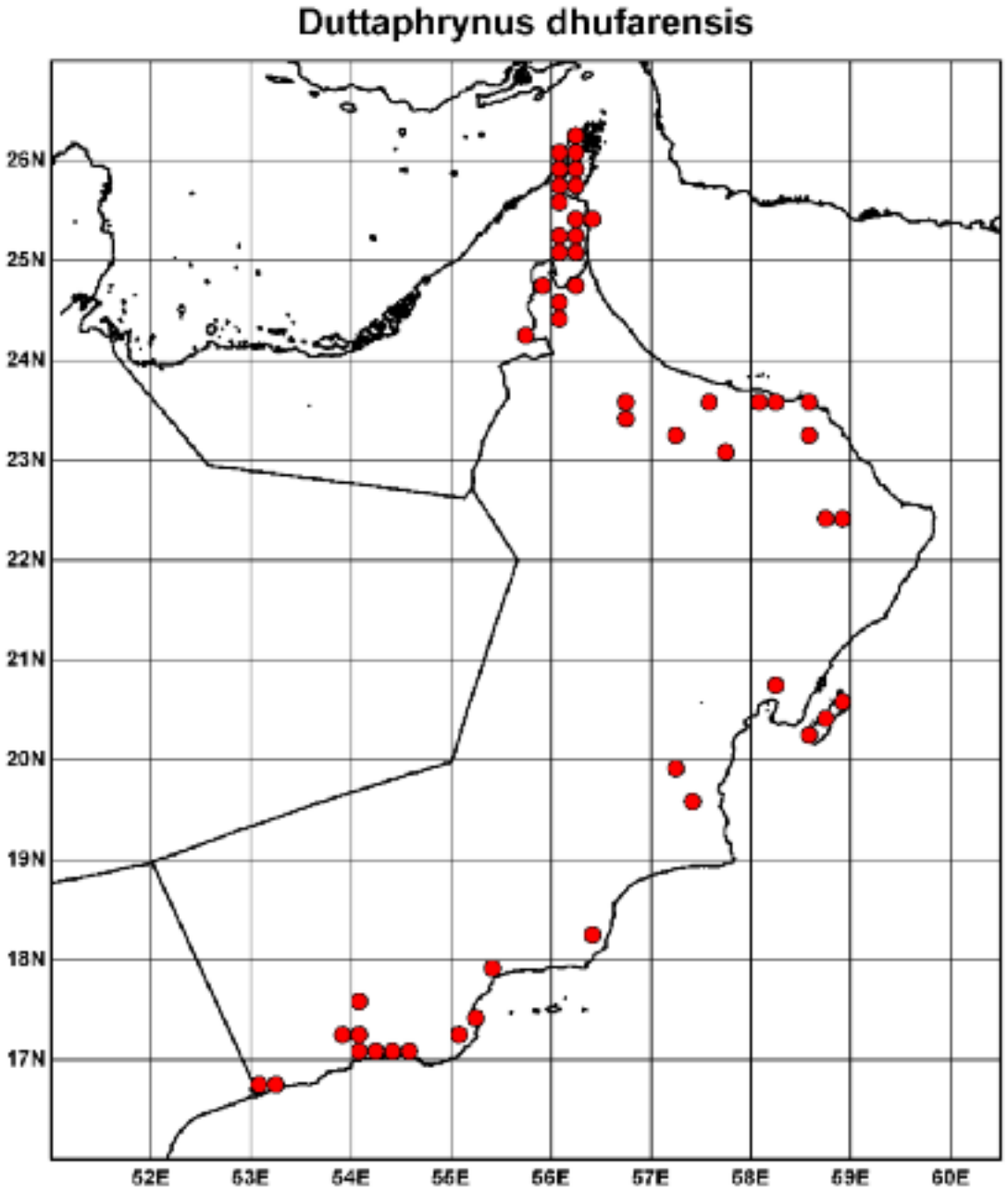
Introduction

Two amphibian species are recorded in the United Arab Emirates, UAE, the Dhofar toad *Duttaphrynus dhufarensis* and the Arabian toad *Duttaphrynus arabicus*. Dhofar toads can usually be found further away from permanent water sources whilst Arabian toads are usually restricted to areas near water. The distribution of both species in the UAE is mainly confined to the wadis of the Northern Emirates. The known distribution of the Dhofar toad in the UAE and Oman is shown in *Fig. 1*.

Fig. 1. A gravid female Dhofar toad in Wadi Al Ain

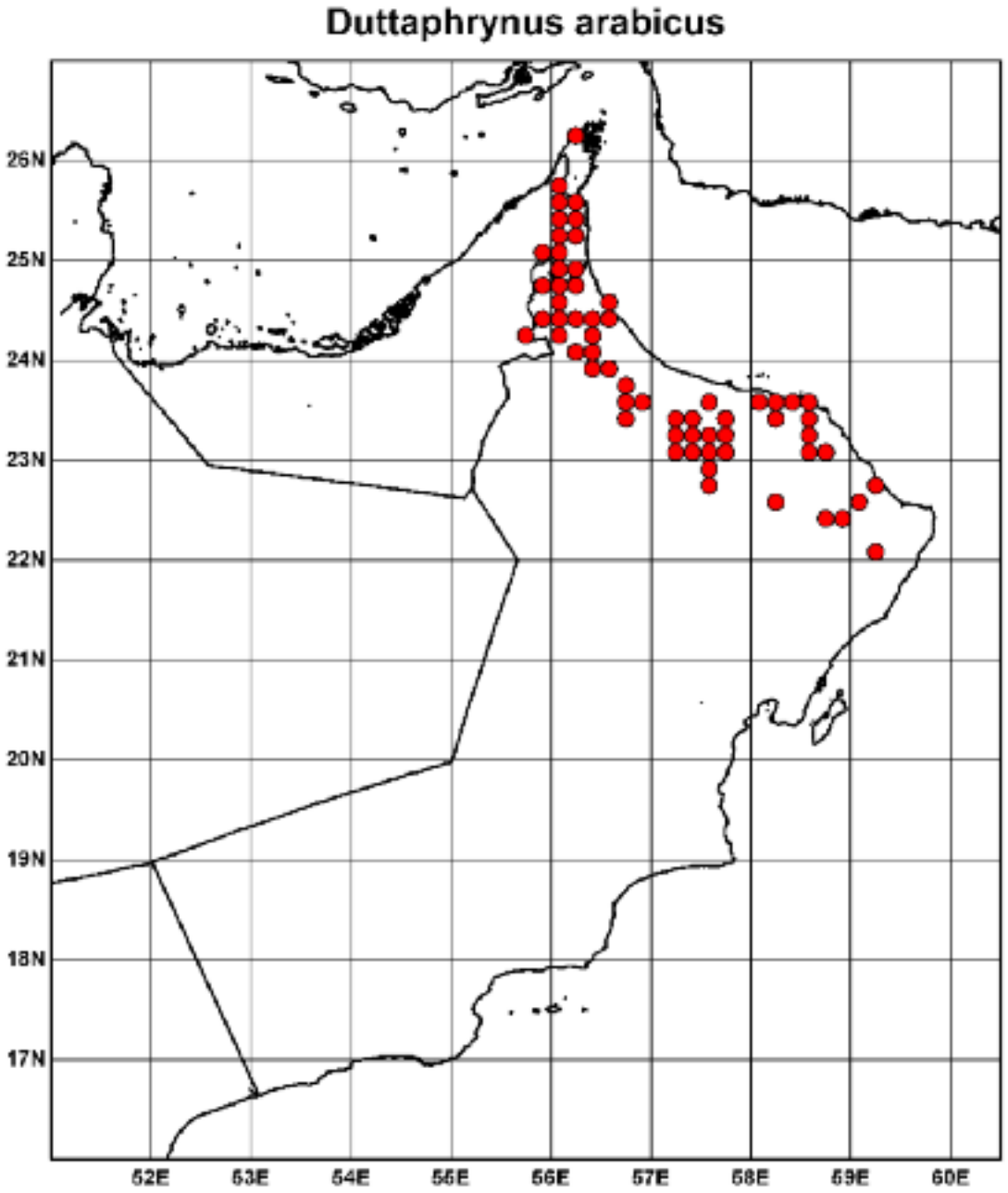
Dhofar toads in Wadi Al Ain

Dr. Arshad Toosy, Manager Veterinary Operations, Al Ain Zoo, had reported that he had seen a toad during 2010 and had heard toads calling in Wadi Al Ain, which runs through the Zakher area of Al Ain city. A daytime survey was done in the Wadi Al Ain on 14 February 2011 and no presence of toads was recorded. On 3rd April 2011 at 19:30 hrs a gravid female was recorded next to Wadi Al Ain at N24.201941°, E 055.726632° by Arshad Toosy as shown in *Fig. 1.* The *wadi* was again searched on 4 April during the morning hours and no further presence of toads was recorded. On 16 April 2011 at 22:15 hrs the *wadi* was checked again. On arrival, toads could be heard croaking in the *wadi* from a distance of at least 150 m. Upon inspection, at least four Dhofar toads were recorded in an area centred on the following location N24.202052°, E055.723477°. This area was searched again on 17 April 2011 at 22:00 hrs. No toads were heard calling and no tadpoles or egg masses were observed in the water. Water had been observed flowing in this *wadi* since February 2011., this appearing to be the run-off from nearby irrigation. There were also *Tilapia* fish present in the water, these being visible along the length of this *wadi.*



Acknowledgements

We would like to thank the Environment Agency - Abu Dhabi, EAD, and the Management of the Al Ain Zoo for their support for biodiversity research in Abu Dhabi emirate.



