TRIBULUS

JOURNAL OF THE EMIRATES NATURAL HISTORY GROUP
VOLUME 17-2007

Tribulus

Volume 17

The Journal of the Emirates Natural History Group

Contents

Cover Illustrations

Front: **A *Pseudotrapelus sinaitus*, photographed near Shawkah, in southern Ra's al-Khaimah. Picture by Drew Gardner**

Back: **A Cape Hare, *Lepus capensis*, photographed near Taweelah. Picture by Drew Gardner**

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The Editorial Board of ***TRIBULUS*** *and the Committee of the Emirates Natural History Group acknowledge, with thanks, the support of the Groupís Corporate members, a current list of whom can be found on page 2, and without whom publication would be impossible. We also acknowledge the support and encouragement of our Patron, H.E. Sheikh Nahyan bin Mubarak Al Nahyan, UAE Minister of Higher Education & Scientific Research.*

TRIBULUS *is published for circulation to members of the three Natural History Groups in the United Arab Emirates, in Abu Dhabi, Dubai, and Al Ain, and is also available at selected outlets in the UAE and on subscription inside and outside the UAE. Subscription in the UAE & the Arabian Gulf states: Dh 50 per year. Overseas details on request.*

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 Dar Al Fajr Press, Printing, Publishing and Advertising, P.O. Box 505, Abu Dhabi, UAE

Editorial

As readers will note, this issue of ***Tribulus***, Volume 17, for the year 2007, is not only several months late, but it is also presented as a single annual volume, rather than in the two parts that have appeared each year since the journal was launched in 1991. It is appropriate to provide an explanation.

The delay in publication, to be completely honest, is primarily because of the fact that those members of the Editorial Board who take on the main tasks associated with publication have had extensive other commitments to discharge, or have been away for extended periods since summer 2007. Production of the journal has always been a labour of love, and there are times when other commitments must take priority.

The decision to cease bi-annual publication and to change to an annual format is partly related to this pressure of other work. It is, however, never easy to arrange for a sufficient number of papers, of suitable quality, to be submitted for publication, and this, too, has caused delays. It is hoped that the change to an annual publication will help the Editors to prompt more potential contributors to submit copy. The fact that papers in ***Tribulus*** are now available on-line, on the website of the Al Ain chapter of the Emirates Natural History Group, (http://www.enhg.org/trib/tribpdf.htm) may also make the journal more attractive as a place in which to publish, of course, and we are grateful to the Group for having arranged to provide this facility. We do, however, plan to continue production of hard-copy issues of the journal, even though this takes longer, since we believe that such issues are preferred by many of our readers and contributors.

Having made the explanations above, we believe that the latest issue of ***Tribulus***, in its single annual volume format, is the most substantial yet, in terms not only of its total content (well over double that of the average number of pages in the former, bi-annual, issues), but also in terms of the nature of its contents.

The journal has always sought to provide a wide range of papers, dealing with the history, archaeology and natural history of the United Arab Emirates, and this issue is no exception. The major papers include an important examination of the flora of one of the country's most diverse, and most endangered habitats, an important review of shark species known in the region (a much under-studied topic), a archaeological baseline study of an important wadi in Fujairah and a lengthy annotated checklist of the UAE's dragonflies and damselflies, containing much previously unpublished data. These are complemented by a host of shorter notes, on archaeology, butterflies, moths, snakes and other topics.

While many of the contributors have previously published papers in ***Tribulus*** – and we hope that they will continue to do so for many years to come we are delighted to welcome some new contributors to this issue of the journal and hope that they, too, will come to see the journal as being a suitable place in which to publish.

Tribulus arose out of the Bulletin of the Emirates Natural History Group in Abu Dhabi, a duplicated, thrice-yearly magazine that commenced publication in 1978, now thirty years ago. The objective of the Bulletin was to provide a place in which some of the early research into the natural history and archaeology of the country could be published – much of which was of considerable value, even if it was written in a non-academic format.

When ***Tribulus*** began, in 1991, its objective was to continue publishing of such material, albeit in a more academic format, and, at the same time, to attract many more contributors from outside the ENHG membership, these comprising primarily people with a more detailed knowledge of the topics concerned. At that time, there was no academic journal in English devoted to the history, archaeology and natural history of the UAE, although there were a number of specialist journals overseas which published papers on these aspects of the Emirates. It was then our belief that there would, some day, be such a journal, produced by a leading local academic institution, or by an innovative local publisher.

Since then, the number of specialist journals outside the country, but which carry UAE-related papers, has increased, but, despite its shortcomings, ***Tribulus*** is still the only journal of its type published inside the country. It is our belief that, over the years, the papers it has published have made a significant contribution to the sum of scientific knowledge about the country, even if that knowledge is not always distributed as widely as we would like.

The amount of research being undertaken continues to grow, and, as the papers in this volume indicate, there is a steady flow of discoveries, in a wide variety of fields and disciplines.

We intend, therefore, to continue to provide a suitable place for the publication of these discoveries, and look forward to further years of publication in our new annual format.

Peter Hellyer

The vegetation of the coastal white sands at Taweela (Abu Dhabi Emirate)

by Gary Brown, Simon Aspinall and Sabitha Sakkir

Figure 1. Typical overview of coastal white sand vegetation at Taweela with scattered perennials and a profusion of annuals. February 2007

Introduction

Taweela is a coastal area located ca. 40 km to the north-east of Abu Dhabi island, ca. 25 km from the border with Dubai Emirate. The coastal white sand vegetation immediately to the east of Taweela power station, extending to Ra's Ghanada and covering an area of ca. 8 sq. km., probably represents the best example of this endangered habitat type in the Emirate of Abu Dhabi.

As a result of rapid coastal development in the UAE, this unique area, which is also of high faunistic value, is potentially under severe threat from coastal development, in particular from planning related to the development of the Khalifa Port and associated industrial zone and the adjacent EMAL aluminium smelter project. The objective of this observational study, therefore, is to document a highly-endangered vegetation type and its flora, to re-state the outstanding conservation importance of the Taweela area, already highlighted by Aspinall (1999), and to place on record for the first time detailed data on the flora of the area.

The opportunity is also taken to provide an update and some corrections to Jongbloed (2003).

The results of this study are based on field observations undertaken by all three authors over the last few years, but with an emphasis on the wet winter of 2006/2007.

Environmental Setting

1. Climate

Details on the climate of the UAE have been given by Böer (1997) and Brown & Böer (2005a). The climate of the Taweela area, as with the UAE in general, is of a bi-seasonal Mediterranean type, characterised by high temperatures and low rainfall. The summers (April to October) are distinctly hot, with daytime temperatures regularly exceeding 40 °C. Rainfall is generally restricted to the cooler winter months (November to March), when temperatures occasionally drop to below 10 °C at night. During the coolest periods of the winter, daytime temperatures are rarely in excess of 20 °C. Annual rainfall amounts vary considerably from one year to another, but the long-term mean value is about 80 mm for the coastal area between Abu Dhabi and Dubai. Potential evaporation (i.e. that water which would evaporate if present) far exceeds precipitation, probably by a factor in excess of 10 (Deil & Müller-Hohenstein, 1996), indicating the high degree of stress to which organisms are exposed. The area experiences high humidity, especially in the summer months.

2. Coastal sands

Coastal white sands differ in their composition and form from the inland desert sands which are of different origin (Feulner, 2005). Coastal sands are derived almost exclusively from marine organisms and carbonate sediments and consist to a large extent of CaCO3. In contrast, the inland desert sands are composed predominantly of quartz grains, and they may appear distinctly red when the grains are coated with haematite (an iron oxide). They largely lack any significant $CaCO_3$ content.

Due to the general lack of pedogenesis owing to the

harsh climatic conditions, the substrate is characterised by the little-altered parent material. Soils, in the general sense of the meaning, are therefore not developed. Although the coastal white sands contain many nutrients, they are highly deficient in nitrogen, primarily due to the virtual absence of organic material, and as a consequence, soil fertility is extremely low.

Except in the immediate proximity of the shoreline or under other exceptional circumstances, coastal white sands do not appear to be influenced by salinity to any great degree, because they are invariably situated well above the high-tide line. This is reflected in the flora, which to a large extent is composed of glycophytes (i.e. species which are largely intolerant or only slightly tolerant of saline substrate conditions). Halophytes are generally restricted to certain microhabitats in the sand sheets, usually depressions, which are occasionally inundated.

Vegetation development on the coastal white sands

1. Water availability for vegetation

Inter-annual variation in the rainfall pattern is a feature which, due to the relatively low total amounts of precipitation received even in wet years, has a much more decisive influence on biological activity than, for instance, in more temperate regions of the world. In the Taweela area, as in many other regions of the UAE, this rainfall variability is reflected by the density, biomass production and species composition of the desert annual flora which develops for a short period during the winter and spring months. Heavy rain received at the onset of the cool period, when followed by occasional showers, as was the case in the 2006/2007 winter season, provides favourable conditions for the development of desert annuals, whereas the populations of these plants may be very low in dry years.

Stable sand sheets, such as coastal white sands, are generally favourable for plant growth in arid region ecosystems due to the capacity of coarse sand to store water, often for substantial periods of time. This has been referred to by Noy-Meir (1973) as the "inverse texture effect", because it is the opposite to the situation in temperate climates, where sand is generally regarded as a poor substrate for plants and finer grained substrates are more beneficial. When it does rain, water percolates the upper sand layers rapidly (and is not lost through run-off). Whereas the upper regions tend to dry out quite quickly, the water is stored in the subsurface sand layers where it is protected from evaporation. Even plants with rather shallow rooting systems are able to tap into this water resource. It should be stressed that only stable sand sheets exhibit this "inverse texture effect", mobile sand dunes are extremely inhospitable environments for desert plants.

2. Vegetation and flora

The vegetation of the coastal white sands in the Taweela area is characterised physiognomically by a sparse cover of perennial dwarf shrubs and grasses (***Figure 1***). Vegetation cover of the perennials rarely exceeds 3%, indicating the harshness of the climate. In winters with good rainfall, desert annuals form open carpets, at least in favourable locations, and percentage cover of these annuals can reach 20%, though coverage values between 5% and 10% are more typical. A list of species typically occurring on the white sands is given in Appendix 1.

Much of the coastal white sand vegetation at Taweela can be assigned to the typical association of the *Cornulaco monacanthae-Sphaerocometum aucheri* according to the vegetation classification system of Braun-Blanquet (1928). This community was first formally described by Deil & Müller-Hohenstein (1996) from Jebel Ali, i.e. ca. 30 km to the east of Taweela. It probably extends with a similar species composition in suitable locations eastwards along the coast into eastern Oman, with Taweela possibly representing the western boundary of its occurrence. Kürschner (1986) recorded a "*Sphaerocoma aucheri* association" with a rather limited number of

Figure 2. The Caryophyllaceae *Sphaerocoma aucheri* is highly characteristic of the coastal white sand vegetation at Taweela. February 2007

Figure 3. Detail of flowering branches of *Sphaerocoma aucheri.*

Characteristic dwarf shrubs at Taweela include *Sphaerocoma aucheri* (***Figures 2 and 3***) and *Cornulaca monacantha* (***Figure 4***), the latter a Chenopodiaceae, the former a Caryophyllaceae which superficially strongly resembles a chenopod. Of the other dwarf shrubs, the Boraginaceae *Heliotropium kotschyi* is a regular associate, whereas the moderately salt-tolerant *Zygophyllum qatarense* is quite widespread, but nowhere dominant, and is sometimes lacking from large areas. Another moderately halophytic dwarf shrub, *Limonium axillare*, is also widespread and usually found in slight depressions in the sands. It is striking that seedlings and young plants of *Helianthemum lippii* can be numerous, often flowering in their first year, but they rarely attain any significant height and give the appearance of being more of an annual or biennial (***Figure 5***), rather than a perennial, as is usually the case. Older plants are present, but are conspicuously less frequent.

The most widespread perennial grass is *Coelachyrum piercii* (***Figure 6***), which in the United Arab Emirates appears to be restricted to a stretch of coastline between Taweela and Ra's al-Khaimah, to the north-east.

Figure 4. The chenopod *Cornulaca monacantha* is widely distributed along the Arabian Gulf coast of the UAE on non-saline sands.

It is highly characteristic of the coastal white sands, but, in the north-east of the UAE, also occurs occasionally on red sands near the coast. The sedge *Cyperus arenarius* (***Figure 7***) is usually widespread and abundant. *Panicum turgidum* is a regular associate and locally common. This species is the dominant constituent on coastal white sands extending along the Arabian Gulf coast from the far west of the UAE to Kuwait in the north (Kürschner, 1998), and forms an open xeromorphic grassland in which *Sphaerocoma* and *Coelachyrum* are absent. *Pennisetum divisum*, a superficially similar tussock grass to *Panicum*, is occasionally present on the coastal white sands at Taweela, but is rather sporadic. *Sporobolus iocladus* is also common and widespread throughout the area.

Coelachyrum piercii, *Panicum turgidum* and *Pennisetum divisum* are perennial grasses whose roots are enclosed by a rhizosheath, a cylindrical covering of fine sand grains which remain attached to the roots by persistent root hairs and the secretion of a mucilage. It is believed that the rhizosheath promotes water absorption and protects the roots from drought. Furthermore, the rhizosheath provides an idea microhabitat for nitrogen-fixing bacteria, and it has been suggested that these may play an important role in enhancing soil fertility (see Danin, 1996). However, it is quite striking that *Cyperus arenarius* does not possess such a rhizosheath, whereas *Cyperus conglomeratus*, an abundant sedge on inland dunes, does.

These and other perennials are accompanied by a profusion of annuals, particularly in wet years. The more regular species, i.e. also occurring in drier years, include: *Arnebia hispidissima*, *Herniaria hemistemon*, *Lotus halophilus* and *Oligomeris linifolia*, followed by *Hippocrepis areolata*, *Launaea capitata* and *Launaea mucronata*. Some annual species, such as the grasses *Cutandia memphitica*, *Rostraria pumila* and *Schismus barbatus* as well as *Eremobium aegyptiacum*, *Ifloga spicata*, *Paronychia arabica* and *Savignya parviflora* are noticeably rarer and virtually absent in drier years. Compared with the situation in Umm al-Qaiwain and Ra's al-Khaimah, further north-east along the UAE's Arabian Gulf coastline, the annual flora, even in wet years, is noticeably less diverse, with species such as *Astragalus annularis*, *Ononis serrata*, *Plantago boissieri* and *Reichardia tingitana*, which are common or even abundant in coastal dunes there, being absent from the Taweela area. Even *Silene villosa* does not appear to occur in the Taweela area, it not having been found despite a fairly intensive search for the species.

Figure 5. Numerous small individuals of *Helianthemum lippii*, often flowering at a very early age, are found on the coastal white sands at Taweela.

Figure 6. The perennial grass *Coelachyrum piercii* is highly characteristic of the coastal white sands east of Abu Dhabi island.

Figure 7. The sedge *Cyperus arenarius* is widespread along the Arabian Gulf coast of the UAE.

Figure 8. Coast white sand vegetation with *Halopyrum mucronatum* (foreground) and *Salsola drummondii* (background). The perennial grass *Halopyrum* is dormant during the summer, whereas *Salsola* is active and therefore green. See also Figure 9. August 2004.

Figure 9. Coast white sand vegetation with *Salsola drummondii*. See also Figures 8 and 11. August 2004

Conversely, a number of species were registered at Taweela that were initially not expected to be present, based on information in Jongbloed (2003). These are dealt with in more detail below, and include *Aizoon canariense*, *Cutandia memphitica*, *Paronychia arabica*, *Polycarpaea spicata*, *Rostraria pumila* and *Schismus barbatus*.

Locally, near Ra's Ghanadha, on the north-eastern fringe of the Taweela area, the halophytes *Halopyrum mucronatum* (***Figure 8***) and *Salsola drummondii* (***Figure 9***) are conspicuous elements in the vegetation of the coastal white sands, along with many other of the perennials mentioned above. Conversely, a number of annuals appear to be lacking. Such stands have been described by Deil & Müller-Hohenstein (1996) as the sub-association *Halopyretosum mucronati* of the *Cornulaco monacanthae-Sphaerocometum aucheri*, and appear to be developed in response to a slight increase in soil salinity.

As indicated above, it is evident that a distinct floristic gradient exists along the coastal zone in the UAE, with the floristically most diverse areas occurring in the north-east and the least diverse in the west. It is possibly no coincidence that a number of species have their western-most distribution limits in the UAE close to Abu Dhabi island, where the coastline, which, west of the island, runs more-or-less from west to east. Further east, it veers off in a north-easterly direction towards Ra's al-Khaimah and the Musandam peninsula. This probably correlates with an increase in rainfall with closer proximity to the Hajar Mountains, as well as a slight decrease in temperature.

4. Comments on the "Wildflowers to the UAE"

The "Comprehensive Guide to the Wildflowers of the United Arab Emirates" (hereinafter simply referred to as the "Wildflowers Guide") by M. Jongbloed (2003) currently represents the best available floristic literature for the UAE, although invaluable information is also contained in Western (1989). This section aims to rectify mistakes pertaining to the coastal flora in the Wildflowers Guide and to update information on the distribution of some species.

Aizoon canariense
The distribution of this species in the Wildflowers Guide (p. 109) should be extended further south-west to Abu Dhabi island, as the species was recorded in 2007 at Taweela. Furthermore, the species is common on the plains at the base of Jebel Hafit.

Cornulaca monacantha
The map in the Wildflowers Guide (p. 292) is inaccurate, in that *Cornulaca monacantha* is common along the entire Arabian Gulf coastline from the Sila'a Peninsula, in the far west, to Ra's al-Khaimah, in the north-east, as already highlighted by Western (1989). Jongbloed treats the morphologically very similar *C. arabica* as a synonym, which is open to interpretation. This taxonomically difficult species is characteristic of the sand sheets in the Liwa / Umm al-Zumul area in southern Abu Dhabi, extending locally northwards to Al Wathba, and its occurrence there should be indicated in the distribution map on p. 292 together with *C. monacantha* (if it is to be treated as the same species as *C. monacantha*).

Fagonia indica / ovalifolia
Fagonia is a highly problematic genus, with the precise delimitation of species notoriously difficult. The extensive work of Beier (2005) has confirmed what had already been suspected by some observers, namely that *Fagonia ovalifoli*a should be treated as a synonym of *F. indica*. The maps in the Wildflowers Guide (p. 546 and 547) can therefore be conveniently combined.

Halopyrum mucronatum
The map in the Wildflowers Guide (p. 69) gives a good indication as to the distribution of the species in the UAE. It has also been recorded from Zirku Island by the first author.

Heliotropium kotschyi / bacciferum
Considerable confusion surrounds the taxonomic status of these two species and their precise differentiation. Our own observations indicate that only one taxon is involved along the coast of Abu Dhabi, and indeed, Mandaville (1990) treats the two as synonyms, referring to the widespread species of coastal regions as *Heliotropium bacciferum* Forssk.
However, according to Prof. A. Miller, Royal Botanic Garden, Edinburgh, (*pers. comm*.), there is no agreement amongst taxonomists as to what precisely constitutes *H. bacciferum*. Having examined the type specimen, he regards *H. bacciferum* as a small prostrate plant occurring on the Red Sea coast of Yemen. Accordingly, he suggests that all plants in the eastern part of the Arabian Peninsula should be treated as belonging to *Heliotropium kotschyi* (Ledeb.) Guerke, which itself is a highly variable species. According to this interpretation, the distribution map in the Wildflowers Guide (p. 214) is, therefore, accurate, and references to *H. bacciferum* in both Mandaville (1990) and Brown & Böer (2005a) should be regarded as *H. kotschyi*.
Whether the distinct montane species occurring in the UAE is in fact *H. bacciferum* or a completely different species is open to question. No useful distinguishing features from *H. kotschyi* are given in the Wildflowers Guide (in fact the photograph of the noticeably small flowers of *H. bacciferum* (p. 210) matches the description of *H. kotschyi* (on p. 214) more closely, and vice versa). Gary Feulner (*pers. comm.*) mentions that the leaves of the mountain plant are noticeably softer and broader.

Ifloga spicata
Ifloga spicata is more widespread than indicated in the Wildflowers Guide (p. 160). Its presence, albeit rare, in Taweela indicates a continuous distribution along a narrow to broad coastal strip from around Abu Dhabi island in the west to Ra's al-Khaimah in the north-east. The first author has also found the species on plains at the base of Jebel Hafit and also in adjacent areas of Buraimi (Oman).

Lasiurus scindicus

The photograph in the Wildflowers Guide (p. 73) unfortunately shows a species of *Cymbopogon*, not *Lasiurus*. Although the species is much favoured by domestic livestock and virtually impossible to identify with certainty when eaten back, *Lasiurus* appears to be less common in coastal areas than indicated in the Wildflowers Guide. The first author has so far only found it in such situations west of Jebel Dhanna, in the far west of the UAE, and just east of Abu Dhabi in a large enclosure protected from livestock grazing, where it was very local. However, it is fairly common in silty-sandy drainage channels at the base of Jebel Hafit, often in flower where the grazing pressure is less intense.

Mesembryanthemum nodiflorum

The map in the Wildflowers Guide (p. 110) gives a good overview of the current distribution of *Mesembryanthemum nodiflorum*. A single specimen was found and photographed in Taweela in 2007 by the third author. Furthermore, two of the authors (GB, SS) have found the species to be common on Zirku and Arzanah, thus adding two further offshore islands to its known distribution. The species was observed by the first author to be locally common both in 2005 and 2007 in Al Jazeera al-Hamra (Ra's al-Khaimah). It may possibly be more widespread along the coastline in disturbed areas.

Paronychia arabica / *Herniaria hirsuta*

The main photograph of *Paronychia arabica* in the Wildflowers Guide (p. 265), which is described as a young specimen, in fact depicts a typical specimen of *Herniaria hirsuta*. ***Figure 10*** shows a typical example of *Paronychia arabica*. The distribution of this species needs to be updated, as it is found at Taweela and thus probably occurs along a narrow coastal stretch at least from Abu Dhabi island to Ra's al-Khaimah. *Herniaria hirsuta* was found to be locally common in Al Jazeera al-Hamra (Ra's al-Khaimah) in 2005.

Polycarpaea spicata

Polycarpaea spicata is far more widespread than indicated in the Wildflowers Guide (p. 268). It is found on coastal white sands and coastal plains and has been recorded from Taweela and Al Jazeera al-Hamra (abundant in the latter location), so that this species too probably has a continuous distribution from Abu Dhabi island to Ra's al-Khaimah. It has also been recorded by the first author on Zirku island, as well as Ras Laffan Industrial City (northern Qatar).

Rostraria pumila

Rostraria pumila (p. 88 in the Wildflowers Guide) was recorded in 2007 in Taweela as well as on coastal dunes from Umm al-Qaiwain to Ra's al-Khaimah, indicating a continuous distribution along the coastal strip from Abu Dhabi island to Ra's al-Khaimah. The first author has also recorded this annual grass from Jebel Hafit, where it is quite common in silty depressions on the surrounding plains.

Figure 10. Detail of the Caryophyllaceae *Paronychia arabica*. Note the conspicuous silver-white stipules. February 2007.

Salsola drummondii

Salsola drummondii is not just locally common, as indicated in the Wildflowers Guide (p. 299), but scattered and locally abundant along the entire coast from Sila'a in the west to at least Dubai in the east (e.g. on remaining coastal housing plots in Jumairah), and possibly further north-east. The habitat varies from slightly saline coastal white sands (Taweela / Ra's Ghanadha), disturbed sabkha (Khalifa City, Abu Dhabi) to coastal marshland (e.g. abundant on the Sila'a Peninsula). ***Figure 11*** shows a detailed view of a typical branch. Note the fresh green colour of the plant (see also ***Figure 9***) which is quite different from the grey-green appearance of the vaguely similar and widespread *Salsola imbricata*.

Schismus barbatus

The distribution of this annual grass as given in the Wildflowers Guide (p. 90) is somewhat strange, having been recorded from Sabkhat Matti, Jebel Hafit and Musandam. In 2007, the authors found it in Taweela, Umm al-Qaiwain and Ra's al-Khaimah, where it is sporadic. The first author has also recorded it from higher elevations in Musandam (Sayh Plateau) and Jebel Hafit, as well as from the Sweihan-Al Hayer area, in eastern Abu Dhabi Emirate, where it was found to be locally common on stable sand sheets. This species is possibly distributed along the entire near-coastal region west of Abu Dhabi island, perhaps predominantly on rocky outcrops.

Sphaerocoma aucheri

The map in the Wildflowers Guide (p. 278) gives a good indication as to the distribution of the species in the UAE. It has also been recorded from Zirku Island by the first author. It is possible that the record from Jebel Hafit in the Wildflowers Guide is erroneous, as it can easily be confused with *Gymnocarpos decandrus* which is common on the mountain. ***Figures 2*** and ***3*** show *Sphaerocoma aucheri*.

Sporobolus iocladus

The map in the Wildflowers Guide (p. 95) gives a good indication as to the distribution of the species in the UAE, which is predominantly coastal. However, it has also been found by the first author well away from the coast in wadis, e.g. on Jebel Hafit and also in Aboule (near Buraimi, Oman).

Zygophyllum qatarense / *Z. mandavillei* / *Z. cf. migahidii*

The taxonomic status of perennial *Zygophyllum* species in the UAE is shrouded in confusion. The features that are used to distinguish them do not appear particularly reliable. This applies especially to *Z. mandavillei*, the *Zygophyllum* species generally thought to occur on inland plains, and its differentiation from *Z. qatarense*. According to Deil (2000), however, *Z. mandavillei* is restricted to a relatively small area of south-western Arabia. Mandaville (1990), whilst noting the taxonomic problems involved with the two species (even stating that the specimen depicted in the original description of *Z. mandavillei* is atypical), and pointing out the occurrence of intermediate forms between the two, does

Figure 11. Typical branch of *Salsola drummondii*. Note the characteristic pear-shaped leaves.

differentiate them. According to his distribution maps (based strictly on collection localities), *Z. mandavillei* appears to be confined to inland localities of the Rub al-Khali, whereas *Z. qatarense* is characteristic of coastal areas, but also occurring inland. If one were to adopt this approach, the maps in the Wildflowers Guide for the UAE (p. 554, 555, respectively) do appear to be reliable. Even along the coast, *Z. qatarense* displays quite substantial morphological variability, which in part is probably a response to varying substrate conditions (in particular salinity). In conclusion, therefore, until a thorough revision of the genus has been undertaken by experts, it seems advisable, in accordance with Deil (2000), to treat *Z. qatarense* and *Z. mandavillei* in the UAE as one taxon, namely *Z. qatarense*. This is also the view of Prof. A. Miller (*pers. comm.*), who regards the characteristics used to distinguish species in the original descriptions as unreliable, noting that in Oman only one variable taxon is involved.

Surprisingly, the highly distinctive *Zygophyllum* species that commonly occurs on the rocky slopes of Jebel Hafit is not differentiated in the Wildflowers Guide, but is apparently lumped under *Z. qatarense* (p. 555). However, it is markedly different from the taxa of the dunes and coastal areas, notably by the fact that it has grey tomentose leaves that are often 2-foliate. In fact, it appears to closely match the description of *Z. migahidii* provided by Mandaville (1990) for wadis and alluvial plains in parts of central Saudi Arabia (Brown & Sakkir, 2004a). Until a precise determination has been carried out, the species of Jebel Hafit (and possibly of other mountain slopes of the UAE) should be referred to as *Zygophyllum* cf. *migahidii*.

5. Conservation aspects

The collection of sound information on the identity and distribution of natural and semi-natural habitats is a vital tool for effective conservation planning. This is even more pressing in the case of the coastal areas in the UAE, which are currently being affected by large-scale infrastructure development (Deil & Müller-Hohenstein, 1996; Brown & Böer, 2005b; Brown *et al*., 2006). The vegetation of coastal areas, including that of the coastal white sands, is only superficially known in the country, particularly west of Abu Dhabi island. Western (1989) was the first author to give a brief introduction to the vegetation from Qatar to Ra's al-Khaimah. Deil & Müller-Hohenstein (1996) and Deil (1998; 2000) have covered specific aspects of the coastal vegetation, mainly in Dubai. More recently, general accounts, including that of the coastal white sands, have been published by Brown & Sakkir (2004b), Brown & Böer (2004, 2005a) and Brown (2006).

It is quite striking that, despite its conservation value and the degree of destruction which has been recognised, mainly by foreign scientists visiting the region (e.g. Deil & Müller-Hohenstein, 1996), the vegetation of coastal white sands has been all but ignored by researchers and authorities working in the UAE, and specifically within Abu Dhabi Emirate, except in the few isolated cases listed above. For instance, this vegetation type is not mentioned in the preliminary classification of vegetation of Abu Dhabi by Roshier *et al.* (1996), and, perhaps more surprisingly, coastal white sand vegetation is completely ignored by Loughland *et al.* (2004) in the recently published "Marine Atlas of Abu Dhabi", which claims to have "successfully documented the location and extent of coastal habitats throughout Abu Dhabi Emirate". It seems that in many cases, coastal vegetation is equated simply to mangroves, and other vegetation types are largely or completely ignored (as in the relevant chapters in Loughland *et al*., 2004), even though mangroves occupy only a small total area of the Abu Dhabi coastline. As underlined by Deil & Müller-Hohenstein (1996), the statement of Zohary (1973) still applies, particularly for coastal areas, that "we are especially ignorant of the vegetation in the Arabian Peninsula".

Brown & Böer (2004) listed the coastal white sands of Abu Dhabi Emirate as a "priority habitat type", i.e. one of exceptional conservation value, stating that the remaining stands should be a focus of conservation efforts. As mentioned above, a strong case for protecting the Taweela area was made by Aspinall (1999), mainly on account of its outstanding avifauna, and to complement a wider network of protected areas already proposed (Aspinall, 1996). It is to be hoped that at this late stage, some sections of the Taweela area can be protected for posterity.

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Acknowledgements

GB would like to thank Dr. Richard Perry (Abu Dhabi) for accommodation during a trip to the UAE in spring 2007 when some of the fieldwork was carried out. We are greatly indebted to Ms. Amina Al-Farsi (Muscat) for obtaining literature at very short notice. Professor Tony Miller (Edinburgh) is thanked for his comments on the taxonomic status of *Heliotropium* and *Zygophyllum*, and Gary Feulner gave some interesting insight into certain taxa. Dr. Peter Cowan (Aberdeen, Scotland) and Dr. Richard Hornby (Abu Dhabi) provided useful comments on the manuscript.

Appendix 1. Species occurring on the coastal white sands at Taweela

Appendix 1. Species occurring on the coastal white sands at Taweela

The following gives a list of species recorded from the coastal white sands in the Taweela area. Those species which are found predominantly in this habitat type in the UAE (although not necessarily exclusively) are labelled CWS. Information on abundance and distribution is based on observations from about eight separate locations scattered throughout the area and collected mainly in 2007 (i.e. in a season of good rainfall).

Aizoaceae
Aizoon canariense L. - Annual. Very rare. Only a few individuals recorded.
Mesembryanthemum nodiflorum L. - Annual. Extremely rare. Only a single individual recorded.

Asteraceae
Centaurea pseudosinaica Czerep. - Annual. Widespread and common.
Ifloga spicata (Forssk.) Sch. Bip. - Annual. Very rare and local.
Launaea capitata (Spreng.) Dandy. - Annual. Widespread and very common.
Launaea mucronata (Forssk.) Muschl. - Annual. Widespread and very common.
Senecio glaucus L. ssp. *coronopifolius* (Maire) C. Alexander. - Annual. Local.

Boraginaceae
Arnebia hispidissima (Lehm.) DC. - Annual. Widespread and very common.
Heliotropium kotschyi (Ledeb.) Guerke - Perennial. Widespread and very common.