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Observations of waterscorpions (Insecta: Heteroptera: Nepidae) in the Nizwa area, northern Oman

by Peter J. Cowan and Elaine M. Cowan

Waterscorpions are heteropteran bugs of the family Nepidae. All nepids have a slender non-retractable respiratory tube arising from the posterior end of the abdomen. It penetrates through the water surface for breathing. Although all species in this aquatic family are referred to as waterscorpions, there are several body types. The two extremes are the broad flat leaf mimics (Nepini, the waterscorpion body shape proper) and the elongate stick mimics (Ranatrini, the water stick-insects). The three other tribes have shapes intermediate between the two extremes (Keffer 2004).

Only one nepine species has been recorded from the Arabian Peninsula, *Laccotrephes fabricii* Stål, 1868 (Linnavuori *et al.* 2011). Walker and Pittaway (1987) used the English name 'Stretched Water Scorpion' for *L. fabricii,* mapping its occurrence in the central, western and southwestern Arabian Peninsula through the Yemen to southern Dhofar. However, it may well be locally common in the Hajar mountains and adjoining areas of the UAE and Oman (Gillett and Gillett 2005, Gillett and Howarth 2004, Jongbloed 1991, Linnavuori *et al.* 2011).

We found water scorpions, presumably *Laccotrephes fabricii*, on four occasions in the Nizwa area of northern Oman. The first was a dead individual (*Figure 1*) on 17th February 2010 at the swimming pool of the Golden Tulip hotel (22° 55.5' N, 57° 37. 1' E, 560 m asl), west of Birkat Al Mouz and in the foothills of the Jebel Akhdar range of the Hajar mountains. We found an individual (*Figure 2*) in a small temporary pool (23° 6.0' N, 57° 25.4' E, 1400 m asl) above Tanuf in the Jebel Akhdar on 25th March 2010. Our final two records came from the, apparently permanent, wadi 'dragonfly pool' (23° 4.5' N, 57° 21.6' E, 680 m asl) between Al Hamra and Tanuf in the Jebel Akhdar foothills (Cowan and Cowan 2013). The third record (*Figures 3–8*) was an individual on 23rd April 2014, whilst the fourth (*Figure 9*) was on 2 June 2014. The figures depict well the raptorial forelegs, flat body and that the respiratory tube is of two longitudinal halves. *Laccotrephes fabricii* is a large ambush predator, body length 38–45 mm without the respiratory tube (Linnavuori *et al.* 2011).

Figures 3–6 and *9* show a waterscorpion out of the water. In Figure 5 the wings are slightly unfurled whilst *Figure 6* shows the hindwings exposed. The waterscorpion entered the water (*Figures 7* and *8*). We did not see it fly. A reviewer of the original draft of our note made the point that flight would be a likely way for waterscorpions to move between and colonise pools in this arid environment. However, Walker and Pittaway (1987) stated that *Laccotrephes fabricii* cannot fly "and is consequently confined to permanent bodies of water…" Another member of the tribe Nepini is *Nepa cinerea*. Most individuals of the latter waterscorpion "are unable to fly as the flight muscles are poorly developed, but occasionally they do fly, in order to colonise new ponds" (ARKive).

Our observations indicate that *L. fabricii* can, indeed, be found in isolated and temporary water bodies, *contra* Walker and Pittaway (1987). The next challenge, therefore, is to observe and photograph a flying specimen!

Fig. 1. A dead waterscorpion at the swimming pool of the Golden Tulip hotel, west of Birkat Al Mouz, 17 February 2010. [All pictures by EMC.]

Fig. 2. A waterscorpion in a small temporary pool above Tanuf in the Jebel Akhdar range of the Hajar mountains, 25th March 2010. The respiratory tube appears damaged.

Fig. 3. A waterscorpion, out of the water, at the wadi 'dragonfly pool' between Al Hamra and Tanuf, 23rd April 2014.

Fig. 4. The waterscorpion, out of the water but on a different rock (Figure 3).

Fig. 5. The waterscorpion, out of the water and wings slightly unfurled.

Fig. 6. The waterscorpion, out of the water and wings more unfurled exposing the hindwings.

Fig. 7. The waterscorpion, in the water but at the surface.

Fig. 8. The waterscorpion, in the water with respiratory tube penetrating the surface.

Fig. 9. A waterscorpion, 2 June 2014, almost out of the water at the wadi 'dragonfly pool' between Al Hamra and Tanuf.

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Establishing a chronology for Holocene climate and environmental change from Mleiha, Sharjah, United Arab Emirates

by Adrian G. Parker, Frank Preusser, Joachim Eberle, Sabah Jasim and Hans-Peter Uerpmann

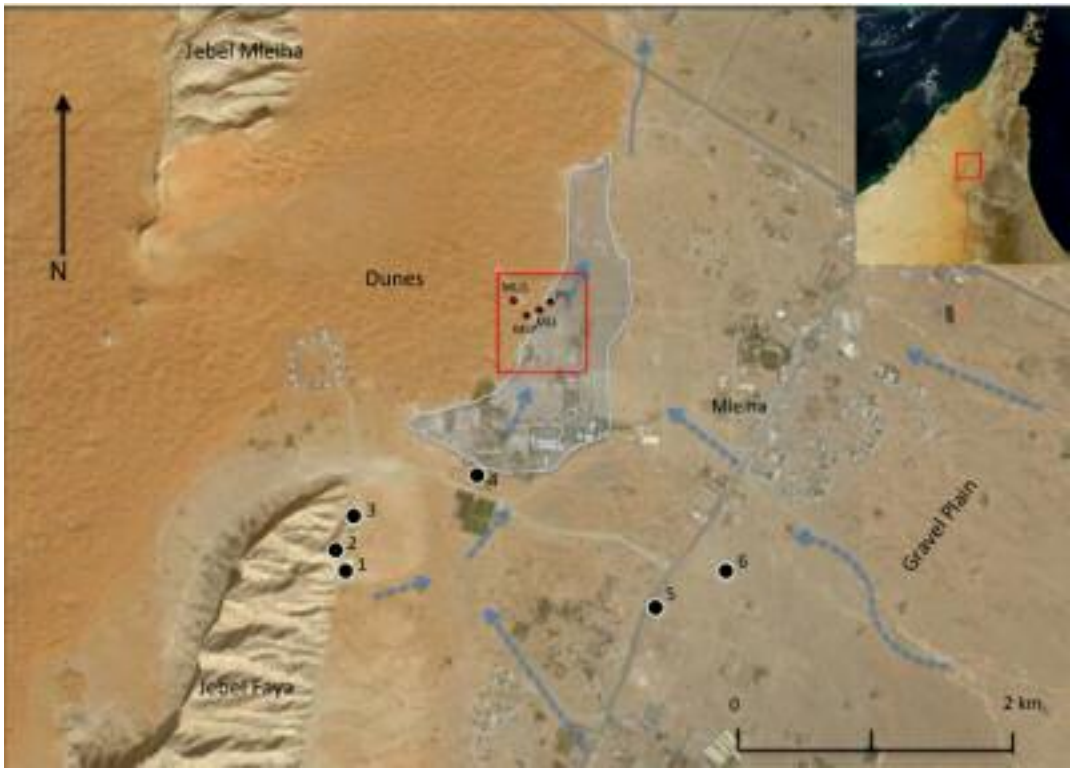

Fig 1. The study area near Mleiha, Sharjah, UAE. Key archaeological sites are denoted by the numbered black dots. 1= Jebel Faya FAY-NE01 Palaeolithic, Neolithic; 2=Jebel Faya FAY NE10 Neolithic; 3= Jebel Faya FAY NE15 Neolithic cemetery; 4= Umm an Nar tomb; 5 and 6 Mleiha period Late Pre-Islamic forts. Image courtesy of Google Earth. Topographic depression marked as lacustrine and fluvial silts is highlighted in light blue. The location of the sample test pits marked in the red square. Direction of drainage shown by arrows.

Introduction

The Arabian Peninsula is located at the interface between the Indian Ocean Monsoon (IOM) and Mid-Latitude Westerlies (MLW), which are two of Earth's most dynamic climate systems (Parker *et al*., 2006; Fleitmann *et al*., 2007). The interplay between these two systems over the last 11,000 years (the Holocene) has had a profound impact on the landscape of the region as well as playing a key role in the development of human societies during the Holocene period.