Brassicaceae
Eremobium aegyptiacum (Spreng.) Boiss. - Annual. Very local.
Savignya parviflora (Del.) Webb - Annual. Rare.

Caryophyllaceae
Herniaria hemistemon J. Gay - Annual. Widespread and very common.
Paronychia arabica (L.) DC. - Annual. Widespread, but rare.
Polycarpaea repens (Forssk). Aschers. et Schweinf. - Perennial. Scattered, but rare.
Polycarpaea spicata Wight ex. Arn. - Annual. Scattered, rare (although easily overlooked) (CWS).
Sphaerocoma aucheri Boiss. - Perennial. Widespread and very common (CWS).

Chenopodiaceae
Cornulaca monacantha Del. - Perennial. Widespread and very common (CWS).
Salsola drummondii Ulbrich - Perennial. Very local.

Cistaceae
*Helianthemum lippi*i (L.) Dum. Cours. - Annual/biennial (?), perennial. Widespread and very common.

Cynomoriaceae
Cynomorium coccineum L. - Perennial. Very rare. Parasite on *Zygophyllum qatarense*.

Cyperaceae
Cyperus arenarius Retz. - Perennial. Widespread and very common (CWS).
Cyperus conglomeratus Rottb. - Perennial. Occasional.

Fabaceae
Crotalaria persica (Burm. F) Merrill. - Perennial. Very rare. Only known from the Jebel Ali-Taweela area in the UAE (CWS).
Hippocrepis areolata Desv. - Annual. Widespread and locally very common.
Indigofera cf. *intricata* Boiss - Perennial. Very rare.
Lotononis platycarpa (Viv.) Pic. Serm. - Annual. Occasional.
Lotus garcinii DC - Perennial. Local and rare (CWS).
Lotus halophilus Boiss. & Spruner - Annual. Widespread and very common.

Geraniaceae
Monsonia nivea (Decne.) Dechne. ex Webb - Annual. Rare.

Orobanchaceae
Cistanche tubulosa (Schrenk) Wight. - Perennial. Rare. Parasite mainly on *Cornulaca monacantha*, occasionally *Zygophyllum qatarense*.

Plantaginaceae
Plantago ovata Forssk. - Annual. Very rare.

Plumbaginaceae
Limonium axillare O. Kuntze -Perennial. Scattered.

Poaceae
Coelachyrum piercii (Benth.) Bor - Perennial. Very common, locally abundant (CWS).
Cutandia memphitica (Spreng.) Boiss. - Annual. Rare.
Eragrostis cilianensis (All.) Vign. - Annual. Rare.
Halopyrum mucronatum (L.) Stapf - Perennial. Very local.
Panicum turgidum Forssk. - Perennial. Widespread and common.
Pennisetum divisum (Gmel.) Henr.- Perennial. Scattered.
Rostraria pumila (Desf.) Tzvelev - Annual. Scattered and locally common.
Schismus barbatus (L.) Thell. - Annual. Scattered and locally common.
Sporobolus iocladus (Nees ex Trin.) Nees - Perennial. Widespread and common.
Stipagrostis plumosa (L.) Munro ex T. Anders. - Perennial. Very rare.

Resedaceae
Oligomeris linifolia (Vahl) J. F. Macbr. - Annual. Widespread and very common.

Zygophyllaceae
Fagonia indica Burm. f. - Annual. Local. Mainly on consolidated ground such as tracks.
Zygophyllum qatarense Hadidi - Perennial. Widespread.

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An Archaeological Baseline Study of Wadi Madhab, Fujairah

by Peter Hellyer and Michele C. Ziolkowski

Figure 1. General map of archaeological sites in Wadi Madhab and adjacent tributary wadis.

Introduction

During the autumn of 2007, the authors undertook an archaeological baseline study of the Wadi Madhab, Fujairah. This was commissioned by Hyder Consulting Middle East, on behalf of the ICG Group, Dubai, as part of planning for a residential and leisure property development covering much of the wadi and of several of its northern and western tributaries. Although previous archaeological work had been undertaken in the area, including both surveys and excavations, the new survey identified a large number of sites that had, apparently, not been previously recorded, including sites from the Iron Age, the pre-Islamic period, probable early or mid-Islamic sites and Late Islamic sites. While many of the newly-recorded sites were single pre-Islamic burial cairns, others included groups of cairns and large buildings.

A short summary of all sites now known to have been recorded in the Wadi Madhab is presented here, to complement and to supplement earlier publications.

Over the course of the last decade, numerous archaeological baseline studies have been undertaken throughout the United Arab Emirates by the authors and others, under the terms of commercial consultancy contracts. For the most part, the results of such surveys have not been published or otherwise made available to the archaeological community, or more widely, because of considerations relating to contract confidentiality. The only notable exception is much of the work undertaken in the Emirate of Abu Dhabi from 1995-2006 by the Abu Dhabi Islands Archaeological Survey, ADIAS, for members of the Abu Dhabi National Oil Company, ADNOC, group of companies. ADIAS ceased its operations in late 2006, following the establishment of the Abu Dhabi Authority for Culture and Heritage, ADACH.

This paper is presented, therefore, to provide an indication of the results being obtained in the UAE from such consultancy surveys.

The management of ICG are thanked for their permission to publish the summary results of the Wadi Madhab survey, and for their willingness to engage in detailed discussions with the authors at the planning stage for the development project to ensure that, as far as possible, significant archaeological sites were studied and/or protected.

General Description of the Wadi Madhab area

Wadi Madhab is a wide and gently sloping wadi lying immediately west of Fujairah City, on the eastern slopes and foothills of the Hajar Mountains, and is entered by a road running along the side of the palace of the Ruler, HH Sheikh Hamad bin Mohammed Al Sharqi. The area known locally as Wadi Madhab is, in fact, a low-lying plain, adjoined by several steep and narrower tributary wadis on its northern and western sides that drain the east-facing mountain slopes. Part of the main plain has been developed for small farms and two large enclosed gardens, within one of which lies the site of an old spring, Ain al-Madhab, now no longer flowing as a result of increased water extraction from the area in recent decades. A number of shallow gullies, caused by rainwater run-off, cross the plain, particularly close to its northern and southern edges, in a west-to-east direction. Along the edges of such gullies, and at several points where the removal of soil has been undertaken, there are exposed geological sections that indicate that much of the plain is comprised of a thick layer of silt and small gravels washed down by rainfall. It is presumed that much earlier evidence of occupation in the main part of Wadi Madhab is now buried under these silt and gravel deposits.

The tributary wadis and the inner parts of the main plain of Wadi Madhab are primarily typical sloping wadi terraces, cut by rainwater gullies, and covered with small rocks and boulders, which have provided the building material for many of the sites identified during the survey.

Notes on former inhabitants of Wadi Madhab

(by Abdullah bin Suhail al-Sharqi)

Until relatively recent times, the inhabitants of Wadi Madhab were from the small Bin Hilal tribe. The main settlement was in the north eastern part of the main wadi plain and in the adjacent smaller tributary wadis. The information that follows is drawn largely from two members of the tribe, Ali bin Awash and his father, Awash, who also kindly guided the author around the wadi to explain the nature and distribution of the tribe's settlement and associated activity. Further information has also been obtained from Sultan bin Hilal, now in his late 70s.

The Bin Hilal inhabitants were traditionally engaged in a small amount of cultivation and also kept livestock, primarily goats, which grazed on the central plain of Wadi Madhab, as well as in the tributary wadis and on surrounding hillsides. There were also a number of small date gardens, which were concealed behind the rocky spur containing the Islamic period hillfort and could not be seen from the coastal plain. This fort itself (Site WM-37) was known as Husn Awlad Braik, after a small tribe, the Libraikat, who formerly lived for a short time in this area of Wadi Madhab.

A number of other tribal groups also settled seasonally in Wadi Madhab during the summer, these including the al-Ghawayd, Shihuh, al-Zooaher and Libdah.

The informants stated that there were more than eight small farms, and more than three wells (only one of which is recorded in the Site Gazetteer, Site WM25, *below*), and that there was formerly an extensive *falaj* system in this area of the plain. As noted in the Site Gazetteer, the remains of one of the *falaj* channels has been identified during the archaeological survey (Site WM-29).

Deceased persons were buried in a cemetery adjacent to the existing Ain al-Madhab park, this cemetery now being fenced (Site WM-26). The last burial there, around 13 years ago, was of the mother of Sultan bin Hilal, one of those who provided information for this note.

The Bin Hilal inhabitants of Wadi Madhab began to leave their houses in the early 1970s and to move to the central plain of Fujairah, where more modern housing was being built for them by Government. At this time, only five or six houses still remained in use.

Previous work

The first known archaeological survey of the Wadi Madhab area was undertaken in the late 1960s by Beatrice de Cardi and Brian Doe (De Cardi and Doe 1971). No further formal archaeological work is known to have been undertaken prior to several seasons of study undertaken between 1987 – 1993 by a team from the Swiss-Liechtenstein Foundation for Archaeological Research Abroad, led by Pierre Corboud, this involving latterly an excavation of an Iron Age hill-top fortress, Husn Madhab, which lies on an outlier of the Hajar Mountains near the north-east entrance to the wadi (Corboud *et al*., 1990, 1991, 1994).

Further excavation was undertaken by a team from the University of Sydney, Australia, led by Daniel Potts, and including one of the authors (MC Ziolkowski), in the mid-1990s of a group of early Islamic copper ore roasting ovens in a tributary wadi at the south-west corner of the Wadi Madhab, while a team from France's Centre National pour les Recherches Scientifiques, CNRS, led by Anne Benoist, undertook a limited amount of survey work in 2000 (*pers. comm*. & Benoist 2002).

MC Ziolkowski also undertook independent survey and recording work in 1997 and 1998 during preparation of her doctoral thesis at the University of Sydney (Ziolkowski 2002).

A list of reports and publications arising from this earlier work is included in the Bibliography

Sites recorded during previous surveys are included in the Site Gazetteer, below, with original Site Numbers, where known, also being given.

Survey Scope

The survey of Wadi Madhab was conducted between September and mid-October 2007, with a brief follow-up survey in December 2007 to delineate several areas designated under the site development plan for protection, because of the presence within these areas of clusters of archaeological features. The survey covered the central wadi plain of Madhab and the tributary wadis (*'awdia*) to the north and west, with the objective being to create a preliminary record of the archaeological features present in the area, and to provide recommendations for

further survey, excavation and preservation. Ceramics (potsherds), where identified, were not removed from sites but were recorded *in situ*. Archaeological sites already known to exist in the area were also inspected.

Those areas which had already been extensively disturbed, such as inside the two fenced plantations, were not examined in detail. Each archaeological site noted in the October 2007 survey was given a site number (Site WM1 – WM32) and summary descriptions were recorded (including photographs and GPS coordinates). Site numbers in the WM format (WM-33 to WM-37) were also allocated to sites recorded during previous survey work, with original site numbers also noted where available, while two further sites identified during a December 2007 follow-up survey were also given site numbers (WM-38 and WM-39).

Where a number of archaeological features were recorded close to each other in a clearly-definable area, the features were grouped with a single site code, (e.g. Site WM-6).

Overview of the Archaeology of Wadi Madhab and its tributaries

As indicated by the results of earlier survey work, the Wadi Madhab area, including its tributaries, has a considerable number of archaeological sites. The number has been very extensively increased as a result of the recent field survey. In all, well over seventy individual archaeological sites and features have thus far been identified within the Wadi Madhab area.

There is considerable variety in the types of site present, including pre-Islamic tombs, which cannot be securely dated without excavation, and may range from the Wadi Suq period to the Late pre-Islamic period, and a Moslem cemetery, this latter having been used within the last fifteen years (*see above*), the remains of large stone buildings, sites related to industrial activity (the copper roasting ovens at Site WM-1), fortifications (two hill-forts), rocks with petroglyphs and ruined buildings and associated features of the Late Islamic period. There are also large raised mounds adjacent to the Islamic cemetery which may conceal earlier cemeteries or settlement evidence, although this cannot be confirmed without excavation.

Chronological periods represented include the Iron Age (1250 to 300 BC), the Late pre-Islamic period (300 BC to mid-7th Century AD), the early/mid Islamic period (mid-7th – 14th Century AD) and the later Islamic period, from the 16th-20th Century AD. It is considered probable that more sites indicative of occupation during the mid-Islamic period (10th-16th Century AD) are also present, perhaps buried as a result of the deposition of silt washed down by rainfall or perhaps concealed under occupation from later periods. Pottery of 14th-20th Century date has been identified that may fall into this period.

Although a number of sites have yet to be securely dated, it is evident, that the sites in Wadi Madhab and its tributaries, and on adjacent hillsides, provide evidence of broadly continuous occupation over a period of over 3,000 years. Evidence from the Bronze Age may yet remain to be identified, since tombs from this period have been recorded elsewhere along the East Coast of the United Arab Emirates, from Khor Kalba, in the south, to Dibba in the north. Large collective tombs of these Bronze Age periods have been identified on low-lying coastal plains or adjacent hillsides at, for example, Bidiya and Sharm, to the north, and Kalba, to the south, as well as within the confines of Fujairah City (Mereishid), where a tomb of this period was identified below the current ground surface during construction work, and similar structures may be concealed beneath the silt deposits on the central wadi plain of Wadi Madhab.

It has previously been suggested by one of the authors (MCZ) that the original main settlement on the Fujairah coastal plain may have been in Wadi Madhab, this perhaps being concealed from the coast by the presence on the main coastal plain of date palm groves. A similar pattern is present at several villages further north, e.g. at Qurrayah, with further extensive settlement in the Wadis Safad and Thayb that flow to the coast at Qurrayah.

It has been further suggested that the main occupation of the Fujairah plain commenced only following the building of the large fort (Fujairah Castle), in the Late Islamic period, and that there was then a gradual move of the centre of population coastwards from the Wadi Madhab to the area of the castle (Ziolkowski and al-Sharqi, *in press*).

Whether or not this interpretation of the evolution of the pattern of settlement is correct, it is evident that the archaeological sites in the Wadi Madhab area are crucial to any understanding of the historic and pre-historic pattern of settlement in the vicinity of the present-day Fujairah City. The presence of the two forts in Wadi Madhab, the Iron Age fort of Husn Madhab, which may also have been re-used in the Late Islamic period (Ziolkowski 2002), and the nearby Late Islamic hill-fort, Husn Awlad Braik, further indicate that the occupation was of regional, rather than purely local, importance. Thus the nearest other Iron Age forts known are at Bithna, inland, in the Wadi Ham, and at Awhala, to the south, and the Husn Madhab Iron Age fort, close to the coast, was presumably linked in some way with these, perhaps as part of a broader political entity.

The Wadi Madhab area contains archaeological sites which are of fundamental importance to any understanding of the evolution of the City of Fujairah and of the political entity of which it is capital.

Survey Gazetteer

Notes:

1. Datum is the WGS84 datum, in decimal degrees format

2. Illustrations are not provided for each individual newly-recorded site where many similar examples exist – e.g. single burial cairns of pre-Islamic date – for which only representative examples are presented, or for previously-identified sites.

Site WM-1

Previously published as Site 73 (Ziolkowski 2002:I: 167) Swiss Site 6 (Corboud et al 1988: 22; 1991: 6).

Copper roasting ovens, slag scatter and ore extraction zone.

GPS:
N 25.151333
E 56.294777

This site consists of five rock-built U-shaped copper roasting ovens built into the side of the mountain, with lumps of slag in the vicinity and an ore extraction zone on the opposite side of the wadi. There are fragments of stone walls present on the mountain slope opposite the ovens (Ziolkowski 2002:I: 167).

These ovens have direct parallels with early Islamic roasting ovens excavated by the German Mining Museum and others in the Sultanate of Oman, for example at the sites of Mullaq and Lasail (Weeks 2000: 207-8). Similar roasting ovens are also located at Wadi Safarfir, southern Ra's al-Khaimah, UAE (Weeks 2000: 208).