Palaeoclimatic records from the region indicate that the early Holocene (11,000 to 6000 years ago) experienced wetter climatic conditions via monsoon rainfall whereas from the mid-Holocene (6000 BP) to the present there was a change to increasingly arid conditions with an adjustment to the Westerly dominated climate system. The Holocene epoch has also been punctuated by a series of abrupt climatic events with several phases of hyper-aridity, which have coincided with changes observed in the archaeological record (Parker *et al*., 2006; Preston *et al*., 2012). To date, only a few fluvial or lacustrine records covering the early to mid-Holocene period from the region have been studied. Little or no information is available for the late Holocene from these geoarchive types (Parker and Goudie, 2008). Several studies have identified phases of dune emplacement across the United Arab Emirates (UAE) sector of the Rub al-Khali sand sea; these are linked to changing aeolian dynamics across the landscape during the Holocene (Atkinson *et al*., 2012; Leighton *et al*., 2014).

The purpose of this ongoing study is to analyse sediments from geoarchives from the interior of SE Arabia in order to determine and build the past climatic context of the area against which the archaeology can be set. The Mleiha region of Sharjah Emirate (*Figure 1*) provides a unique record for human occupation spanning the last 125,000 years from the Palaeolithic through to the modern day (Armitage *et al*., 2011; Uerpmann *et al*., 2013; Mouton, 1999).

Study location

The Jebel Faya anticline forms a narrow, discontinuous bedrock ridge, which extends approximately 30 km from Jebel Buhais in the south, through Jabel Faya, Jebel Mleiha, and Jebel A'zab to Sha'biyyat As Saman, a few kilometres south-west of Dhaid. This range reaches a maximum height of 407 m asl on Jebel Mleiha, becoming smaller, and more fragmented further north where it forms a series of small rocky outcrops between the dunes. The Faya range is predominantly formed of Cretaceous strata, comprising limestones and conglomerates of the Qahlah, Simsima and Muthaymimah formations. Outcrops of serpentinite, belonging to the obducted Oman-UAE ophiolite, outcrop in places along the Faya range (Farrant *et al*., 2006).

An extensive series of low angle *bahadas*, (alluvial plains formed along the mountain front as a result of the lateral growth and coalescence of adjacent alluvial fans), extend out between 10 and 16 km from the front of the Hajar Mountains across the Mleiha-Madam plain. These are dominated by ophiolite-rich gravels that spread out towards the Faya range where alluvial channels merge into wadi systems. Two major drainage systems have developed in the Faya area (Farrant *et al*., 2006; Parton *et al*., 2013). The southern system cuts through the Faya range, between Jebel Aqabah and Jebel Faya, and merges into Wadi Iddayyah – Batha Ar Rafi'ah. The northern drainage system flows towards Jebel Faya and Jebel Mleiha and is deflected northwards towards Sha'biyyat Milehah. The alluvial fans in this part of the system extend as far as Dhaid, where they merge into a series of channels, which converge at Falaj al-Mo'alla to form Wadi Madsah.

The study site (*Figure 1*) is a topographic depression (Lat/Long N25°08'20.83" E055°51'44.64") to the west of Mleiha, close to Jebel Faya and Jebel Mleiha, which is filled with fluvial, lacustrine and aeolian sediments. These sediments were identified as part of the University of Tübingen-Sharjah archaeological research project, led by Prof Hans-Peter Uerpmann and Dr Sabah Jasim, and provide an extensive chronological sequence spanning the mid to late Holocene period. A wadi channel incised into these sediments has led to several exposures that were sampled in 2010. The depths of natural sediment exposures were extended using test pits. In addition, quarrying for sand in the area for construction purposes has led to several sediment exposures through the dune-sequence overlying the lacustrine silts and fluvial gravels which extend laterally beneath the dunes. Initial findings from four test sections (MLQ, MLP, MLL and P0) are reported here (*Figure 2*). Several other sections are currently being studied and details will be reported in full at a later date.

This work provides the first insights into climate change, environmental processes and landscape dynamics against which human occupation of the landscape of the Mleiha region can be set. Key methods are being used to understand how changes in rainfall and aridity have varied over the time using physical, chemical and biological analyses.

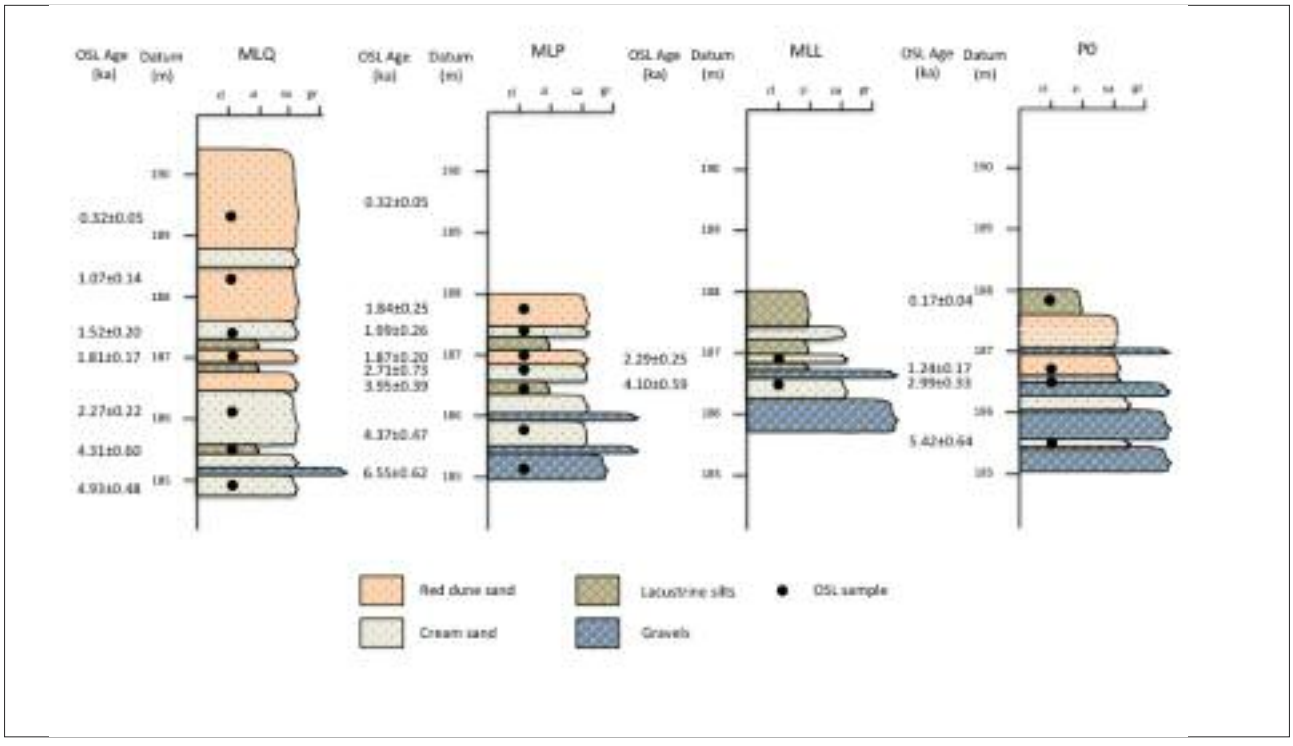

Fig 2. Stratigraphic sections from Holocene sediment exposures at Mleiha, Sharjah. Heights shown in arbitrary datum

Results and discussion

Twenty samples were dated using Optical Stimulated Luminescence (OSL) dating from four key sediment sections (Figure 2). Preliminary results suggest the following sequence of events is recorded within the examined sediments. A series of basal gravels were noted in three of the sediment test pits (MLP, MLL and P0). It should be noted that these gravels were not bottomed. The coarse grained layers in the lower sections of these three profiles show clear features of fluvial deposition via episodic sheet floods or shallow water channels from the Hajar Mountains transporting the predominantly ophiolite-rich material. An OSL age of 6.55±0.62 ka (4550±620 BC) was determined towards the base of test pit MLP. The sedimentation of fluvial dominated deposits was interrupted in the Middle Holocene at 5.42±0.64 ka (3420±640 BC) (P0). During the Neolithic, wetter conditions than today have been recognised across south-eastern Arabia. During this period monsoonal rainfall led to the development of lakes and active channel flow in wadis across the region with evidence for grassland covering the dunes of the Rub al-Khali in the region between 8.50 – 6.00 ka (6500-4000 BC) (Parker *et al*., 2006; Parker and Goudie, 2008). Evidence for Neolithic occupation of the landscape around Mleiha has been identified from a number of important stratified and dated archaeological sites. Along Jebel Faya, key sites include FAY NE15, which comprised stratified sediment sequences containing lithics, animal bone and human remains from a cemetery site adjacent to a small wadi which drains from Jebel Faya into the Mleiha plain basin (Kutterer and de Beauclair, 2008). In addition, a sequence of Neolithic occupation has been noted at the FAY NE01 and FAY NE10 sites (Uerpmann *et al*., 2013) and at an extensive cemetery site at Jebel Buhais (Uerpmann *et al*., 2006).

Aeolian cream-coloured sands, dating to the Bronze Age, 4.30-4.10 ka (2300-2100 BC), were found overlying the gravels in three of the test pit sections (MLQ, MLP, MLL). It is possible that sediments dating to this period also exist in test pit P0 but no dates were made on sediments of this age. These dates correspond to a regionally identified phase of aridity, which has been interpreted from sand infilling the desiccated lake basin at Awafi, Ra's al-Khaimah (Parker *et al*., 2006) and a major phase of dune accumulation near Al Ain, where 7 m of emplacement occurred between 4.30 and 4.00 ka (2300-2000 BC) (Atkinson *et al*., 2012). Three phases of ponded lacustrine sedimentation were identified at Mleiha and dated to ~ 4.00 ka (2000 BC), 1.80 ka (AD 200) and 0.17 ka (AD 1830) respectively. In test pit MLP the uppermost lacustrine layer (~187.1 m OD) contained Late Pre-Islamic Mleiha period pottery. The OSL ages for lacustrine silts across the sections broadly fit into the Late Iron Age/ and PIR or pre-Islamic recent or Late Pre-Islamic periods. No other lake sites have been identified from elsewhere in the region dating to this period. This provides the first terrestrial palaeoenvironmental record from SE Arabia spanning this period. These lacustrine silts extend laterally westwards and are overlain by red aeolian dunes up to 8 m high. These dunes show rapid dune encroachment over the site during the last 1500 years. At Mleiha, a major inland settlement was present during the pre-Islamic recent period. Between the 3rd century BC and the 4th century AD two substantial mud-brick forts and dozens of houses and burials are known to have existed (Benoist *et al*., 2003). Kennet (2005) suggests that by the 3rd century AD occupation had declined and that by the 5th century the site was deserted altogether. In addition to the decline of settlements across SE Arabia at this time, Kennet suggests that there is evidence for a wider economic decline during this period. The cause for this decline is uncertain. However, the pattern of reduced settlement that began after the first or second centuries AD and continued until the seventh century AD may have been linked to the severe droughts identified by Fleitmann *et al.* (2009) from a speleothem record from Hoti Cave in the Hajar Mountains of Oman. This 2,600 year long record spans the Iron Age, Late Pre-Islamic and Islamic periods. The speleothem record indicates changes in rainfall across the region with several pronounced periods of drought. Of note is a decline in rainfall between AD 500 and AD 1,000 with an intense drought occurring around AD 530 (Fleitmann *et al*., 2009). During this period, a series of profound societal changes have been suggested from Arabia. Of note is the transition between the Late Pre-Islamic and Islamic periods within the archaeological record. The development of lacustrine sediments at Mleiha may help explain the inland expansion of Late Pre-Islamic period influence due to increased water availability.

The decline of the Late Pre-Islamic sites at Mleiha may be linked to increased aridity and major drought, as identified in the Hoti Cave speleothem record, which led to major changes in water availability, desiccation of the water body and the onset of major dune reactivation and migration across the Mleiha landscape. The ongoing work at Mleiha is crucial for understanding the climate and landscape record through time and how this may have impacted human occupation as identified in the archaeological record.

Acknowledgements

Funding to support the dose rate calculations for the OSL dating was kindly provided the Emirates Natural History Group (ENHG) and the British Foundation for the Study of Arabia (BFSA).

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A lost Islamic inscription from Wadi Duwaini, Fujairah

by Peter Hellyer

Introduction

The presence of petroglyphs (rock art) in the mountains of the United Arab Emirates has been well documented, with several publications in academic journals, the most comprehensive lists having been recorded by Dr. Michele Ziolkowski (Ziolkowski 1998, 2007; Ziolkowski & Mohammad Hasan, 2000). They are known from throughout the mountains, some close to existing or abandoned villages and some in other locations where they may have served as territorial markers. While definitive dating is not possible, a comparison of the range of geometric, anthropomorphic and zoomorphic designs with finds from archaeological excavations suggests that, while many are probably from the Islamic period, some may date from the local Iron Age, c. 1,300 – 300 BC, and perhaps earlier.None have yet been reported in early Semitic languages, predating the emergence of Arabic. Several Arabic inscriptions have also been reported, though few have been published.This note describes one such rock inscription in the Emirate of Fujairah that has now been destroyed.

The Wadi Duwaini inscription

The inscription was on a large rock in the middle of the col dividing the upper (eastern) end of Wadi Duwaini from the steep hillside running down to the coastal plain, just north of the Port of Fujairah, where an oil refinery and several oil storage tank farms are now located. It was identified in 2007 by PH and Nasr Abdulrahman during an archaeological baseline study undertaken for the IPIC oil pipeline from Habshan (Abu Dhabi) to Fujairah, and was allocated a temporary site number of SAF(D)-5, i.e. Safad(Duwaini) (Hellyer 2008). The location was recorded by a hand-held GPS, in WGS 84, decimal degrees, format, as N 25.21430 / E 056.33742. Wadi Duwaini is the last tributary to join Wadi Safad, from the south, before the latter proceeds roughly northwards to emerge onto the coastal plain at the town of Qidfa. Prior to the introduction of motor transport into the UAE's East Coast, the route over the col would have provided shorter and quicker access to and from the coastal plan, whether on foot or by donkey, than the lower reaches of Wadi Safad.The large rock on which the inscription was situated, at the

top of the col, would, therefore, have served as an important marker on the trail – perhaps the reason why it was chosen as a site for the inscription.The inscription, in Arabic, is an incomplete Islamic *fateha*, (declaration of faith) with the underlined words being clearly visible.

La ilaha illa ***Allah wa-Muhammad rasul Allah***

لا إله إلا الله محمد رسول الله

i.e. *There is no god but Allah, and Mohammed is the messenger of Allah.*

It is not possible to ascribe any possible date to the inscription, other than the fact that it must, of course, date to the Islamic period. Moreover, since the inscription has been destroyed, as well as the area in which it was located, any further studies, such as a close re-examination of the inscription or more survey work in the immediate vicinity, are no longer possible.As noted above, the rock on which the inscription was located was on the most direct route from Wadi Safad, through Wadi Duwaini, to the coastal plain. It is appropriate, therefore, to summarise other archaeological evidence from the Islamic period in the general vicinity, some of which has also now been destroyed. In Wadi Duwaini, sites recorded during the 2007 survey include an undated petroglyph, several scatters of pottery from the Late Islamic periods and a small scatter of pottery from the mid-Islamic period (15th-17th Century), associated with rudimentary stone structures, along the most convenient walking route from Wadi Safad via Wadi Duwaini to the col on which the Islamic inscription was located and thence to the coastal plain. A long-abandoned Islamic period settlement was identified near the head of Wadi Duwaini during further survey work in early 2012. Numerous archaeological sites have been recorded in Wadi Safad itself, which stretches for over fifteen kilometres inland. Those sites upstream from the confluence with Wadi Duwaini include small abandoned settlements from the Islamic period and extensive terraced field systems, particularly in the vicinity of the hill-top fort, Husn Safad, where initial activity has been tentatively dated to a period between the 16th and 17th Centuries AD (Longden and Garfi, 2000. p, 7).

An Islamic inscription is also present at Husn Safad. It is on a large rock located on the hillside below the walls of the fort and above the adjacent wadi bed, situated at N 25^0 E 56^0

This includes the following words:
La ilaha illa Allah (there is no god but Allah)

Muhammad Rasul Allah. Salla Allahu 'alayih wa-Sallam (Muhammad the messenger of Allah, may Allah pray upon him and give him peace)

(Ziolkowski 2002; Appendix VI, Inscriptional Evidence. p. 1)

It is possible that this, as well as the now-destroyed inscription, may have been made when the hill-fort at Husn Safad was occupied.
It is clear that there was formerly a local tradition of inscribing religious phrases on rocks, on occasion along well-travelled routes.
Michele Ziolkowski has recently (2013) recorded another Arabic inscription in the vicinity of the village of Nahwa, an enclave of the Emirate of Sharjah within the larger Omani exclave of Wadi Madha, a few

The Husn Safad inscription (Picture by Michele Ziolkowski)

kilometres north of Wadi Safad and Wadi Duwaini, while Mohammed al-Madhani, a resident of Wadi Madha, has amassed a small collection of rocks with Arabic inscriptions (Ziolkowski, *pers. comm.*). These have not yet been translated or published.

To the south, another was recorded by Bertram Thomas, Finance Minister and Wazir to the Sultan of Muscat and Oman, now the Sultanate of Oman, between 1925- a tributary of the Wadi Qawr, being described as follows: "I later saw some rough boulder inscriptions in Wadi Ghaf, an affluent of Wadi Qaur… ……" "….one of the glazed red boulders so inscribed bears the words 'There is no God but God, Muhammad is the Prophet of God', in angular, almost Cufic character." (Thomas 1931, p. 198).

Well to the north of Wadi Safad, another inscription, translated as 'There is no god but Allah", is present, superimposed on other motifs, on a large rock at Hasat al-Risoom which was formerly used as a marker on a route known as Tareeg al-Boshe (literally 'the road for camels') used for journeys through the mountains between Dibba and the plains on the western side of the Hajar Mountains (Ziolkowski & Mohammad Hassan (2000), p. 265)

The Wadi Duwaini inscription and the majority of the other sites in the Wadi Duwaini mentioned above were identified, as noted earlier, during an archaeological baseline study conducted as part of planning for the construction of the Habshan-Fujairah oil pipeline.