A charcoal sample obtained from one of the oven deposits at Wadi Madhab provided an AMS radiocarbon date range of 890-1015 cal. AD (2 sigma; Beta 91470: 1090 ± 30 BP; CALIB 3.0.3.c-Stuvier and Reimer 1993) (Weeks 2000: 208).

One glazed sherd was recovered from the site, and has been dated to the 7th to 10th centuries AD (Ziolkowski 2002:I: 253).

Figure 1. One of the copper roasting ovens at Site WM-1.

Site WM-2
Pre-Islamic cairn
GPS:
N 25.14902
E 56.29919

A small circular-shaped cairn, constructed with mountain rocks and using dry stone masonry. Located on the wadi plain south-east of the copper roasting ovens at site WM-1. No ceramic sherds or other associated finds.

Note concerning the small circular-shaped cairns

The feature at Site WM-2 and other pre-Islamic graves / cairns at other sites in the Wadi Madhab are comparable to three circular-shaped graves excavated by MCZ in Wadi Saqamqam, where over 50 such graves are present. None of those excavated in Wadi Saqamqam retained any material to permit definitive dating, but they have been compared to other such examples excavated at Traif, in Kalba, to the south of Wadi Madhab, by Dr. Sabah Jasim of the Sharjah Directorate of Archaeology. (Jasim, *n.d.*). They are all considered to be pre-Islamic in date (Ziolkowski 2003: 12). For a full discussion outlining the location of comparable graves, see Ziolkowski 2003: 9-10.

Comparable burial cairns have also been noted at Fara and Gizemri in Fujairah, south west of Wadi Madhab (Ziolkowski & al-Sharqi 2005: 206). Carl Phillips has excavated a number of similar burial cairns and smaller circular-shaped graves in the Kalba area and has proposed a date range of post Iron Age/Late pre-Islamic period (C Phillips *pers comm*: 2004), i.e. the period from around 300 BC to the mid-7th Century AD.

Figure 2. Cairn at Site WM-2

Site WM-3
Pre-Islamic cairn
GPS:
N 25.14965
E 56.29790

A small circular-shaped cairn, similar to WM-2. Located on the wadi plain south-east of the copper roasting ovens at Site WM-1. No ceramic sherds or other associated finds.

Site WM-4
Pre-Islamic grave
GPS:
N 25.14973
E 56.30175

A small circular-shaped cairn, similar to WM-2. Located on the wadi plain, close to the base of the mountain, south-east of the copper roasting ovens at site WM-1. No ceramic sherds or other associated finds.

Site WM-5
Pre-Islamic cairn
GPS:
N 25.14991
E 56.30118

A small circular-shaped cairn, similar to WM-2. Located on the wadi plain, close to the base of the mountain, south-east of the copper roasting ovens at site WM-1. No ceramic sherds or other associated finds.

Site WM- 6
Graves (pre-Islamic), enclosures and wall fragments
GPS

(Perimeter coordinates reflecting a large area with numerous features within)
(1)
N 25.15532
E 56.30037
(2)
N 25.15563
E 56.29962
(3)
N 25.15612
E 56.30072
(4)
N 25.15476
E 56.30169

These sites are all located within a tributary wadi. One body sherd of possible Iron Age date was recorded during the survey as well as a small body sherd of 'red coarse ware', dating from the Islamic period. Three wall fragments were also noted within the area.

Figure 3. Potsherd of possible Iron Age date associated with one of the circular cairns at Site WM-6.

Figure 4. 'Figure-of-eight' cairn at Site WM-6

Figure 5. Rectangular structure at Site WM-6

Archaeological Features present:

A: Circular cairns
A total of 12 small circular-shaped cairns, comparable to the single examples at Sites WM-2 to WM-5, above.

B. Figure-of-eight type burials
Four 'figure-of-eight' burials, each consisting of two circular-shaped graves built side by side and built of mountain rocks using dry stone masonry. Pending further investigation, these are presumed to date to the same period as the single graves/cairns. No associated finds.

C. Triple cairn
A group of three, possibly more, conjoined circular cairns, of the same construction as the single and 'figure-of-eight' graves, above, and of the same presumed date. No associated finds..

D. Rectangular stone enclosure
A large rectangular-shaped enclosure situated close to the base of the mountains, built of a double row of large mountain rocks and wadi boulders. The building is approximately 7.5 by 7 metres, with three walls surviving, those on the western and southern sides being the best preserved. There is no surviving wall on the eastern side, adjacent to the existing track. This may have been washed out as a result of downslope erosion.
The walls are wide and contain a rubble fill. 'Figure-of-eight' graves are attached to the exterior southern and eastern sides of the structure. No associated finds.

E. Oval structure with dividing wall
An oval-shaped stone structure with a dividing wall, built with mountain rocks and wadi boulders in dry stone masonry. Its date and function cannot yet be determined. No associated finds.

F. Structure of irregular shape.
An irregularly-shaped stone structure, built of mountain rocks using dry stone masonry, of undetermined date and function. No associated finds.

Figure 6. Oval structure at Site WM-6

Figure 7. Irregular-shaped structure at Site WM-6

Figure 8. Oval-shaped grave at Site WM-7

Site WM-7
Pre-Islamic cairns and structure.

GPS:
N 25.15750
E 56.29949

N 25.15714
E 56.29953

The features encompassed within this Site Code are all located between the above two coordinates and lie in the centre of a tributary wadi, on a slightly raised area. All features are constructed with large mountain rocks and wadi boulders using dry stone masonry. Features present include: a circular-shaped structure; two oval-shaped graves; two circular-shaped deflated burial cairns; and two small circular-shaped graves.

Figure 9. Two circular-shaped cairns at Site WM-7

Figure 10. Well-preserved circular grave at Site WM-8

Site WM-8
Pre-Islamic cairns and structures.
GPS:
N 25.15875
E 56.29948

The site is on the central plain of the wadi, with archaeological features present being two small circular-shaped graves, one being particularly well-preserved, and one conjoined grave, consisting of three circular-shaped graves, with two U-shaped rock-built structures close by. No ceramics or other associated material.

Figure 11. Structures on the wadi terrace at Site WM-9

Site WM-9
Settlement (?) and pre-Islamic grave
GPS:
N 25.15616
E 56.30220

This site is located on the eastern side of the wadi plain in a tributary wadi, in the vicinity of this GPS point.
The structures are both on the edge of the wadi terrace and at the base of the mountains and consists of a series of roughly square-shaped structures built with rocks and set in dry stone masonry. The structures are in varying states of preservation, and in some cases 4-5 courses of rock walling remain. The entrances to the three structures on the plain/terrace are on the eastern side of the structures.
The thirteen examples located at the base of the mountains opposite are set into the hillside. These are similar in shape and visible entrances are located on the western side of the structures.
Located close to the structures on the wadi plain is one small circular-shaped cairn, similar to those recorded elsewhere during the survey and of presumed pre-Islamic date.
No ceramic or other material evidence was noted at the site and both the date and function of these features is unclear.

Figure 12. Large cairn at Site WM-10

Site WM-10
Cairn (pre-Islamic)
GPS:
N 25.15564
E 56.30218

A large deflated circular-shaped burial cairn, with a visible central chamber, located close to Site WM 9 on the wadi plain.

Site WM-11
Structure and pre-Islamic graves
GPS:
N 25.15451
E 56.30412

Located to the south of sites WM-9 and WM-10 in a tributary wadi and close to the base of the mountains, this site includes a small semi-circular-shaped structure and two circular-shaped pre-Islamic period graves.

Figure 13. Pre-Islamic grave at Site WM-11

Figure 14. Oval structure at Site WM-13

Site WM-12
Pre-Islamic graves
GPS:
N 25.15396
E 56.30799

A group of pre-Islamic burials at the entrance to a tributary wadi and close to the base of the mountains, near the dirt track that leads into this wadi. Archaeological features present include four circular-shaped graves and one group of three circular-shaped conjoined graves. One body sherd of Fine Ware (orange) ceramic was noted, dating to the Islamic period (and, therefore, not associated with the graves).

Site WM-13
Oval structure
GPS:
N 25.15838
E 056.30736

Located in a tributary wadi, a heavily disturbed oval structure on the terrace on the south side of, and above, a small wadi bed, aligned roughly N-S. Dimensions c. 6 metres by 3 metres. No associated finds.

Figure 15. Large rectangular structure at Site WM-14, facing north-east

Site WM-14
Rectangular building
GPS:
N 25.15884
E 056. 30767

On the raised central terrace, near the south-western edge of a tributary wadi, the site comprises a large rectangular structure, partly dug into hillside at the upper (northern / north-eastern) end, constructed of locally available boulders, with a double-skinned wall and small gravel infill. Approximately 6 metres (northern & southern end) by 12 metres. At the lower, southern, end of the East-facing wall, is a small roughly-rectangular extension, with heavily disturbed walls, approximately 3 metres by 3 metres. A possible doorway is present approximately half-way along east side. Up to four courses of stone walling survive.
A second, small, heavily-disturbed structure is a few metres away from the NW corner, under a thorn tree.

Site WM-15
Pre-Islamic grave
GPS:
N 25.15635
E 56.30955

One small circular-shaped pre-Islamic grave located in the lower half of the wadi plain in a tributary wadi, comparable to other sites (e.g. WM-2, WM-3, above). No visible ceramics or other finds.

Site WM-16
Pre-Islamic grave
GPS:
N 25.15314
E 56.31136

A figure-eight type pre-Islamic grave consisting of two circular-shaped burials. Located in the lower half of the wadi plain in a tributary wadi. No visible ceramics or other finds.

Site WM-17
Pre-Islamic grave
GPS:
N 25.15160
E 56.31094

A small circular-shaped pre-Islamic grave located in the lower half of the wadi plain. No visible ceramics or other material.

Figure 16. U-shaped structure at Site WM-18

Site WM-18
Group of pre-Islamic graves and rock-built structures, located between the following GPS coordinates.

GPS:
N 25.15142
E 56.31193

N 25.15214
E 56.31213

These features are located in the lower half of the wadi terrace of a tributary wadi, close to the base of the mountains and a small jebel on the side of the plain. The features include a small circular-shaped grave; a badly deflated U-shaped structure built with mountain rocks, (where two, badly eroded body sherds of Iron Age type were noted; an irregular-shaped rock-built wall (?), consisting of a double row of rocks with a rubble fill (one body sherd present, of indeterminate type); another irregular-shaped wall (possibly the corner of a building), constructed with a double row of mountain rocks and a rubble fill; a Red Coarse Ware body sherd, (Islamic period); a second small circular-shaped grave; and a large circular-shaped deflated structure (indeterminate usage); a rim sherd of Fine Ware (cream) from an Islamic period water vessel.

Note: Subsequent survey in early 2008 identified several potsherds of mid-Islamic date.

Figure 17. Fragment of a wall at Site WM-18

Figure 18. Possible conjoined pre-Islamic graves at Site WM-19.

Site WM-19
Conjoined graves (?) of pre-Islamic date
GPS:
N 25.15080
E 56.31305

A rock-built feature consisting of an oval-shaped structure with two circular-shaped structures at either end. They may be pre-Islamic graves. This feature is located on the plain at the base of a small *jebel* at the entrance to a tributary wadi. The area is heavily disturbed due to relatively recent activity. No visible ceramics or other material.

Site WM-20
Islamic period remains

(Site WM-20A)
GPS: (Two oval-shaped features)
N 25.15198
E 56.31626

GPS: (Courtyard house and animal enclosure)
(Site WM-20B)
N 25.15091
E 56.31603

Towards the centre of a tributary wadi are two oval-shaped rock-built structures, likely to be related to the Late Islamic period remains located at the entrance to the wadi. These comprise the remains of a 'courtyard' house with an adjacent enclosure for livestock.

Figure 19. Oval-shaped structure, Site WM-20

Figure 20. Courtyard house and adjacent animal enclosure at Site WM-20

Site WM-21
Group of rock-built features
GPS:
N 25.14988
E 56.31665

A group of rock-built features located southeast of the entrance to a tributary wadi, on the plain but close to the base of the mountains. One structure consists of a long, irregular-shaped wall, built with a double row of rocks and a rubble fill. There is a possible figure-of-eight type grave but this is unclear. A rectangular-shaped structure with rounded corners is also present, which may be the remains of a badly-deflated *khaimah* type house of Islamic date. There is a large amount of relatively modern building activity in the immediate vicinity. No visible ceramics or other material noted.

Figure 21. Possible figure-of-eight type pre-Islamic grave at Site WM-21

Site WM-22
Late Islamic period courtyard house
GPS:
N 25.14939
E 56.31656

This site is located close to Site WM-21 and is situated on the central wadi plain. It consists of a large walled rectangular-shaped room built with mountain rocks, with an entrance along the southern (long) wall. The walls are preserved to a height of five courses. Attached to the front of the room is the remains of a low courtyard wall built with modern concrete blocks, added fairly recently, although there is no material evidence to indicate the date of construction of the large room. It is presumed to be of Late Islamic date.

Figure 22. Remains of room at Site WM-22

Site WM-23
Large rectangular-shaped structure
GPS:
N 25.14883
E 56.31948

Located at the base of the mountains, to the north of the entrance to the northernmost tributary wadi, Site WM-23 is a large, rectangular-shaped structure, constructed of mountain rocks and with patches of cement present along the walls, indicating relatively recent repair.
The interior contains a smaller room, constructed of cement blocks, built into the northeast corner and a small hearth at the front.
Ceramics (potsherds) present included a single Islamic period Red Coarse Ware sherd and two Iron Age body sherds.
The walls of this structure are quite wide and now badly deflated and it is possible that this feature represents an earlier building (purpose unknown), which was altered during the Late Islamic period. The existence of a large rectangular building in this area has been previously noted, by Anne Benoist, of the CNRS – France, who suggested that it might be of a pre-Islamic date (Benoist 2002: 44). This seems highly probable.

Figure 23. General view of deflated stone structure at Site WM-23

Site WM-24
Water bund (?)
GPS:
N 25.15049
E 56.32254

Located towards the rear area of the northernmost tributary wadi is a raised, curved wall, built into the slope of the wadi. It may be a water bund (deflector), to facilitate the collection of rainwater for irrigation. There were no visible ceramics or other material and the date of the feature cannot be determined.

Site WM-25
Water well
GPS:
N 25.14262
E 56.32025

Located on the central plain of Wadi Madhab, close to the Islamic cemetery, Site WM-25 is a well-maintained Late Islamic period water well.

Figure 24. Late Islamic period water well, Site WM-25

Site WM-26
Islamic Cemetery
GPS:
N 25.14065
E 56.31844

A large Islamic cemetery located on a large, low-lying mound, rising from the wadi plain behind the Ain Al Madhab Park. The cemetery was last used around 13 years ago (*see above*) and the site is fenced off.

Figure 25. General view of Islamic cemetery, Site WM-26

Site WM-27
Mounds
GPS:
N 25.14011
E 56.31771

This site is located directly beside the Islamic cemetery to the south. It consists of three large mounds, for which there appear to be four plausible explanations:
a) they are related to the removal and piling up of soil for agricultural purposes,
b) they contain earlier Islamic graves, from which the stone markers have now disappeared,
c) they contain settlement/burial remains (period indeterminate),
d) they were formed naturally.

Two sherds of Islamic period fine ware ceramic were noted on the surface of one mound although these may not be representative of any archaeological material that may be present below the surface since such pottery is widely distributed in the area.

Figure 26. View of mounds, showing rise in ground level, at Site WM-27

Site WM-28
Pre-Islamic grave
GPS:
N 25.14808
E 56.31360

Located on the central wadi plain of Wadi Madhab, close to, and on the Fujairah City side of, a large rectangular plantation, this site is a relatively well-preserved small circular-shaped grave. No visible ceramics or other archaeological material.

Site WM-29
Falaj
GPS:
N 25.14476
E 56.30781

Located on the central wadi plain, beside the dirt track, is a long 'wall', which resembles a silted-up water irrigation channel/*falaj* stretching for a distance of c. 130m. It appears to be badly disturbed. No visible ceramics or other archaeological material. A number of large depressions in the surrounding area are reminiscent of old, silted-up agricultural plots.

Figure 27. Portion of possible old *falaj*, Site WM-29

Site WM-30
Rectangular structure
GPS:
N 25.14595
E 56.30645

Located on the central wadi plain close to the previous site, WM-29, is a large rectangular-shaped, rock-built structure. It has wide walls with rubble fill. It is badly deflated and disturbed. No visible ceramics or other archaeological material. Its date and function is unclear.

Figure 28. General view of structure at Site WM-30

Site WM-31
Group of pre-Islamic graves

GPS (Located within the following coordinates)
N 25.14665 **N 25.14652**
E 56.29702 **E 56.29731**

N 25.14664 **N 25.14665**
E 56.29746 **E 56.29723**

Located on the western part of the main wadi plain, at the base of the mountains are the following features: a badly-deflated, large 'figure-of-eight' type grave (?) and six circular-shaped graves.

Figure 29. Possible figure-of-eight type grave at Site WM-31

Sites recorded during December 2008 follow-up survey

In the general vicinity of the Site WM-18 group of sites, two further, individual, cairns were noted which had not been recorded in the original survey. These lie close to each other, and are separated by several dozen metres from the nearest sites in the WM-18 group, from which they are divided by a shallow wadi.

Site WM-38
N 25.15256
E 056.30136

Circular stone cairn, probable pre-Islamic burial

Site WM-39
N 25.15239
E 056.31052

Circular stone cairn, probable pre-Islamic burial

Sites identified during previous surveys

Descriptions are summarised from earlier publications and from Ziolkowski *2007*. No illustrations are presented for these sites.

Site WM-32

(*Ziolkowski: 2007*).
Petroglyphs

N 25.14783
E 56.32694

The site is situated in the northernmost tributary wadi and consists of three large rocks with petroglyphs, several circular-shaped pre-Islamic graves, comparable to other examples elsewhere in the Wadi Madhab area, three circular-shaped rock enclosures and remnants of stone walling. It is located at the end of a dirt track that skirts the base of the mountains.
The petroglyphs are made with an outline formed by percussion, and include the following types of design:

Anthropomorphs (rider {and horse}, various).

Geometric (ovoid {foot}, various).

Zoomorphs (horse {and rider}).

Site WM-33

Previously published as Site 68 (Ziolkowski 2002:I: 164); (Swiss Site 61; Corboud et al. 1990: 29; 1991: 19). Beatrice de Cardi also noted a large number of burial cairns in the vicinity (de Cardi 1971: 256).

Lookout and pre-Islamic burials.

N 25.142638
E 56.327388

The site contains five pre-Islamic cairns, stone-built walls and raised platforms. The cairns are similar to those noted at Sharm, Bidyah, Qidfa, Qurayyah and Saqamqam, as well as elsewhere in Wadi Madhab. Two stone walls were also noted, plus a circular-shaped rise with a flat surface and stone retaining wall (Ziolkowski 2002:I: 164). The Swiss survey team recovered Iron Age period ceramics from this site (Corboud *et al*. 1991: 19).
The dating for the walling is unclear. It may be defensive in nature and related to the Islamic remains in the area.

Site WM-34

Previously recorded as Site 69 (Ziolkowski 2002:I: 164-5); (Swiss Site 60; Corboud et al. 1990: 29; 1991: 19). This site was first noted by Beatrice de Cardi (Site 24, Husn Madhab) (de Cardi 1971: 255).

Husn Madhab – Iron Age fort

N 25.144055
E 56.32675

An Iron Age fortress situated on the low-lying slopes of the mountains overlooking the plain of Fujairah. This hilltop fortress was built from locally sourced mountain rocks in dry stone masonry. The site contains a perimeter wall with an entrance on the northeastern side. Attached to the wall at various points are eight internal rooms or units.
The Swiss-Liechtenstein team excavated three trenches at this site in 1993 and noted the importance of this site due to its dimensions and the state of preservation (Corboud *et al.* 1994: 5-6). Ceramics from the site were studied by Anne Benoist, and she has subsequently dated the site to the end of the Iron II / beginning of the Iron III periods (Benoist 2002: 44). (Iron II: 1100-600BC; Iron III: 600-300BC). Benoist has noted the possibility of further Iron Age remains in the area (Benoist 2002: 44). According to Potts, the remains of a *falaj* of uncertain date is located nearby the Iron Age fortress (Potts 1990: 374).

One of the authors (MCZ) has also recovered Islamic period ceramics from the site and has proposed that it may have been re-used in later periods (Ziolkowski 2002:I: 164-5).

Site WM-35

Previously published as Site 70 (Ziolkowski 2002:I: 165); Swiss Site 62 (Corboud et al. 1990: 29; 1991: 19).

Defensive walls and pre-Islamic burials

GPS :
N 25.144638
E 56.326972

This site consists of eight pre-Islamic burial cairns and various stone wall fragments located on the low-lying slopes of the mountains, which overlook the plain of Fujairah. The cairns are similar to those noted elsewhere in Wadi Madhab and its tributaries, and elsewhere along

the UAE East Coast. The stone walls are constructed with dry stone masonry or a double row of mountain rocks with mud mortar and rubble fill (Ziolkowski 2002:I: 165). The Swiss survey team recovered Iron Age period ceramics from this site (Corboud *et al.* 1991: 19).

Site WM-36

Previously published as Site 71 (Ziolkowski 2002:I: 165); Swiss Site 36 (Corboud et al. 1988: 28; 1991: 13).

Fortification and pre-Islamic burials

GPS:
N 25.144833
E 56.329

This site consists of pre-Islamic burial cairns and a stone built wall constructed with mountain rocks in dry stone masonry. In this area, the Swiss survey team recorded a total of 76 pre-Islamic burial cairns. The sizes of these cairns vary in diameter from 1.5 to 3.5 metres (Corboud *et al.* 1991: 13).

Site WM-37

Previously published as Site 72 (Ziolkowski 2002:I: 165-7); Swiss Site 7 (Corboud et al. 1988: 22; 1991: 7). This site was first noted by Beatrice de Cardi (de Cardi 1971: 255-6).

Islamic period fortified settlement (Husn Awlad Braik)

GPS:
N 25.14392
E 56.32412

A defensive zone containing various structures and lookouts. The site is situated on the low-lying slopes of the mountains overlooking the plain of Fujairah and the plain of Wadi Madhab. This site contains a perimeter wall constructed with a double row of mountain rocks with a rubble fill. An entrance is located on the southeastern face. The walls contain defensive firing slots. Within the perimeter wall is a stone tower, square-shaped with rounded corners. The tower was constructed with a double row of mountain rocks containing mud mortar and gravel fill. The site contains two lookouts located outside the perimeter wall. The first lookout overlooks the entrance to Wadi Madhab, and the second overlooks the interior of the wadi.
This site is comparable with the Islamic period hilltop fortress in Wadi Safad, Fujairah. The construction techniques and layout are similar. For details see: King 1994; King & Maren-Griesbach 1999: 10-18; Longden & Garfi 2000: 5-7.
Local sources have noted (to MCZ) that this hillfort was already old by the time of the leadership of Sheikh Hamad bin Abdullah al-Sharqi in the late 19th century (Ali bin Abdullah, *pers. comm.*: 2004). While it is not possible to sight Fujairah fort from this hill-fort, one can see the western half of the plain of Fujairah including the entrance to the Wadi Ham, and the southeastern shoreline. However, the Iron Age hillfort (Site WM-34) can be sighted from the Islamic hillfort, and from this point one could see the fort and village of Fujairah
The base of the mountain contains a number of associated structures, including eleven rectilinear, semi-subterranean stone structures (*khaimah* type buildings), two rectangular–shaped structures of dry stone masonry, and one rectangular structure built with a double row of mountain rocks and rubble fill (Ziolkowski 2002:I: 165-6).
Ceramic sherds collected from the site have been dated from the 14th to 20th Centuries AD (Ziolkowski 2002:I: 239-53).

Acknowledgements

Professor Peter Magee, Bryn Mawr College, kindly examined a sherd from Site WM-18, while he and Professor Dan Potts, University of Sydney, reviewed the manuscript of this paper. They are thanked for their assistance. The ICG Group, Dubai, who commissioned the original survey as part of their plans for a residential and leisure development in the Wadi Madhab, are thanked for their permission for this summary publication of results. Abdullah S. al-Sharqi provided assistance during fieldwork.

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An Updated Illustrated Checklist of Dragonflies and Damselflies of the UAE

by Gary R. Feulner, Robert W. Reimer and Richard J. Hornby

Introduction

Graham Giles (1998) published an illustrated checklist of UAE damselflies and dragonflies (Order Odonata) numbering 20 species, and forecast the occurrence of several more on the basis of literature reports and his own excursions in northern Oman. That checklist is updated here by the addition of six species confirmed over the intervening years, all from among those mentioned by Giles: the damselflies *Ceriagrion glabrum*, *Pseudagrion decorum* and *Ischnura senegalensis*, and the dragonflies *Sympetrum fonscolombii*, *Crocothemis sanguinolenta* and *Orthetrum ransonneti*. The checklist is supplemented by brief notes about the habits and habitats of individual species in the UAE. Recent references of particular interest to field naturalists are also mentioned.

Fig 1a. *Arabineura khalidi* male. [RWR]

Fig 1b. *Arabineura khalidi* female. [RWR]

Fig 1c. Pairs of *Arabineura khalidi* ovipositing gregariously on a floating branch. [RWR]

<u>*Ceriagrion glabrum and Pseudagrion decorum.*</u> Two additional species, the damselflies *C. glabrum* and *P. decorum*, were reported from the UAE soon after publication of the original checklist (Feulner 1999) and *P. decorum* was found to be breeding regularly at the Rufaysah dam in Wadi Shi, near Khor Fakkan (Feulner 2001).

<u>*Ischnura senegalensis.*</u> Local recognition of a third additional damselfly species, *I. senegalensis*, had a much less straightforward history. In March 2006, two of the authors (Reimer and Hornby) observed and photographed a damselfly present in abundance in and near reeds fringing a large pond at a golf course under construction at Al Maqam, just west of Al-Ain. On the basis of their photographs and comparison with website images, they suspected it was something other than the similar *I. evansi*, a common UAE mountain species. However, they recognised the need for caution, since *I. evansi* and *I. senegalensis* are extremely close in appearance, no website images are available for *I. evansi*, no published resources specifically discuss field distinction of these two species, and the same authors had photographed almost identical-looking damselflies from mountain front water bodies in the Mahdhah area, NE of Al Ain and Buraimi, where *I. evansi* was presumptively the species present.

Definitive taxonomic identification of most damselfly species is based upon microscopic examination, particularly of genital anatomy, and the genus *Ischnura* is a notoriously difficult one since in many species females, and sometimes males, may be heterochromic and even heteromorphic (see ***Figs. 4b, c & d***); apparent hybrids have been described as well (W. Schneider, *pers. comm.*). Historically most experts have declined to attempt identification from photographs, so it appeared that definitive progress could only be made by collecting specimens for expert examination. However, as photographic technology has improved, permitting ever more detailed images, and as the number of amateur enthusiasts has grown, who wish to identify without risk of damaging or destroying, a measure of change has come to expert attitudes. K-D.B. Dijkstra and Richard Lewington have recently published a guidebook, *Field Guide to the Dragonflies of Britain and Europe* (Dijkstra & Lewington 2006), based on the premise that species distinctions, although only conclusively determined by traditional laboratory methods, will generally correlate with macroscopic distinctions of one sort or another that can be relied on by a conscientious observer in the field.

Dijkstra and Lewington's book includes most of the Odonata species that can be found in the UAE, but does not include either *I. evansi* or *I. senegalensis* (or any of the UAE's other damselflies), whose ranges do not extend to Europe. Dijkstra was nevertheless consulted and was kind enough to comment on the images obtained by Reimer. He was of the view that the photographs from a mountain front site near Mahdhah clearly showed *I. evansi*, on the basis of short anal appendages and pterostigmae completely filled with dark colour. On the other hand, it appeared to him that the Al Maqam photographs were consistent with *I. senegalensis* by virtue of the long lower appendages and the lesser extent of black in the pterostigmae (K-D.B. Dijkstra, *pers. comm.*). Wolfgang Schneider, viewing somewhat different photos from the same sites (mountain front and Al Maqam), came to a similar conclusion, likewise on the basis of the lower anal appendages, but emphasised the exceptional difficulty of distinguishing *Ischnura* species from photographs alone, and the need for voucher specimens to be certain (W. Schneider, *pers. comm.*).

At the same time, Schneider provided the information that *I. senegalensis* has in fact been definitively recorded within the UAE in recent years. Observations were made and a single voucher specimen taken by visiting naturalists in March 2001 at Ramtha Lagoon in Sharjah (now being transformed into Al Wasit Nature Reserve). Additional observations were made at Dubai's Wimpey Pits (now Al Warsen Lakes) and a site near the northern end of the "Mahdhah 64" road in northernmost Oman (Kappes & Kappes 2001, whose photographs demonstrate the extreme heterochromicity of female specimens). Schneider himself collected a copulating male and female *I. senegalensis* in late February 2005 at a pond near Sharjah University City.

On the basis of recordings to date, it appears that *I. evansi* is the predominant Ischnura species at mountain sites, consistent with prior understanding, but closer investigation now seems warranted to determine (1) whether *I. senegalensis* may have been overlooked heretofore at non-montane anthropogenic sites throughout the UAE, and (2) the extent to which *I. senegalensis* may also inhabit mountain sites sympatrically with *I. evansi.*

Fig 2a. *Arabicnemis caerulea* male. [RWR]

Fig 2b. *Arabicnemis caerulea* female. [RWR]

Fig 3. *Ceriagrion glabrum* male. [RWR]

Fig 4a. *Ischnura evansi* male. [RWR]

Fig 4b. *Ischnura evansi* female with andromorph (male-form) colouration. [RWR]

Fig 4c. *Ischnura evansi* female in one of two gynomorph (female-form) colourations. [RWR]

Fig 4d. *Ischnura evansi* female in a brighter gynomorph colouration. [GRF]

Fig 4e. *Ischnura evansi* mating in wheel formation. [RWR]

Fig 5a. *Ischnura senegalensis* male. [RJH]

Fig 5b. *Ischnura senegalensis* female with gynomorph colouration. [RWR]

Fig 5c. *Ischnura senegalensis* mating in wheel formation. [RJH]

Fig 5d. A hyper-abundance of *Ischnura senegalensis* at Maqam in March 2006. [RWR]

Sympetrum fonscolombii. On three occasions from 2000 to 2005, always in November, one of the authors (Feulner) observed and photographed single individuals of a red male dragonfly that was clearly not one of the several red or reddish species already known to occur in the UAE. *S. fonscolombii* was suspected. Reference to Askew (2004) permitted confirmation of the *Sympetrum* genus on the basis of wing venation, but it was not until the publication of Dijkstra (2006) that comparison of photographs, including one of an unidentified female in the author's collection, also photographed in November, allowed a confident identification of *S. fonscolombii.*

Schneider concurred in the interpretation of the photographs and provided the further information that *S. fonscolombii*, too, had been recorded in recent years by visiting naturalists: ca. 10 at Wadi Bih dam in mid-March 2001 (Kappes & Kappes 2001) and a single male at Fujairah National Dairy Farm in late January 2003 (Herren 2003).

The reported *S. fonscolombii* sites are extremely diverse (see notes below) and most observations have been of single individuals, but the initial suspicion of seasonal dispersal or migration in November is not supported by the observations of the visiting naturalists.

Crocothemis sanguinolenta. The discovery and identification of *C. sanguinolenta* was an exciting but less complicated affair, since Schneider himself collected a male and female at the popular waterfall and pools in Wadi Wurayah, Fujairah, during a brief visit in late February 2005 (W. Schneider, *pers. comm.*). *C. sanguinolenta* resembles the common *C. erythraea*, which generally frequents still and stagnant water, but it is smaller and has a noticeably thinner abdomen, which should facilitate discrimination by amateur observers.