The report on that study (Hellyer 2008) recommended that the inscription should be properly studied and that the rock should be moved, since it lay directly on the route of the pipeline. Unfortunately the contractors preparing the right of way for the route commenced work without receiving final authorisation to do so, and the rock on which the inscription was located was bulldozed down the steep outer slope facing the coastal plain. Subsequent efforts to remove the bulldozed material, in the hope of finding the rock, even if in fragments, were unsuccessful.

The photograph accompanying this paper is, therefore, the only surviving evidence of the inscription.

Acknowledgement

I am grateful to Dr. Michele Ziolkowski, author of numerous studies on the petroglyphs of the UAE's mountains, for her comments on drafts of this paper, for sharing unpublished information from her own work, for drawing my attention to the report by Bertram Thomas, and for her much valued, and far-too-rare, company in the field.

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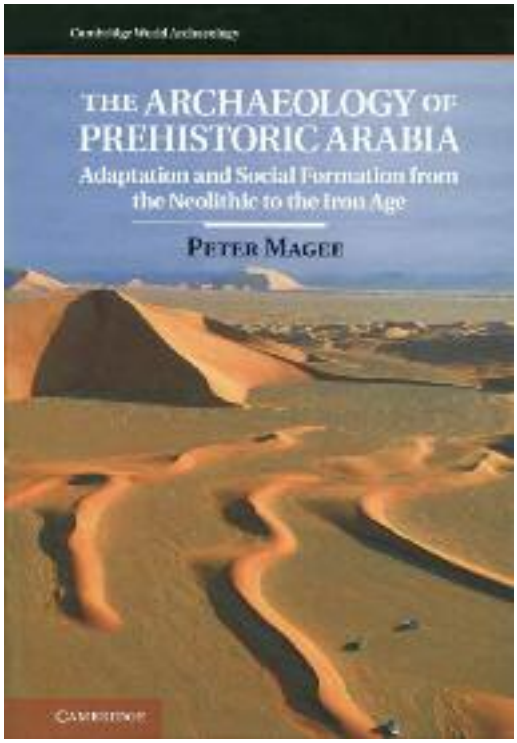

The Archaeology of Prehistoric Arabia: Adaptation and Social Formation from the Neolithic to the Iron Age.

By Peter Magee. Cambridge University Press (2014). ISBN: 978-0-521-86231-8. (Cambridge World Archaeology series).

It will be no secret to readers of *Tribulus* that over the past couple of decades an enormous amount of new information about the archaeology of the United Arab Emirates has been revealed. With a dozen or more foreign academic teams working in the UAE every year, along with the efforts of local antiquities departments, some excellent and some less so, the information revealed by their excavations has revolutionised our understanding of the UAE's past. In 1998, I gave my book on the initial work of the Abu Dhabi Islands Archaeological Survey, ADIAS, the title of *"Filling In The Blanks"* because that was what it set out to do – to report on archaeological discoveries in an area which, up until then, had been little studied and could, therefore, be described, with some accuracy, as a blank space on the map of Arabia's history.

Although much work had already been done by the mid-1990s elsewhere in the UAE, much more has followed over the course of the last twenty years, with numerous sites, of great importance, having not only been excavated but also, importantly, published. Through publications such as the *Proceedings* of the 1st and 2nd International Conferences on the Archaeology of the UAE and of the annual Seminar for Arabian Studies in London, as well as through journals like *Arabian Archaeology and Epigraphy*, (as well as through occasional papers in *Tribulus*), we now have a much greater degree of knowledge about the UAE's past that would have seemed possible only a few years ago, even if there are still blanks which need to be filled in.

This process of archaeological discovery and interpretation has not been confined to the UAE – it has been under way throughout the Arabian peninsula, from the northernmost reaches of Saudi Arabia to the coastline of Oman and from the mountains of Yemen and their hinterland to the islands offshore Kuwait. This has shown, clearly, that the peninsula, far from being a huge mass of uninhabitable sandy and gravel desert, surrounded by habitable coastal fringes, has historically been an area with a shared and distinct history.

Yet, since the publication of *"The Arabian Gulf in Antiquity"*, a two-volume masterpiece by Professor Dan Potts, in 1990 & 1991, there has been no serious attempt to bring together the ancient history of the peninsula as a whole. Indeed, that book itself confined its scope to eastern and south-eastern Arabia, although commencing with the Pleistocene.

At last, however, that gap in the literature has been filled with this book by Professor Peter Magee of Bryn Mawr College in the USA, a former student of Potts who first worked in the Emirates over 20 years ago and has been responsible for the excavation of the important Iron Age site at Muwailah and for recent excavations at the multi-period site at Tell Abraq. *"The Archaeology of Prehistoric Arabia"* seeks to introduce and explain the history of the peninsula since the beginning of the Neolithic period, around 9000 BC, to the Iron Age, to around 800 BC.

One key theme in the book is that, contrary to common belief, there is enormous ecological and environmental diversity within the peninsula and that this diversity has itself been subject to substantial change over millennia. Arabia has highlands and lowlands, and, thanks to fluctuations in the global climatic systems, has at times enjoyed, in some areas at least, periods of extensive rainfall, such as during the Holocene Moist Phase, when large lakes were to be found in the deserts we know today. The human population has needed to learn not only how to make use of the available resources in this environment, but also to adapt to the changes in resources. This, Magee notes (p.45) "required highly adaptive resource procurement strategies that in turn fuelled unique social and economic lifeways." From the early Neolithic / Holocene, he traces how "these cultural systems were renegotiated and reconfigured through subsequent millennia as the inhabitants of Arabia further adapted to a changing landscape contained ever-sharply defined resources as well as the potential action with numerous neighbours." (p.45).

Helpfully, Magee divides his work not only chronologically, but also geographically, with the

peninsula being broadly split into east and south-eastern Arabia, the south west and the north-west, allowing those who wish to do so to jump, for example, from the UAE and Oman in the Neolithic period to the Bronze Age that followed. By doing so, however, they will miss the evidence presented from other parts of the peninsula and, importantly, the data that indicates not only the developments in each region, but also how they are inter-related. Thus, having mentioned the development of the *falaj (aflaj)* system of irrigation in south-eastern Arabia early in the Iron Age – which he stresses, correctly, occurred here first, much earlier than in Iran - he then mentions the probable existence of *aflaj* in the northern Arabian oasis-settlement of al-Ula, arguing that, since the dromedary had already been domesticated by this time, "it cannot be ruled out… that the technology was introduced into northwestern Arabia at this time." (p. 256). This is only one example of the many links between the various Arabian civilisations put forward by Magee as evidence of the inter-connections that existed.

Some of his conclusions will startle those archaeologists whose primary experience is in Mesopotamia, who have tended to look on the people of the Arabian peninsula during the period under review as being, for the most part (with occasional exceptions such as the Umm al-Nar civilistion), somewhat obscure communities of raiders, nomads and fishermen, who descended from time to time on Mesopotamia, in a pattern typical of nomadic people existing on the fringes of major empires deriving their stability from settled agriculture. In contrast, he convincingly argues, sites such as Dumat al-Jandal, al-Ula and Tayma, in north-western Arabia, were substantial settlements. Much work is still required to uncover the history of these sites, but it is evident that they were of great significance. Indeed, he notes, they were sufficiently powerful, thanks to the domestication of the camel, to have a major effect on the trading patterns of the whole of the Asian part of the Middle East.

Thus, he notes, "from the late second millennium BC onwards, the inhabitants of Arabia interacted with the emerging empires and secondary states of the Near East at a level that was unparalleled in previous millennia. This was to continue through the first millennium BC unto the late pre-Islamic period and then culminate in the emergence and spread of Islam in the seventh century AD." (pp. 259-260).

The emergence of Islam is outwith the chronological scope of this book – but Magee's argument that the emergence of these north-western Arabian centres laid the foundations of the subsequent ability of early Muslim armies to sweep across the region is a welcome attempt to place that success within a long historical continuum.

There is much in *"The Archaeology of Prehistoric Arabia"* that will challenge preconceptions held by scholars with little knowledge of the peninsula, from the Neolithic period onwards. Focussing on the empires of Mesopotamia or Egypt and on the Levant, it has been customary for them to view the archaeology and history of the Arabian peninsula as being essentially peripheral to the history of the region as a whole, with the exception of a few, short-lived instances of the emergence of particular civilisations, such as those of Umm al-Nar, in the UAE, Dilmun, in Bahrain and al-Hasa and the Yemen Highlands.

Making excellent use of the results of the archaeological investigations over the past couple of decades, Magee shows, in contrast, that Arabia was far from being peripheral. Within it developed societies that adapted successfully to changing environmental conditions, of a complexity far beyond that which affected the well-watered lands along the Nile, Tigris and Euphrates, and, in so doing, developed specifically Arabian models that engaged effectively, and by no means as unimportant partners, with the very different societies to their north.

Readers with a specialist knowledge of some of the key sites mentioned in Magee's text will, of course, on occasion wonder why something of apparent significance is not mentioned. Thus, to take a UAE example, while he refers to the presence of Ubaid 4 sherds on Dalma (p.71) and to the coarse, hand-made ceramic industry to be found at several sites of an Ubaid period date in eastern Saudi Arabia, (p.72) he fails to mention the unique vessels made from gypsum plaster on Dalma, which are, in fact, more numerous than the imported Ubaid sherds that have been found there. That, he readily concedes (*in litt.*), was an unfortunate oversight.

That, though, is a minor quibble.

This book is magisterial in its scope and it achieves two very important tasks. First, it presents a well-researched and coherent overview of the archaeology of the peninsula from 9000 BC to 800 BC. Secondly, since it not only achieves this but also offers new insights into the relationship between the peninsula and the lands to its north, it gives Arabia, for the first time, due credit as being a major component of the prehistory of the Middle East. There is no longer any excuse for those who seek to suggest that the peninsula was of peripheral and minimal importance prior to the coming of Islam.

"The Archaeology of Prehistoric Arabia" deserves to be on the bookshelves of anyone with a serious interest in the history and archaeology of the Middle East, scholars and laymen alike.

Peter Hellyer

Fifty years of Emirates Archaeology: Proceedings of the Second International Conference on the Archaeology of the United Arab Emirates. Edited by Daniel T. Potts & Peter Hellyer. 260 pp. ISBN: 978-1-86063-323-2. Ministry of Culture, Youth and Community Development. Abu Dhabi. 2012.

When one considers that European archaeologists have been exploring and documenting the cultural heritage of the ancient Near East for over 200 years, one could be forgiven for believing that archaeological research in the UAE is still in its infancy. Indeed, the book under consideration represents the outcome of a conference held in Abu Dhabi in 2009 that marked only the 50th anniversary of the commencement of archaeological research in that Emirate by a team of Danish archaeologists. In that 50 years, however, the pace of archaeological research in the UAE has intensified and revealed an astonishing cultural heritage that stretches from the Palaeolithic to the recent past.

Following Forewords and Introductions, the first chapter by Flemming Højlund is a richly detailed account of the first archaeological excavations carried out in Abu Dhabi in 1959. These excavations were key to the discovery of the Umm an-Nar Bronze Age culture in southeastern Arabia. Højlund provides a wonderful array of correspondence and photographs dating to the 1950s and 1960s which, in themselves, represent a sort of visual 'archaeology' of a physical and cultural landscape that has been completely transformed in the last 50 years.

The subsequent chapters move in chronological order, starting with the discoveries of Miocene fossils in Abu Dhabi. Evidence for Palaeolithic occupation of the UAE is featured in two subsequent chapters, by McBrearty and Wahida *et al*. This research, which is increasingly of fundamental importance for our understanding of the movement of modern humans from Africa, has done much to place the UAE on the world map of archaeological research. The Neolithic sites of Akab and Jebel Buhais are the subject of two papers, by Méry and Charpentier, and Kutterer and Uerpmann respectively. Each of these sites is, in their own way, astonishing. Akab contains a platform made from the remains of dozens of slaughtered dugongs. Its purpose remains unclear but it is without parallel in the Near East and attests to the unique relationship that the Neolithic nomadic pastoralists of the UAE had with their landscape; a theme that is also discussed in the joint paper on the history of domesticated animals by Uerpmann and Uerpmann. The site of Jebel Buhais is also unique within the Near East. Analysis of the hundreds of bones and teeth from the site have provided a wealth of information on the diet and health of the Neolithic nomadic pastoralists that were interred at the site. Kutterer and Uerpmann's paper focuses on the evidence for trauma and violence among the population. They make a convincing case that trauma resulted because of stress over depleting environmental resources during the 5th millennium BC when the Indian Ocean Monsoon was delivering less rainfall than it had in previous centuries.

The Bronze and Iron Age (c. 3000- 300 BC) archaeology of the UAE is the focus of seven papers. Of particular note is Sabah Jasim's reporting on Bronze Age tombs near Jebel Buhais in Sharjah. These tombs, which have been published in more detail since the time of this conference, contain an astonishing collection of Umm an-Nar, Wadi Suq and Iron Age artifacts. An interesting perspective on trade with South Asia during the third and second millennium BC is also presented by Wright, one of the leading scholars of the Indus civilisation. Two papers by members of the Spanish team who have worked since the mid-1990s at the Iron Age site of al-Thuqaibah provide important new details on the environment and eventual abandonment of the site.

Of singular importance is the paper by Benoist *et al*. on their excavations at the Iron Age ritual site of Masafi. This paper provides me with an opportunity to return to my opening comments about the rapid pace of discovery within the UAE. When I started to work in the UAE in the early 1990s, it was generally thought that there was little, if any, evidence for religion and ritual during the Bronze and Iron Ages. Benoist's excavations, first at Bithna and now at Masafi, have revealed an astonishing array of cultic paraphernalia dating between 1000 and 600 BC. Included are dozens of bronze snakes, weapons and highly decorated, often with applique snakes, ceramic vessels. A figurine of an animal that appears to represent a hybrid of different species, and which is decorated with attached applique snakes, is not only stunning but speaks to the rich vitality of ritual art during the Iron Age. If this range of artifacts had been found at a site in one of the other countries of the Middle East where western archaeologists have had a longer history, it would appear on the front cover of the semi-scholarly/popular archaeology magazines (e.g *Near Eastern Archaeology, Antike Welt etc.)*.

Papers on the late pre-Islamic period include a re-analysis of the Temple at Ed-Dur by Haerinck and a summary of archaeological evidence at the beginning of the Sasanian period by Mouton and Cuny. Both add important details to previously completed work on a timeframe that in many ways is still poorly understood.

The archaeology of the Islamic period is the focus of four papers by Kennet, Petersen, Velde and Hanae and Tatsuo Sasaki. In combination they provide an important summary of settlement patterns, trade and the relationship between textual sources and archaeological evidence. Kennet's paper is of particular interest to those who are coming to the archaeology of the UAE for the first time. He suggests that from the late pre-Islamic into the early 20th century can be divided into six periods and he provides a detailed overview of key sites and economic developments within each phase. His paper is complemented by Velde's that focuses on the site of

Julfar in Ra's al-Khaimah. This reviewer is still astounded by Velde's reconstruction of the seven kilometre long fortification wall which protected Julfar and ran through the Wadi Sur. Such an architectural features speaks volumes about the unique nature of urbanism in this part of the world.

All the papers in this volume are joined by several inter-related themes. Obviously each explores the history and archaeology of the UAE through the lens of archaeological evidence from within the country, but more than that each paper presents models and interpretations that seek to understand the UAE's history from an autochthonous perspective. In this sense, the collection of papers marks a milestone that not only celebrates 50 years since the discovery of the Umm an-Nar but also illuminates how far the study of this region has come since the days when the ancient UAE was understood purely in terms of the trade dynamics of the Arabian Gulf and Mesopotamia. We now have a local continuous archaeological record that stretches from the Neolithic to the modern day and still sporadic, but convincing, evidence of even earlier occupation when humans first dispersed across the globe. Thanks to the work of the archaeologists represented in this volume, that record is now understood and interpreted in reference to the unique environmental resources of the UAE. Essentially, in fifty years, an entirely new region of the ancient world has emerged where previously there was, at best, inference from distant historical sources or, more commonly, just silence. This extraordinary picture has become possible because of the current practice of state-sponsored archaeological research and reporting in the UAE. To return to my opening comments: although research is still in its infancy in a purely chronological sense, in many ways therefore the current practice of archaeology within the UAE has outpaced many of the more canonical areas of study in the ancient Near East.

All of this fascinating archaeological evidence is of little import if it is not communicated in an effective fashion to the public and community of scholars who are interested in the ancient world. I am pleased to write that this book certainly achieves that goal. It is beautifully illustrated with colour photos, line drawings reproduced at very high quality, and maps in each chapter. Its layout and design echoes the proceedings of the first national conference on UAE archaeology, held in 2001, with papers published in 2003, that has become a standard reference work for scholars and layman alike. This book will undoubtedly serve a similar role in years to come and its editors, Peter Hellyer and Dan Potts, and the Ministry of Culture, Youth and Community Development are to be congratulated for producing such a wonderful resource.

Peter Magee

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The Amphibians and Reptiles of Oman and the UAE, by Andrew S. Gardner. Frankfurt Contributions to Natural History, Chimaira Buchhandelsgesellschaft mbH, Frankfurt am Main. 2013. Hardback, 480 pages, colour photographs. ISBN 978-3-89973-433-1.

As someone who for many years has been trying to find more information about the reptiles of eastern Arabia, this book is, to me, a godsend. It is scholarly, weighty, attractive, and very well produced, containing a wealth of information which is otherwise difficult to obtain. We have waited a long time for Drew's *magnum opus*, but it was well worth the wait, and the weight! All the information we are likely to need is neatly presented in a form that would grace any bookshelf but can also be taken into the field. The book is very systematic in its approach and has a huge number of very good photographs, the great majority of which were taken by the author. Not only does every species have at least one good photograph, but there are also excellent photographs of habitats and tracks.

As might be expected, one can pick a few holes in this otherwise excellent book. By far the biggest of these holes is that there is no index. For such an important (and expensive) book as this, the lack of an index is a significant weakness. The contents list at the front has a complete list of all the species described, arranged alphabetically by scientific name within families. This should be fine for people who know the scientific name and family of the species they want to look up, but this is not entirely satisfactory. For people who only have an English name to search for, there is no alternative but to leaf through the book.