Orthetrum ransonneti. An enigmatic blue *Orthetrum* has been observed and photographed in mountain wadis in the UAE and northernmost Oman over a number of years and was suspected to represent an unrecognised resident species (***Fig. 17a***). In habits and habitat it resembles *O. chrysostigma* but the pruinescent blue male does not have the waisted abdomen of *O. chrysostigma*. At the same time it is distinctly larger and has a heavier abdomen than *O. taeniolatum*, with which it otherwise agrees in general form, eye color (upper eye brownish rather than blue-green as in *O. chrysostigma*) and wing venation (as depicted in Askew (2004) and Dijkstra & Lewington (2006)). Older females of blue *Orthetrum* spp. may sometimes achieve the pruinescence characteristic of males (***see Fig. 17c***), which could give the false impression of a "blue" male with a thick abdomen, but photographs confirm that the blue specimens in question are in fact males.

Christopher Drew, then with Abu Dhabi's Environmental Research and Wildlife Development Agency (now the Environment Agency – Abu Dhabi, EAD), had concluded as early as 2002 that the unknown blue male was probably *O. ransonneti*, based on expected occurrences and the brief distinguishing information available in Askew (1988), including keys to related species (C. Drew, *pers. comm.*). However, available published keys did not include *O. ransonneti*, the species had not been encountered by Giles, no photographs or detailed descriptions were readily available, and at the time local amateurs were not yet in close communication with knowledgeable experts. As a result, an authoritative determination remained pending until the matter was reprised in connection with finalising the updated checklist presented here.

Inquiries were made, accompanied by photographs, to three distinguished experts acquainted with the dragonflies of Europe, the Near East and Africa, and actively engaged in regional studies. The initial responses served to emphasise that *O. ransonneti* is an uncommon species that remains poorly known and seldom collected, despite having a widespread distribution in arid regions from North Africa to Afghanistan. Only one of the experts consulted had ever seen it in the wild. In Oman, it has been collected on only a few occasions, in the mountains south and west of Muscat and also in Dhofar (Waterston & Pittaway 1991; Schneider & Dumont 1997). Thus while *O. ransonneti* was generally acknowledged as the presumptive choice (as originally reasoned by Drew), a positive identification remained elusive.

Observations and photographs by Feulner made it possible to associate the enigmatic blue male with a brownish female having a distinctive banded abdomen and thoracic markings (***Fig. 17b***), but even this information did not advance matters. The experts were uniform in expressing their interest in the distinctive female, but all professed to be unacquainted with any *Orthetrum* like it (W. Schneider, *pers. comm.*; K-D.B. Dijkstra, *pers. comm.*, V. Kalkman, *pers. comm.*).

It was apparent that expert review of actual specimens would be required to resolve the mystery. A convenient opportunity presented itself almost immediately in the form of a visit to the UAE by Vincent Kalkman in February 2008, in connection with his responsibilities as chair of the Odonata Group of the IUCN. Reimer escorted Kalkman on a field trip to a mountain front site where they were successful in collecting a specimen of the putative *O. ransonneti* male. Kalkman's positive verdict came in an e-mail from Holland a few days later, and was based upon examination of the secondary genitalia plus direct comparison with specimens of *O. ransonneti* in his care at the Netherlands National Museum of Natural History (three males from Egypt and Turkey and a female from Iran, two of them dating to the 19th century). Preserved specimens of dragonflies lose most of their original colour, but Kalkman noted that the single female specimen seemed to show the same banded triangles on the abdomen as seen in photos of UAE females.

Some characteristics that may assist in field identification of *O. ransonneti* are mentioned in the notes below.

Possible additional species

Inevitably, additional species can be expected to appear from time to time in the UAE, at least temporarily. Giles (1998) has already mentioned the possibility of *Trithemis pallidinervis* (Kirby, 1889), *Tramea basilaris* (Beauvais, 1817) and *Urothemis thomasi* (Longfield 1932), which have been reported from northern Oman. A report exists of *Sympetrum meridionale* (two males) at Wimpey Pits in Dubai (Kappes & Kappes 2001) but is considered unconfirmed; if correct, it would represent a first record for Arabia (W. Schneider, *pers. comm.*).

Even apart from the possibility of new species, identification can sometimes be problematic. Females of *O. chrysostigma* seen independently by two of the authors (Feulner and Reimer) in disparate environments in the greater Al Ain/Buraimi area in late 2007 were unusually ruddy in colour (***Fig. 16c***) and could not be positively identified until they were found and photographed by Reimer in association with more typical specimens. Perhaps they were teneral, i.e. recently emerged. The same authors have also observed unusually small specimens of *Crocothemis erythraea* in the Mahdhah area of Northern Oman, which raised questions of identification (see notes below).

Checklist of UAE Odonata species

	Vernacular Name*
ZYGOPTERA (Damselflies)	
Family Protoneuridae	
1. ***Arabineura khalidi* (Schneider, 1988)**	Hajar Wadi Damsel
Family Platycnemididae	
2. ***Arabicnemis caerulea* Waterston, 1984**	[Powder Blue Damsel]
Family Coenagrionidae	
3. ***Ceriagrion glabrum* (Burmeister, 1839)**	[Olive-Eyes Damsel]
4. ***Ischnura evansi* Morton, 1919**	Evans' Bluetail [Blue-Banded Damsel]
5. ***Ischnura senegalensis* (Rambur, 1842)**	*Senegal Bluetail*
6. ***Pseudagrion decorum* (Rambur, 1842)**	*Elegant Sprite*
ANISOPTERA (Dragonflies)	
Family Gomphidae	
7. ***Lindenia tetraphylla* (Vander Linden, 1825)**	Bladetail [Arabian Lobetail]
8. ***Paragomphus genei* (Sélys, 1841)**	*Green Hooktail*
9. ***Paragomphus sinaiticus* (Morton, 1929)**	*Sinai Hooktail*
Family Aeshnidae	
10. ***Anax imperator* Leach, 1815**	Blue Emperor [Emperor]
11. **A*nax parthenope* Sélys, 1839**	*Lesser Emperor*
12. ***Anax ephippiger* (Burmeister, 1839)**	*Vagrant Emperor*
Family Libellulidae	
13. ***Crocothemis erythraea* (Brullé, 1831)**	Broad Scarlet [Carmine Darter]
14. ***Crocothemis sanguinolenta* (Burmeister, 1839)**	*Bloody Scarlet*
15. ***Diplacodes lefebvrei* (Rambur, 1842)**	Black Percher [Purple Darter]
16. ***Orthetrum chrysostigma* (Burmeister, 1839)**	Epaulet Skimmer [Girdled Skimmer]
17. ***Orthetrum ransonneti* (Brauer, 1865)**	
18. ***Orthetrum sabina* (Drury, 1773)**	Slender Skimmer [Oasis Skimmer]
19. ***Orthetrum taeniolatum* (Schneider, 1845)**	Small Skimmer [Azure Skimmer]
20. ***Pantala flavescens* (Fabricius, 1798)**	Wandering Glider [Globe Skimmer]
21. ***Selysiothemis nigra* (Vander Linden, 1825)**	Black Pennant [Desert Darter]
22. ***Sympetrum fonscolombii* (Sélys, 1840)**	*Red-Veined Darter*
23. ***Trithemis annulata* (Beauvais, 1807)**	Violet Dropwing [Purple-Blushed Darter]
24. ***Trithemis arteriosa* (Burmeister, 1839)**	Red-veined Dropwing [Gulley Darter]
25. ***Trithemis kirbyi* Sélys 1891**	Orange-winged Dropwing [Orange Darter]
26. ***Zygonyx torridus* (Kirby, 1889)**	Ringed Cascader

[*Note: Most of the vernacular or common names listed above are taken from Dijkstra & Lewington (2006) or Walker & Pittaway (1987). Names from the latter are shown in [brackets]. For species not included in either of those references, the authors have proposed common names (shown in *italics*) based on the scientific names, except in the case of the Hajar Wadi Damsel, *Arabineura khalidi*, a species frequently encountered by local naturalists, whose name is intended to reflect its endemic status and typical habitat. Although the use of common names may seem to make the subject initially more accessible (and they are included here for that purpose), the reader is cautioned that "common" names are not necessarily in common use, and may differ from place to place and from author to author. Moreover, they may sometimes be contradictory. For example, Walker & Pittaway call *Selysiothemis nigra* the "Desert Darter", the same name used by Dijkstra & Lewington for *Sympetrum sinaiticum*, a species not found in Arabia. In order to avoid confusion of this sort, the authors have relied on and strongly recommend the use of scientific names.]

Fig 6a. *Pseudagrion decorum* male. [GRF]

Fig 6b. *Pseudagrion decorum* pair mating in wheel formation. [GRF]

Fig 7a. Mature *Lindenia tetraphylla* male from Dhofar, Oman. [RWR]

Fig 7b. Immature *Lindenia tetraphylla* male from Kuwait, probably only a day old (V. Kalkman, *pers. comm.*) [Gary M. Brown]

Fig 7c. *Lindenia tetraphylla* mating pair from Dhofar, Oman. [RWR]

Fig 8a. *Paragomphus genei* male. [RWR]

Fig 8b. *Paragomphus genei* female. [RWR]

Fig 9a. *Paragomphus sinaiticus* male. [GRF]

Fig 9b. *Paragomphus sinaiticus* female. [GRF]

Fig 9c. *Paragomphus sinaiticus* exuvia, the shell left behind when the adult dragonfly emerges. [RWR]

Fig 10a. *Anax imperator* male. [RWR]

Fig 10b. A dead female *Anax imperator*. [GRF]

Fig 10c. *Anax imperator* larva. [RWR]

Fig 11. *Anax parthenope* male. [RWR]

Fig 12a. *Anax ephippiger* male. [RWR]

Fig 12b. A male *Anax ephippiger* guards a female as she lays her eggs on a reed. [RWR]

Fig 13a. *Crocothemis erythrea* male. [GRF]

Fig 13b. *Crocothemis erythrea* female. [GRF]

Fig 13c. *Crocothemis erythraea* female showing colouration resembling a male *Trithemis annulata*. It was seen mating and ovipositing. [RWR]

Fig 14. *Crocothemis sanguinolenta* male from South Africa. [John C. Abbott]

Fig 15a. *Diplacodes lefebvrei* male. [RWR]

Fig 15b. *Diplacodes lefebvrei* female. [RWR]

Fig 16a. *Orthetrum chrysostigm*a male. [GRF]

Fig 16b. *Orthetrum chrysostigma* female. [GRF]

Fig 16c. Young *Orthetrum chrysostigma* female. [RWR]

Fig 17a. *Orthetrum ransonneti* male. [GRF]

Fig 17b. *Orthetrum ransonneti* female. [GRF]

Fig 17c. Mating pair of *Orthetrum ransonneti*. [GRF]

Fig 18a. *Orthetrum sabina* male (sexes alike).
[Barbara R. Reimer]

Fig 18b. An *Orthetrum sabina* consumes another dragonfly it has captured. [GRF]

Fig 19a. *Orthetrum taeniolatum* male from Greece. [Paul Cools]

Fig 19b. *Orthetrum taeniolatum* female from Greece. [Paul Cools]

Notes on habits and habitats

The notes below are intended to give an indication of the typical habitats and behaviour of the UAE's dragonfly and damselfly species, which may aid in locating and identifying them. Most Odonata, although not all, are found in close association with freshwater habitats. As a result, many species have been relatively scarce in recent years due to the prolonged drought of 1999 through 2004.

In our area, dragonfly diversity is generally greatest at sites along or just within the mountain front, including traditional plantations, which typically afford a combination of freshwater bodies (natural pools and streams as well as man-made ponds and *falaj* systems) and a diversity of microenvironments. Reliable dragonfly sites are somewhat more common in the south of the UAE's mountain areas and in the adjacent areas of northern Oman (Wilayat Mahdhah), where permanent surface water is more abundant than in the north. For the same reason, dragonflies are uncommon in the Musandam region, where surface water is normally scarce. Based on local experience, the most diverse site so far encountered is the so-called Hatta Pools (located in Wadi Qahfi in northern Oman), where 15 species were observed within a 150-200m radius in mid-April 1998, following three years of rainfall substantially above the average.

Male dragonflies are generally more colourful and distinctive than females. In addition, males of most species stake out a territory near water where they perch and/or patrol, and are therefore readily seen. Most females come to water only for food and sex, including egg laying (oviposition), but they can often be found perched among nearby vegetation (e.g. *Arabicnemia caerulea*, *Crocothemis erythraea*) or rocks (e.g. *Trithemis arteriosa*). Copulation resembles a dragonfly version of *soixante-neuf* called the "wheel" position and in most species can be maintained in flight. In damselflies copulation can be a protracted affair lasting hours. Egg-laying (oviposition) by females is accomplished by depositing eggs on the water surface (Libellulids) or in slits in submerged vegetation (damselflies and Aeshnids). In many species an ovipositing female is "guarded" by a male (her latest consort) (***Fig. 12b***) or flies in tandem with him (head to tail, male in front).

Many of the local species have adjusted their behaviour and physiology to the circumstances of the Arabian environment. For example, whereas in Europe most dragonflies are active only during the warmer part of the day, in the UAE many species rest in the shade during the heat of the day; in warmer weather they may fly even at dusk. Similarly, species which in Europe may spend as much as two years as pond-dwelling larvae develop in temporary pools in the UAE in a matter of two or three months (e.g. *Anax imperator*).

Arabineura khalidi. The most common damselfly in mountain wadis, often found over gravel wadi beds far from surface water. Does not typically seek shade or cover. Cryptic colouration blends well with wadi rocks, making it difficult to follow in flight. Often oviposits en masse on floating and decaying vegetation (***Fig. 1c***). Endemic to wadis of the Hajar Mountains of UAE and northern Oman, but now known to be much more common and widespread than previously thought. Synonym: *Elattoneura khalidi*. [Note: The photos of *A. khalidi* and *A. caerulea* in Giles (1998) were inadvertently reversed.]

Arabicnemis caerulea. Mountain wadis, among vegetation at and near shallow pools. Powder blue male is distinctive; female duller, grayish. Also found in Yemen (Walker & Pittaway 1987; Schneider & Dumont 1997). [Note: The photos of *A. khalidi* and *A. caerulea* in Giles (1998) were inadvertently reversed.]

Ceriagrion glabrum. Rare. Single UAE site in Wadi Qawr, near abundant but temporary water and in association with dry reeds, where its striking colour may in fact be cryptic. Also found at mountain front plantations in N. Oman, likewise in association with reeds.

Ischnura evansi. Common among low or overhanging vegetation immediately adjacent to shallow pools, irrigation ditches, artificial ponds. Also at freshwater springs within Dhayah salt marsh, Ra's al-Khaimah. Female heterochrome; thorax may be vivid orange. Possible field confusion with *I. senegalensis*, especially at anthropogenic sites. Nocturnal migration has been reported in Kuwait (Waterston & Pittaway 1991) and eastern Saudi Arabia (Schneider & Dumont 1997).

Ischnura senegalensis. Hyperabundant at pond at Al Maqam Equestrian Centre & Golf Club in Al Ain, in and adjacent to reeds. Also Ramtha Lagoon (Al Wasit), Sharjah and Wimpey Pits (Al Warsen Lakes), Dubai. One natural site at pools at N. end of "Mahdhah 64" road, northernmost Oman. Possibly overlooked elsewhere due to confusion with *I. evansi*. See also discussion in main text, above.

Pseudagrion decorum. Uncommon, generally at larger pools in mountain wadis (W. Maydaq, W. Qawr dam); breeds regularly at Rufaysah dam (Wadi Shi, Khor Fakkan). Males often perch in the open on fixed or floating vegetation. Female oviposits underwater by descending a plant stem (Feulner 2001).