The difficulty is actually worse than this because there have been such a lot of nomenclatural changes in recent years that we often don't know what the current name of a species should be. A standard section in the account of every species is Synonymy, so one should be able to locate one's search object through the alternative names given here, and normally one can, but this is not foolproof. The Gulf Sand Gecko, which is locally common along the Abu Dhabi coastline, has always been known, in my experience, as *Stenodactylus khobarensis*, but it is now named in this book as *Pseudoceramodactylus khobarensis*. Very surprisingly, the only word in the Synonymy section for this species is "None". If it never was a *Stenodactylus*, it would be nice to be told about it. The lack of an index, which would solve the problem through the English name, compounds the problem.

This is not the only shortcoming of this sort. *Hemidactylus turcicus*, the "Turkish Gecko", receives no mention at all. This is presumably because there has been a taxonomic revision, and the name has been replaced by something else, but *Hemidactylus turcicus* is not mentioned under Synonymy for any of the numerous species of *Hemidactylus*. I remain mystified!

Anyone with more than a passing interest in the reptiles of the UAE will have heard of the Wonder

Gecko, and until a few years ago, these people would have been happy in the knowledge that its scientific name is *Teratoscincus scincus*. This name is not given at all in Drew's book, as he uses the new name, *Teratoscincus keyserlingii*, which is the name used for the same beast in Iran and Pakistan. The book is frustratingly lacking in information as to why this change came about. In fact the Pertinent References section lists a paper by Macey *et al*. (2005) which should provide the answer, but how many people will bother to delve into the journal *Molecular Phylogenetics and Evolution* to find it? The lack of information is surprising as the author had been keen to initiate research on this genus, but unfortunately it did not come about. The subject is of more than passing interest, because if it could be shown that the UAE's population of Wonder Gecko is now sufficiently distinct from the Iranian population as to merit the status of a separate species, this would be the UAE's only endemic vertebrate species (and therefore, in conservation terms, a top priority). Very strangely, the Synonymy section for this species in Drew's book only lists *Teratoscincus zarudnyi* NIKOLASKY 1986. If the use of the name *Teratoscincus scincus* has all been a big mistake, we would like to know!

The introductory section states that the book will "attempt to provide a standardised set of English names", but it does not help this cause by listing alternatives for some species. There is no alternative English name given for what is probably our commonest desert lizard, Schmidt's Fringe-toed Lizard. Most people know this as the White-spotted Lizard. If there is a good reason for opting for the former, we won't argue, but we would like to know why, and inclusion of the other name as a non-current alternative would have been useful.

The distribution maps are an excellent feature of the book, and are a tribute to the author's personal efforts in mapping distribution and maintaining a database. For many species there is an apparently dramatic reduction in density on the Oman side of the UAE border. This is obviously an anomaly and reflects the great intensity of effort in the UAE (and the greater size of Oman). The mapping unit chosen is ten minutes, i.e. one sixth of a degree, which is a reasonable choice, but it would have been good just to mention that the width of a square in the south of the region is 7% greater than the width of a square in the north.

The species accounts state the distribution of each species in terms of countries, and the introductory text names the species that are endemic to Oman (none are endemic to UAE), but it would have been useful to have included a list of Arabian endemics.

A final minor quibble is that I feel the title of the book, i.e. *"The Amphibians and Reptiles of Oman and the UAE"* is slightly odd. I would have put reptiles first, as the score between the two groups is 89:2, and this doesn't include the marine species!

These quibbles do not detract from the fact that this book is truly a magnificent piece of work and a major contribution to natural history and nature conservation in the region.

R. J. Hornby

Beyond Dubai: Seeking Lost Cities in the Emirates. David Millar. Melting Tundra Publishing, Cochrane Alberta, Canada. www.meltingtundra.com
296 pp. paperback UK pounds 7.95; US $ 12.95)

Over the years, book reviews in *Tribulus* have tended to deal with new, and often rather weighty and complex, tomes on different aspects of the UAE's environment, archaeology and natural history. Indeed, reviews of that type are also to be found in this issue.

To include a review of *'Beyond Dubai: seeking lost cities in the Emirates'* is, therefore, something of a novelty. The book, a slim paperback, offers nothing more than a description of journeys around the country (and to Dhofar), switching from the conventional, like modern cities, highways and a description of dune-bashing at the 'Big Red' dune, near Madam, to quick descriptions of some of the country's most attractive scenery and most significant archaeological sites.

It is, though, because of that, along with the fact that the author is a long-time member of the Dubai Natural History Group, who has now, sadly, moved on, that we've considered it worthy of a review.

It is commonplace for visitors – and, sadly, for many expatriate UAE residents – to believe that the UAE has nothing much in the way of history, beyond the pastiche reproductions of "Bedouin encampments" or "heritage villages." Regular readers of this journal will know, of course, that the reality is markedly different.

Millar was prompted to write the book, he states, because he had already come to live in the UAE, in Dubai, and his Scottish partner was displaying some reluctance to come and join him because she was under the impression that the UAE was all modern; lacking traditions, history and culture. The book is, therefore, a loosely-strung together report of a series of journeys around the country as he tried to convince his lady-friend, who had come out to visit, that there was, in reality, much more to the country than she imagined.

Amusing descriptions of some of the country's major cities are interspersed with quick summaries of some of the main archaeological sites, amongst them (and there are far too many to list) being Hili, Tell Abraq, Julfar, Sir Bani Yas, the fossil elephant trackway at Mleisa and Al Sufouh in Dubai – sufficient to convince even the sceptic that the UAE does, indeed, have a history that stretches back into the very distant past. At the end of the journeys, and of the book, Millar's lady-friend concedes that, yes, there's plenty of culture and heritage here and, somewhat

sheepishly, that she had already quit her job back home before she came for the trip.

So was all of Millar's planning of the journeys unnecessary?

Only he and his partner can answer that for themselves, but for a broader audience who want to learn a bit about the UAE, its present as well as its fascinating past, this book is certainly well worth a read. For those wanting to learn more, there is a useful short bibliography too, in which I was pleased to note that *Tribulus* got a mention.

The archaeologists may, no doubt, have a few quibbles about Millar's interpretation of the sites on which they have worked. I'm curious myself, for example, to know where he got the idea that the sulphur mines at Jebel Dhanna had "been exploited by the Portuguese to make gunpowder" (p. 262). In the work there by the Abu Dhabi Islands Archaeological Survey and in archive research, we found no evidence at all for that. Nor it is right to suggest (p.234) that the 'beehive' tombs at Jebel Hafit are of the same age as the Umm al-Nar period tombs at Hili.

There are, too, a few irritating little mistakes, such as the spellings of Jumeriah (for Jumeirah) and Umm al-Nur (for Umm al-Nar), or the incorrect suggestion that the people of Fujairah are Wahhabi. And, in a book published in 2014, it should, surely, be possible to describe Sheikh Saud bin Saqr Al-Qassimi as Ruler of Ra's al-Khaimah, rather than as Crown Prince, since he succeeded his father as Ruler back in 2010.

That, though, really is nit-picking on my part.

For first-time visitors, and for long-term residents who have, at last, woken up to the fact that there's more to the UAE than big cities, tall buildings and malls, 'Beyond Dubai' is an excellent introduction to the country. I hope it will be well and widely read.

Peter Hellyer

Other Books

Copies of the two books mentioned below have been received, but are not reviewed in this issue. It is hoped that full reviews will be carried in the next issue.

Geological evolution of the United Arab Emirates: Over six hundred million years of Earth history.

R.J. Thomas & R.A. Ellison (*eds.*). Published 2014 by British Geological Survey, Keyworth, Nottingham, with the support of the Department of Geology and Mineral Resources, UAE Ministry of Energy. 287 pp. ISBN 978-0-85272-770-6.

Contact details: Ministry of Energy, PO Box 59, Abu Dhabi, UAE. www.moenr.gov.ae & BGS: Keyworth, Nottingham NG12 5GG www.bgs.ac.uk

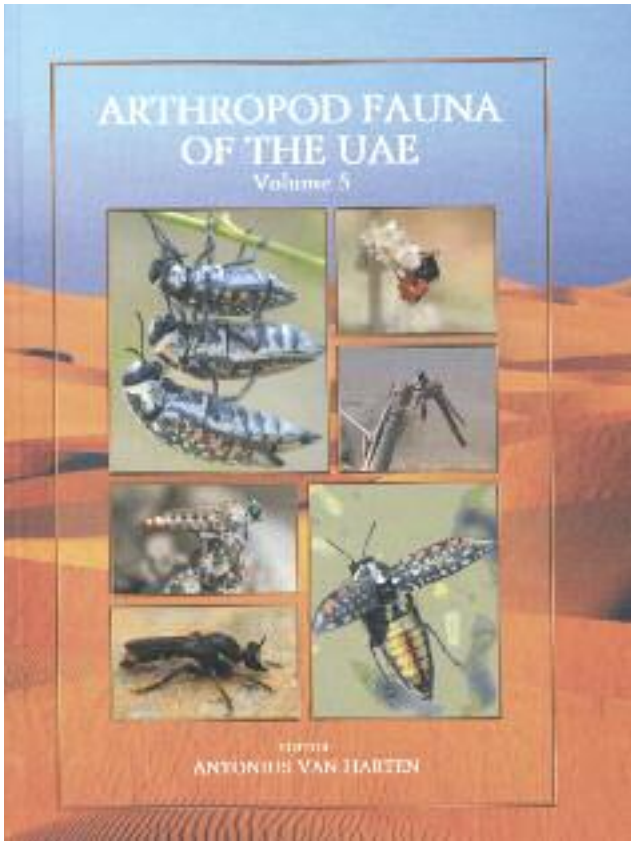
This book represents the results of nine years study by the British Geological Survey of the UAE's geology, a project funded by the Ministry of Energy, and, in the words of the Ministry's Foreword, "is aimed at a wide audience from geology undergraduates and academia in general to professional geologists and all those interested in the natural world… the book describes the dynamic geological evolution of the country during the over 800 million years of earth history represented in this eastern part of Arabia."

Over 30,000 observation points were made over the entire country, with the result that the UAE has become "one of the most comprehensively surveyed countries in the world and one of very few to have a complete national, fully attributed, digital geological dataset."

The book is complemented with a whole series of geological maps, at scales from 1:500 000 to 1: 25 000, sheet explanations, several volumes of memoirs and reports, all of which are available, like the book itself, from the Ministry of Energy, in either printed or digital format.

Lavishly illustrated, the book, and the associated detailed material on which it is based, are testimony both to the expertise of the BGS and to the wisdom of the initiative by the Ministry to commission the research in which they are based.

Arthropod Fauna of the UAE – Volume 5. Antonius van Harten (*ed.*). Publiished in 2014 by the Department of The President's Affairs, PO Box 372, Abu Dhabi, United Arab Emirates. E-mail: Dopa@dopa.ae 744 pp. ISBN: 978-9948-22-086-2 . Price in the UAE: Dh 125 + p&p.



The latest volume in the series – results of a detailed study of the UAE's arthropod fauna, including insects, spiders, scorpions and terrestrial crustaceans, undertaken from 2004-2011, under the title of 'The UAE Insect Project.'.

In this volume, chapters have been written by 53 specialists from 21 countries. Of the families dealt with in the volume, 20 had not previously been recorded in the UAE. In total, the volume adds 184 genera and 341 species to the known fauna of the UAE, with two genera and 45 species new to science being described.

Overall, the study has so far added over 2,100 new species to the list of arthropods known from the UAE, with 15 genera and 372 species being new to science – not recorded anywhere else in the world.

In a Foreword, Dr. Mubarak Sa'ad Al Ahbabi, Chairman of The Department of The President's Affairs, notes:

" This book, and the four previous volumes in the series that have already been published, are ground-breaking in several ways. The insects and other arthropods of the UAE are the most numerous species of wildlife to be found in the country, but, prior to the launch of the UAE Insect Project in 2004, they had received relatively little attention, in comparison to other wildlife, such as birds, mammals or fish. The Project has involved a large number of the world's leading specialists on arthropods, who have ... made an enormous contribution to the knowledge of this component of the country's wildlife and of the UAE's remarkable biodiversity. As a result of the UAE Insect Project, moreover, the United Arab Emirates is now the best-studied country in the entire Middle East region in terms of its insects and other arthropods. That is something of which we can be rightly proud."

Two further volumes in the series are planned.

Obituary

Michael Desmond Gallagher (1921-2014)

Michael Gallagher passed away peacefully on 27th July 2014 at the ripe old age of 92. It marks an end of an era of biological research and conservation in Arabia, especially in Oman. He will be remembered and missed by a large number of people as most who have been active in wildlife in Arabia over the last several decades would either have known Michael personally or at least corresponded with him.

Michael Gallagher was born in Surrey, England on 3rd September 1921. He joined the British Army at an early age and served in North Africa during the Second World War. Later postings took him to Arabia (Aden, Bahrain and Sharjah) as well as to Christmas Island and (British) Guyana. Michael's interest in natural history was at first a hobby and he was entirely self-taught. At his retirement in March 1998, his publication list stood at 115, including several books. His interests spanned over a very wide field of natural history as can be appreciated by the fact that no fewer than 26 species and three subspecies of animals (including mammals, insects, reptiles and molluscs) and one species of plants have been named in his honour.

Birds, however, were always his main interest and he joined two surveys by the Oman Flora and Fauna Society to the mountains of northern Oman (1975) and southern Oman (1977) writing the chapters on birds from both surveys. Later, Michael was commissioned by the Diwan of the Royal Court in Muscat to write a book on the birds in Oman, resulting in the publication in 1980 of ***The Birds of Oman*** with Martin Woodcock painting the plates. It was a milestone publication, appearing in both English and Arabic, and the first complete avifauna for any country on the Arabian peninsula.

Upon retiring from his career in the armed forces in 1982, Michael was invited by Sultan Qabus to stay in Oman. He joined the Ministry of National Heritage and Culture in Oman in 1982 and set up the Natural History Museum in Muscat which opened in 1985. Michael was Curator at the museum until his retirement and from the beginning initiated collections in the museum of shells, corals, insects, fossils and more. He also started the National Herbarium of Oman at an early stage. Michael never married and dedicated his life to the world of nature.

In 1986, Michael was a founding member of the Oman Bird Records Committee (OBRC) the Omani equivalent to the Emirates Bird Records Committee. The first OBRC meeting was held in his home on 2nd July 1986. The aim of the committee was to promote awareness of birds in Oman, promote wildlife conservation, evaluate all claims of rare birds in Oman and maintain a credible national list of birds. The first organised bird database in Arabia was produced as a card index by Mrs E. F. ('Effie') Warr. In 1981 the cards relating to Oman were handed over to Michael Gallagher who further developed the card index and added all new, accepted sightings to the cards. By 1988, it had grown to over 5,000 cards at which time a computerised database was initiated and the records transferred.

If one word could describe Michael, it would be meticulous. He kept neat records of all observations and correspondence. He could be moody at times, but also very generous and hospitable. During several OBRC meetings at my place, Michael would arrive five or ten minutes early, but would stay in his car or stand outside next to his car since, as he put it: 'I have not been invited till 3 pm'.

At Michael Gallagher's retirement, a symposium was held in Muscat in his honour. A packed lecture hall heard presentations on a wide variety of topics including flora, reptiles, sea turtles, birds and mammals. The talks resulted in *'The Natural History of Oman, A Festschrift for Michael Gallagher'* edited by Martin Fisher, Shahina Ghazanfar and Andrew

Spalton, who had also organised the symposium. It was a fitting appreciation of Michael's wide reaching contributions. Few people, if any, have had a greater impact on the knowledge of the natural history of Oman than Michael Gallagher.

Michael Gallagher continued as a member of OBRC till his retirement in 1998. The last claim to which he attended was of a Scaly-breasted Munia circulated by the Recorder of the time, David Sargeant. Michael wrote at the bottom of the claim form: 'Dave, My last act before leaving Oman (& OBRC) 18 Apr 98, Farewell, Michael'.

Farewell to you too, Michael.

Jens Eriksen

Peter Hellyer adds:

Michael Gallagher's military service brought him to the Gulf in 1969, initially in the HQ, British Land Forces Gulf, in Bahrain, until 1971, and then to the UAE, where he was a member of the Military Advisory Team, MAT, based in Sharjah until 1973.

While, rightly, coy about his military activities, Michael spent much of his leisure time on the hobby of birdwatching, writing to me in 2009 that "as is well-known, this is a common hobby, particularly where people are in a strange country and where few facts are available of the shifting bird population. We (i.e. he and friends) gathered lists together, which encouraged others to contribute, and we shared these with other expatriates, hobby groups, authors, scientists and (from 1978) with the Ornithological Society of the Middle East."

One lengthy fieldtrip, of several days, for which he managed to get approval from his military superiors, in 1970 or 1971, by calling it 'Operation Tuyur Watch' (Operation Bird Watch), provided some of the first bird records from parts of the UAE's then remote interior.

From such small beginnings grew the UAE's first bird checklist, initially maintained by OSME, and then transferred, over twenty years ago, to the newly-founded Emirates Bird Records Committee, which still notes that his record of five great white pelicans, seen flying off Khor Fakkan, is the second of only seven records on the national database.

Once he had moved on to Oman, Michael corresponded extensively with other birdwatchers who followed him to the UAE, like Colin Richardson, swapping information and providing advice. Twenty five years ago, when I stumbled across a small chick swimming across a pool of rust-coloured water in a rubbish dump near Khor Kalba, it was to Michael that I turned for confirmation that I had found the first breeding evidence for the UAE of moorhen, now a common and widespread species. Other exchanges included one, of some length, on the topic of whether the collared kingfisher, breeding in Khor Kalba, actually bred on the Omani side of the border as well as the UAE side, with Michael's hand-drawn sketch of the location of the border supporting his suggestion that some of the mangroves on the Omani side might just be large enough. We never resolved the issue…

More recently, Michael was a valued member of the **Tribulus** Scientific Advisory Board for several years, offering advice on birds, reptiles and a wide variety of other fauna.

He richly deserved his reputation as one of the founders of UAE ornithology.