Lindenia tetraphylla. Rare. A migrant species. No specific UAE records or specimens are known (Schorr *et al.* 1998; Schneider *pers. comm.*), but found in neighbouring countries, e.g. Kuwait and northern Oman. Range shown in Walker & Pittaway (1987) includes UAE. N. Oman records from flowing water (Giles 1998); Dhofar records from slow-flowing large stream (Wadi Darbat); Kuwait records from coastal desert. Habitat in Europe is typically large lakes or slow-flowing rivers, with or without vegetation.

Paragomphus genei. Rare. Scattered wadi sites near vegetation, including plantations and falajes (traditional irrigation channels). Multiple sightings along *falaj* in W.

Sharm, northern Oman, in March and April 2007, including mating pairs. Apparently a migrant, not seen during drought years.

Paragomphus sinaiticus. Common, perches on exposed rocks beside larger wadi pools. Returns to original perch after sorties.

Anax imperator. Common. Electric blue male unmistakable. Males patrol territorially over pools or chains of pools in mountain wadis. Abdomen slightly arched in slow flight. In summer, may perch frequently, hanging in tall vegetation. Females oviposit alone and unguarded, unlike other UAE *Anax* spp.

Anax parthenope. Uncommon. Rare during turn-of-century drought. Occasional at wadi pools with vegetation. Also at freshwater springs within Dhayah salt marsh, Ra's al-Khaimah.

Anax ephippiger. Widespread, from sand desert (Liwa, Umm az-Zamul) to Hajar Mountains and Musandam. Swarms regularly seen in January. May be found far from water, including highest mountains. Most common dragonfly in sand deserts of Abu Dhabi. Only local *Anax* which may appear yellowish in flight. Synonym: *Hemianax ephippiger*.

Crocothemis erythraea. Common at pools with fringing vegetation, including stagnant and foul water. Red males dominant over most other perching Libellulid species. Females often relatively common and conspicuous in nearby vegetation. Females on the Saiq Plateau of Oman are a darker brown than those seen in the UAE and neighbouring Oman.

[Note: In late 2007, a number of specimens were observed in the Mahdhah area of Oman that appeared to be distinctly smaller than typical *C. erythraea*. In particular, the characteristic flattened, swaybacked abdomen was shorter, so that these dragonflies were not significantly longer than the associated *Trithemis arteriosa*. They are reckoned to be *C. erythraea* (W. Schneider, *pers. comm*.; K-D.B. Dijkstra, *pers. comm*.), but the presence of such atypical individuals, especially in relatively open, atypical habitats for *C. erythraea*, is a reminder of the need for observers to be aware of the possibility that an unrecognised species could be present. In particular, in the case of *C. erythraea*, a closely-related sister species, *C. servilia* (Drury, 1773) ranges from southern Turkey eastward across Asia, and has been described as the oriental counterpart of the European and North African *C. erythraea* (Dijkstra & Lewington 2006). The two were considered synonymous by some authors, but detailed anatomical studies have supported a distinction (Askew 2004). It is not impossible that the ranges of the two species could overlap in the Hajar Mountains. Unfortunately, field discrimination alone must be considered unreliable. *C. servilia* is described as slightly smaller and sleeker than *C. erythraea*, but adults are virtually identical in most other macroscopic respects (Dijkstra & Lewington 2006).]

Crocothemis sanguinolenta. Single known site at pools near permanent waterfall in Wadi Wurayah, Fujairah. See also discussion in main text, above.

Diplacodes lefebvrei. Common near larger natural and man-made water bodies, e.g. Wimpey Pits (Al Warsen Lakes), Al Maqam golf course pond. Also at freshwater springs within Dhayah salt marsh, Ra's al-Khaimah. Often perches in obelisk position (i.e., with the abdomen held relatively erect). A small species that defers to others. In the UAE both the black male and pale female can be confused with *Selysiothemis nigra*. Distinguishing features of *D. lefebvrei* are: long, relatively dark-coloured pterostigma; small orange patch at base of hindwing; wing venation is distinct, with small cells; dark males have a dark face (frons); white claspers contrast with black abdomen in male.

Orthetrum chrysostigma. Common in mountain wadis. Perches on rocks (and to a lesser extent vegetation) near pools. Pale blue male is readily distinguished by pinched "waist" at base of abdomen.

Orthetrum ransonneti. Occasional in mountain wadis. Perches on exposed rocks near pools, frequently hanging on vertical surfaces. Seen in all seasons, including extremes of heat and cold. Sympatric with *O. chrysostigma*. Female may oviposit unescorted. Considered an arid region specialist. See also discussion in main text, above.

[Note: Although the identity of *O. ransonneti* is confirmed for the first time in this report, it is not uncommon in the UAE and N. Oman and has been observed in mountain and mountain front habitats from at least the Tayyibah area (N of Masafi) to the greater Al-Ain/Buraimi area, including Wilayat Mahdhah, Oman and rocky wadis at the base of Jebel Hafit in the UAE, in the newly developed area known as Green Mubazzarah. Globally it is an uncommon species that remains poorly known, despite having a widespread distribution in arid regions from North Africa to Afghanistan, but excluding western Arabia (Waterston & Pittaway 1989). The blue male is readily distinguishable in the field from *O. chrysostigma* by its robust and uniformly tapered abdomen; absence of amber colour at the base of the hindwings; pale blue face; upper eye brown, not green; and relatively short pterostigma. Its large size (= *O. chrysostigma*) distinguishes it from *O. taeniolatum*, with which it shares some of the foregoing characteristics. Female is distinctive: abdomen is vividly banded with dark triangles dorsally.]

Fig 20a. *Panatala flavescens* male. [Graham B. Giles]

Fig 20b. *Panatala flavescens* female. [RJH]

Fig 21a. *Selysiothemis nigra* male. [RWR]

Fig 21b. *Selysiothemis nigra* female. [RWR]

Fig 22a. *Sympetrum fonscolombii* male. [GRF]

Fig 22b. *Sympetrum fonscolombii* female. [GRF]

Fig 23a. *Trithemis annulata* male. [RWR]

Fig 23b. *Trithemis annulata* female. [GRF]

Fig 23c. A female has difficulty emerging from its exuvia. [RWR]

Fig 24a. *Trithemis arteriosa* male. [GRF]

Fig 24b. *Trithemis arteriosa* female. [RWR]

Fig 24c. *Trithemis arteriosa* female lacking the wing spots that are typical of UAE females of this species (see Fig. 24b) but uncommon in African females. [GRF]

Fig 24d. Immature male *Trithemis arteriosa*. [GRF]

Fig 24e. Immature male *Trithemis arteriosa*. [GRF]

Orthetrum sabina. The most common species at stagnant and foul water, found in irrigation ditches, sumps (e.g. Ramtha lagoon [Al Wasit]) and temporary ponds on saline waste ground, but also at larger wadi pools. Perches on vegetation. Observed to prey on small butterflies and other dragonflies (***Fig. 18b***).

Orthetrum taeniolatum. Rare in mountain wadis. Small, pale blue male may be sympatric with the similar *O. chrysostigma*.

[Note: The diminutive *O. taeniolatum* must be considered one of the rarest of the UAE's dragonflies. The species ranges across the Eremic Zone from North Africa through Northern India, including western Arabia (Waterston & Pittaway 1989). However, two surveys in Northern Oman in the early 1990s did not add to the single prior record from that area (Schneider & Dumont 1997). Giles (1998) recorded several UAE sightings during the "wet" years of the mid-1990s but it has not been recorded thereafter by any of the present authors. Moreover, accumulated experience permits us to question several of Giles' photographic records, which appear to be atypical individuals of other species. Ironically, Giles did not encounter *O. ransonneti*, which most closely resembles *O. taeniolatum* in various details other than size (uniformly tapered abdomen, no amber colour at the wing base, relatively short pterostigma). It may be best to regard *O. taeniolatum* as an infrequent migrant whose presence in the UAE and Oman may depend upon exceptional rainfall or other conditions.]

Pantala flavescens. Widespread and locally common. Patrols with dipped abdomen, usually more than c.1.5m above ground. Seldom perches. One of the first species to appear after rainfall in an area, sometimes in swarms. Groups often patrol near trees. May be found far from water, including highest mountains. Occasional in sand desert. Occasional in mangroves, where it is the most commonly observed dragonfly. Swarms also observed at other coastal sites. Regular flight periods have been reported in Arabia in March-April and October-January (Waterston & Pittaway 1991; Schneider & Dumont 1997).

Selysiothemis nigra. Uncommon but migratory and can be locally abundant at large man-made water bodies, e.g.: Rufaysah Dam (Wadi Shi, Khor Fakkan); Al Warsen Lakes (formerly Wimpey Pits), Dubai, where males have patrolled in swarms while associated females perched on nearby waste ground; and the Al Maqam golf course pond in Al-Ain, where a swarm migrated through in May 2007. Occasional females on low shrubs on waste ground in the Dubai hinterland. Often perches in obelisk position.

[Note: In the UAE both the dark male and pale female can be confused with *Diplacodes lefebvrei*. Distinguishing features of *S. nigra* are: short, very pale pterostigma with distinct anterior and posterior margins that together resemble an "equal sign" (=); face (frons) remains pale, even in dark gray males; wing venation is indistinct and somewhat translucent, with large cells; male claspers somewhat orange coloured; broad interior of hindwing.]

Sympetrum fonscolombii. Scattered records of single individuals from diverse sites: coastal salt bushes, coastal hills, a low-lying suburban dump site, a dairy farm and a large, remote, permanent mountain pool; plus ca. 10 individuals at Wadi Bih dam. See also discussion in main text, above.

Trithemis annulata. Common at larger, still or stagnant water bodies. Perches on vegetation, less commonly on rock or concrete.

Trithemis arteriosa. The most common dragonfly in rocky mountain wadis. Males perch prominently on rock or vegetation near even the smallest pools, usually in obelisk position. They typically return to original perch after brief sorties. Thin abdomen of male is diagnostic (but colour is yellow in immatures). Female perches on rock or shrubs in general vicinity of pools. Distinctive orange wing spots are rarely absent in UAE and Oman females. Very tolerant of close observation. Males bold and will challenge other dragonflies despite small size.

Trithemis kirbyi. Common in larger mountain wadis. Males perch low on rocks and gravel beside shallow flowing water, usually in bright sun. Females often far from water, in trees and shrubs. Large amber patches at base of both forewings and hindwings are diagnostic in male and female.

Zygonyx torridus. Patrols over flowing water, often 1-2m high, seldom perches. Rare in drought years. Male blue-black, female blue-gray, both with light banding on sides of abdomen.

Dragonfly identification and recommended references

The identification and classification of dragonflies and damselflies, like most of insect taxonomy, is a matter for specialists in the first instance, and is typically based on features not readily apparent in the field (often details of the genitalia). Nevertheless, many species are in fact visually distinctive, and many others, although less distinctive, can be discriminated by conscientious and informed field observers, once expert study has established the macroscopic features that can reliably be used to distinguish them.

In the case of Odonata generally, field identification on the basis of colouration is complicated by the fact that for several days after emergence, the colouration of immature individuals may be very different from that of typical adults (see Figs. 16c, 24d, 24e, 25c), and in some species even adults may continue to darken as they mature. In addition, the same species may vary somewhat within its geographic range. Damselflies (*Zygoptera*) are generally more difficult to distinguish than dragonflies (Anisoptera), not only because they are smaller, but because macroscopic differences are less readily observable and individual species may be more

variable in appearance (see ***Figs. 4b, c & d***).

Two printed resources have been mentioned above which should routinely be consulted in connection with the identification of problematic Odonata in the UAE. These are Askew (2004) and Dijkstra & Lewington (2006). However, neither of these pretends to be comprehensive for Arabia and both of them largely exclude the species of Asian origin that can be found there. Field observers in the UAE and Oman may therefore also wish to consult the several regional studies and other resources referenced below.

Online pictorial libraries are now available for both Europe and Asia (see references below). Arabia is unfortunately not yet well represented in online resources, with the result that (for example) at the date of this writing there are no online photographs of *I. evansi*, the most common *Ischnura* species in the UAE and Oman, as to which the authors would have benefited greatly from access to high resolution images of professionally identified specimens.

Acknowledgements

Sincere thanks are due to Dr. Wolfgang Schneider for reviewing photographs and providing details of observations from the literature, as well as for his ongoing contributions to the study and conservation of Arabian flora and fauna; to Dr. Klaas-Douwe B. Dijkstra, also for reviewing photographs and providing information and guidance, and for his marvellous new book, which will give great joy and encouragement to many amateurs; to Dr. Vincent J. Kalkman for his assistance in resolving the enigma of *Orthetrum ransonneti*; and to Graham Giles, whose 1998 study encouraged further efforts by the authors, for providing images of several hard-to-find and/or hard-to-photograph species. The authors also wish to thank Khaled Rafeek of Abu Dhabi, several of whose photographs were used to assist in discriminating between *I. evansi* and *I. senegalensis*, Dr. J.C. Abbott, who provided the photograph of *Crocothemis sanguniolenta*, and Paul Cools, who provided the photographs of *Orthetrum taeniolatum*.

Fig 25a. *Trithemis kirbyi* male. [RWR]

Fig 25b. *Trithemis kirbyi* female. [GRF]

Fig 25c. Immature male(?) *Trithemis kirbyi.* [GRF]

Fig 26a. *Zygonyx torridus* (sexes alike) perched in a tree. [Graham B. Giles]

Fig 26b. *Zygonyx torridus* in flight. [RWR]

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A note on Elasmobranches (sharks and rays) of UAE and Musandam, Oman, with special mention of Bowmouth Guitarfish or Shark Ray (*Rhina ancylostoma*)

by Christophe Tourenq, Maral Khaled Shuriqi, Greg and Kristi Foster, Christophe Chellapermal, Sebastien Lebon and Debra Rein

Introduction

There are over 1,000 species of Chondrichthyans (cartilaginous fish) including Elasmobranches: the sharks (c. 400 species, not all described) and batoid fish (including skates, stingrays, guitarfishes and sawfishes – c. 600 species, not all described), and Holocephales: chimaeroid fish (c. 30+ species, poorly known with confused taxonomy) in the world (Camhi *et al.* 1998). Sharks and their relatives have lived for over 450 million years. The now extinct Megalodon (*Carcharodon megalodon*), a giant prehistoric shark, which lived between 16 and 1.6 million years ago, is the biggest known carnivorous fish to have ever lived. Because of its cartilaginous skeleton, no fossil of Megalodon has thus far been found, and it is only known from its teeth, up to 17 cm long. The reproduction of its jaws, based on some of the largest teeth, suggests that the Megalodon could grow to a length around 13 to 16 metres and an approximate mass of 48 tonnes. Sharks, like apex predators on land, play an important role in the structure and functioning of marine communities, and as such, are a part of a healthy marine ecosystem (Camhi *et al.* 1998, Compagno *et al.* 2005).

Folktales from UAE pearl divers mention isolated attacks by sharks in the Arabian Gulf but jellyfish or barracuda were considered more dangerous. Regularly, local press reports (i.e. Gulf News 30 May 2007: http://archive.gulfnews.com/articles/07/05/30/10128732.html) of shark sightings in UAE waters provoke excitement, a mix of fascination and fear, imprinted in our minds since the release in the seventies of the movie "Jaws" about shark attacks on Amity Island, a quiet summer resort town on the east cost of the USA.

However, except for a single article from Brown (1992) published in ***Tribulus***, a rough compilation in Hellyer and Aspinall (2005), and field guides referring to Oman coastal waters (Randall 1995, Field 2005) or the Arabian Peninsula in general (Carpenter *et al.* 1997), there has been little information published on Chondrichthyans inhabiting UAE waters.

Based on this scarce published literature, the official website "UAE Interact" (http://www.uaeinteract.com) supported by The National Media Council, and unpublished reports from the Environment Agency-Abu Dhabi (EAD), Emirates Marine Environment Group (EMEG) and local deep sea fishing companies (Ocean Active Ltd.), there should be at least 45 different species of sharks, guitarfish and rays present in the waters of the Arabian Gulf and off the Eastern Coast of UAE (**Table 1**). For those who are not fishermen or divers, fishmarkets and harbour docks are often the only place where you can admire these particular fish (***Figure 1***).

On 7th August 2007, while offloading diving equipment from a diving trip, we easily identified a female Tiger Shark (*Galeocerdo cuvier*) of 225 cm total length (from tip of the snout to tip of the tail measured with a ruban meter) laying on the docks of Dibba-Fujairah port (***Figure 2***). As one of the most widespread species of sharks in temperate and tropical waters in the world, the Tiger Shark has already been reported from UAE waters (Hellyer and Aspinall 2005).

It is mostly considered a coastal species, found from near the surface to depths of 140 m, occurring on, or adjacent to, continental and insular shelves, frequenting river estuaries, harbours, coral atolls and lagoons (Compagno 1984a). Mostly nocturnal, their diet is quite eclectic, ranging from fish to seabirds and rubbish. They are considered potentially harmful to humans, responsible for fatal attacks on people but often unaggressive when encountered underwater (Compagno *et al.* 2005). This species is classified as "*Near Threatened*" by the World Conservation Union (IUCN), caught in target and non-target fisheries (Simpfendorfer 2000). Tiger Sharks from the Arabian Gulf and Oman Sea are said to reach up to 750 cm total length (Assadi and Dehghani 1997). We were told by fishermen that an individual of 6 m had been caught in the same waters the week before the Dibba-Fujairah specimen noted above.

Figure 1. Sharks for sale in the Dubai fishmarket, January 2007. Black-tipped pectoral fins of the hammerhead shark in the back indicates probably a Scalloped Hammerhead (*Sphyrna lewini*). Photo C. Manini.

Table 1. Elasmobranches (sharks and rays) of UAE and Musandam. Names follow the latest FAO and IUCN Shark specialist Group nomenclature (Carpenter et al. 1997, Bonfil and Abdallah 2004, Compagno et al. 2005). 1: Field (2005), 2: Hellyer and Aspinall (2005), 3: UAE interact: (http://www.uaeinteract.com/nature/marine), 4: Ocean Active Ltd (pers. com.), 5: Emirates Marine Environment Group (*pers. com.*), 6: Brown (1992), 7: EAD (unpublished), 8: this study.

Family	*Scientific name*	Common name	Source
STEGOSTOMATIDAE	*Segostoma fasciatum*	Zebra Shark	**1,4**
RHINCODONTIDAE	*Rhincodon typus*	Whale Shark	**2,4,5,6**
HEMYSCYLLIDAE	*Chiloscyllium arabicum*	Bamboo Shark	**2,4,7**
	Chiloscyllium griseum	Grey bambooshark	**7**
LAMNIDAE	*Carcharodon carcharias*	White Shark	**5**
	Isurus oxyrinchus	Shortfin Mako	**3?,4**
TRIAKIDAE	*Hypogaleus hyugaensis*	Blacktip Tope	**3(*)**
	Mustelus mosis	Arabian smooth Houndshark	**7**
HEMIGALIDAE	*Hemigaleus macrostoma*	Hootooth Shark	**3**
CARCHARHINIDAE	*Carcharhinus sealei*	Blackspot Shark	**3**
	Carcharhinus dussumieri	Whitecheek Shark	**3,7**
	Carcharhinus plumbeus	Whaler Shark	**3,7**
	Carcharhinus brevipinna	Spinner Shark	**3,4,8**
	Carcharhinus limbatus	Blacktip Shark	**3,4,7**
	Carcharhinus sorrah	Spottail Shark	**2,3?**
	Carcharhinus amblyrhynchos	Grey Reef Shark	**1**
	Carcharhinus melanopterus	Blacktip Reef Shark	**1,2,3,4,7**
	Carcharhinus leucas	Bull Shark	**2,4,5,7**
	Galeocerdo cuvier	Tiger Shark	**2,3,4,5,8**
	Rhizoprinodon acutus	Milk shark	**4,7**
	Rhizoprinodon oligolinx	Grey sharpnose shark	**7**
	Negaprion acutidens	Sicklefin Lemon Shark	**3?**
	Scoliodon laticaudus	Spadenose shark	**7**
SPHYRNIDAE	*Eusphyra blochii*	Winghead shark	**7**
	Sphyrna mokarran	Great Hammerhead	**3,5**
	Sphyrna lewini	Scalloped Hammerhead	**2,4,5**
PRISTIDAE	*Anoxypristis cuspidata*	Narrow/Knifetooth Sawfish	**2,5**
	Pristis zijsron	Longcomb/Green Sawfish	**2,5**
TORPEDINIDAE	*Torpedo panthera*	Panther Electric Ray	**1,3,7**
	Torpedo sinuspersici	Marbled Electric Ray	**1,4**
RHINOBATIDAE	*Rhina ancylostoma*	Bowmouth Guitarfish	**8**
	Rhinobatos granulatus	Sharpnose Guitarfish	**2,3,7**
RHYNCHOBATIDAE	*Rhynchobatus djiddensis*	Giant Guitarfish	**2,7**
DASYATIDAE	*Himantura gerrardi*	White-spotted Whipray	**2**
	Himantura uarnak	Reticulate Whipray	**1,2,3**
	Himantura jenkinsii	Pointed-nose Stingray	**1**
	Himantura imbricate	Scaly Whipray	**7**
	Taeniura meyenii	Blotched Fantail Ray	**1,3,7**
	Pastinachus sephen	Cowtail Stingray	**1,4.7**
	Dasyatis kuhlii	Spotted Stingray	**3,4**
GYMNURIDAE	*Gymnura poecilura*	Longtail Butterfly Ray	**7**
MYLIOBATIDAE	*Aetomyleus nichofii*	Banded Eagle Ray	**2,3,7**
	Aetobatus narinari	Spotted Eagle Ray	**2,3,4,7**
	Rhinoptera javanica	Javanese Cownose Ray	**3**
MOBULIDAE	*Manta birostris*	Giant Manta	**1,4**

(*) cited as "Grey reef shark (Hypogalius balfouri)"

Figure 2. Female Tiger Shark (*Galeocerdo cuvier*) caught by UAE fishermen offshore Dibba and landed in Dibba-Oman port on 8th August 2007. Note the broad, bluntly rounded snout and the vertical dark grey bars and spots on the flanks and back. A one dirham coin was added as comparison. Photo M. K. Shuriqi.

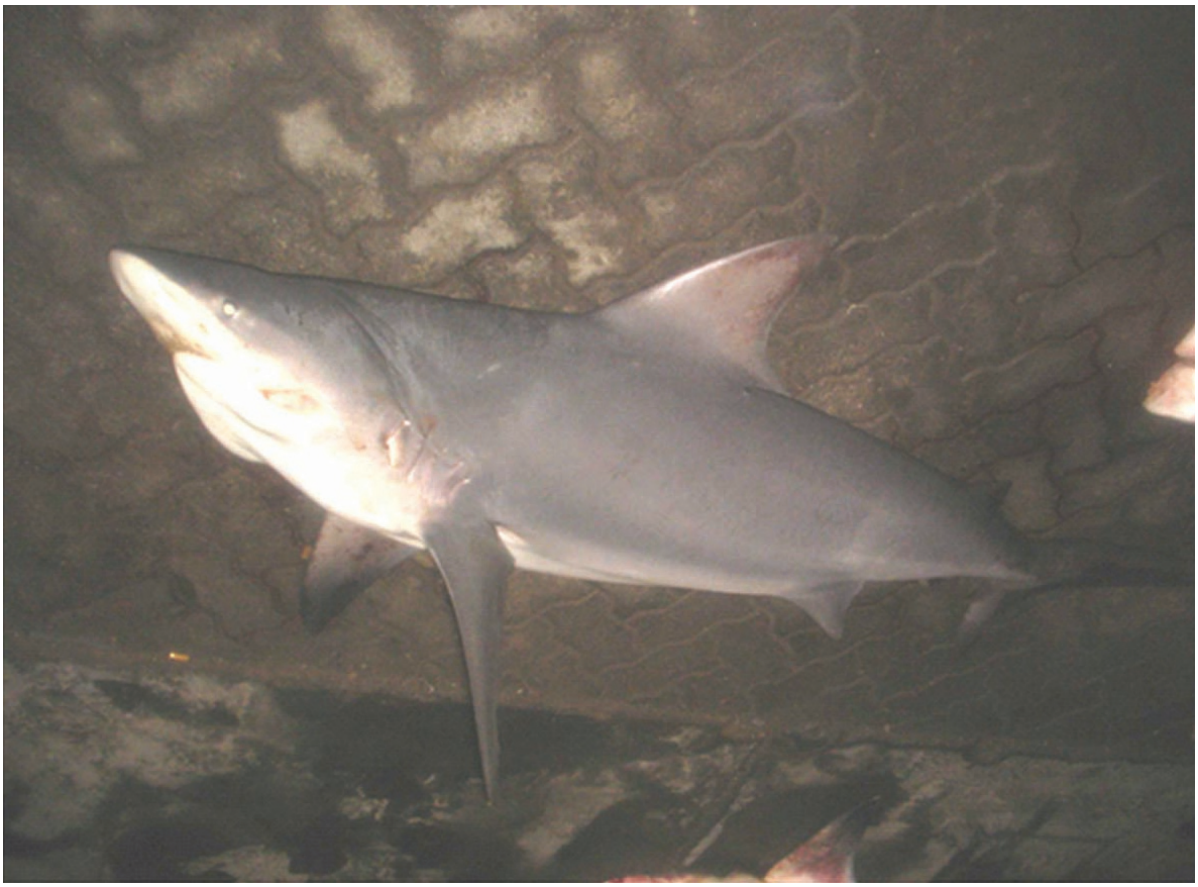

Figure 3. One of the three Spinner Shark (*Carcharhinus brevipinna*) caught by UAE fishermen offshore and landed in Dibba-Fujairah port on 8th August 2007. Note the dark grey/black-tipped pectoral and dorsal fins, the narrow pointed snout.
Photo M. K. Shuriqi.

Figure 4 (above). Bowmouth Guitarfish or Shark Ray (*Rhina ancylostoma*) caught by Omani fishermen in the Musandam Peninsula (Hormuz Straits) and landed in Dibba-Oman port on 8th August 2007. The white 43 sized flip-flop is used as scale. Note the pectoral fins attached to the head and not overlapping pelvic fins as in Angelsharks (Squatinidae). Photo C. Tourenq.

Figure. 5 (right). Details of the head of the Bowmouth Guitarfish or Shark Ray (*Rhina ancylostoma*) caught by Omani fishermen in the Musandam Peninsula (Hormuz Strait) landed in Dibba-Oman port on 8th August 2007. Note the prominent spiracles behind the eyes and the three rows of spines. Photo C. Tourenq.

Figure 6. (below) Ventral view of Bowmouth Guitarfish landed in Dibba-Oman port on 8th August 2007. Note the gills at the intersection of the pectoral fins and the head, the nostrils with incurrent and excurrent apertures above the mouth with ridged jaws and crushing teeth in undulating rows. Photo S. Lebon.

Along with the Tiger Shark, we also saw at Dibba-Fujairah port on 7th August 2007 three female Spinner Shark (*Carcharhinus brevipinna*) of 220 cm each (***Figure 3***). The Spinner Shark is a slender shark, grey above, white below, with a white band on its flanks, often not conspicuous, and with a long, narrow, pointed snout, long gill slits and small, narrow-cusped teeth. The first dorsal fin is usually small, there is no interdorsal ridge and the labial furrows longer than in any other grey shark (Compagno 1984a). Young Spinner Shark individuals are plain-finned, but large juveniles to adults show black tips usually on the pectorals, second dorsal, anal and ventral caudal lobe, and sometimes on pelvics, first dorsal and dorsal caudal lobe (Compagno *et al.* 2005). The absence of an interdorsal ridge prevents confusion with the Spot-tail Shark (*Carcharhinus sorrah*) and the origin of the first dorsal fin behind the rear tip of the pectoral fin prevents confusion with the very similar Blacktip Shark (*Carcharhinus limbatus*), both species said to be present in UAE waters and the region (Carpenter *et al.* 1997, Bonfil and Abdallah 2004, Hellyer and Aspinall 2005).

The Spinner Shark is a common coastal-pelagic shark species of the continental and insular shelves in, near and offshore warm-temperate, subtropical and tropical shallow waters, from a depth less than 30 m to at least 75 m. It forms schools and feeds mainly on pelagic bony fishes, also small sharks and copepods. The name Spinner comes from its vertical spinning leap out of the water as a feeding technique or when caught by the line. This species is classified worldwide as "*Lower Risk/near threatened*" by the IUCN and is frequently captured in recreational and commercial fisheries, its meat being valuable and its fins marketable (Burgess 2000). However, because it frequents nearshore waters as adults, and inshore areas as juveniles, the Spinner Shark is highly vulnerable to fishing pressure and human-induced habitat alteration. As a consequence, the northwest Atlantic subpopulation of the Spinner Shark was classified as endangered and the species as "*Vulnerable*" in this part of the world (Burgess 2000). Spinner Sharks are amongst the most common sharks caught by deep sea sport-fishermen offshore of Musandam and in the Gulf (N. Bowles, *pers. comm.*).

On 8th of August 2007, one of us (*C. Chellapermal*) alerted other authors to the presence of a strange "shark" for sale by local fishermen on the docks of Dibba-Oman port. We were among several witnesses to see this "shark" that did not resemble any other fish species that we knew (***Figure 4***). It was a female, measuring a total length of 180 cm, with a broad, rounded snout, two dorsal fins of which the first being above the pelvic fins, large high pectoral fins, and remarkable ridges of spiky thorns over the eyes and on the back and shoulders. Its colour was olive-grey above with numerous white spots on fins, upper body and tail, and white below. A faded black band could be seen between the two prominent spiracles behind the eyes (***Figure 5***). Our first impression was that it was a species of "Angelshark" (Squatinidae). But, unlike most of Angelsharks, its pectoral and pelvic fins were not overlapping and its gills were located at the insertion of the pectoral fins to the head. Its mouth with teeth in undulating rows was situated well behind the snout, indicating bottom-dwelling feeding habits (***Figure 6***). After consultation of published references (Compagno 1894b, Frimodt 1995, Randall 1995, Assadi and Dehghani 1997, Carpenter *et al.* 1997, Bonfil and Abdallah 2004, Compagno *et al*. 2005, Field 2005, Hellyer and Aspinall 2005) and the recognised scientific online source "FishBase" (Froese and Pauly 2007), we quickly identified the "shark" as a Bowmouth Guitarfish or Shark Ray (*Rhina ancylostoma*).

The Bowmouth Guitarfish inhabits coastal areas, and coral reefs close inshore. Even though it can be found sometimes in the water column, it is mostly a benthic species that lives on sand and mud sea bottoms where it feeds mainly on bottom crustaceans and molluscs (Compagno and Last 1999, Michael 1993). Its heavily ridged jaws with teeth in undulating rows are used to crush the hard shell of its preys (Compagno *et al.* 1989). Because of the rows of large spines present above the eye, on the centre of the nape, and on the shoulder that might have a defensive function, this guitarfish is difficult to handle and can damage the catch when caught in trawls (Compagno and Last 1999). Its distribution in the Indo-West Pacific ranges from the Red Sea and East Africa to Papua New Guinea, north to Japan, to south to New South Wales, Australia (Compagno and Last 1999, Bonfil and Abdallah 2004).

Being taken as by-catch of demersal trawl fisheries, this species is classified as "*Vulnerable*" by IUCN (McAuley and Compagno 2003) and is said to be rare in the region and even absent from the published local fish fauna lists (Randall 1995, Carpenter *et al.* 1997, Field 2005, Hellyer and Aspinall 2005). When interviewed, Omani fishermen said that they caught some individuals time to time with their lines and that only the fins are used for human consumption.

An urgent need for the study and conservation of sharks and rays in the UAE.

Since the sharks at Dibba-Fujairah were quickly sold, we unfortunately could not take any other pictures, nor take a sample for DNA analysis or other measurement. It should be mentioned that the species described above are all classified as endangered by the IUCN (IUCN 2006). Because of their particular biology (*i.e.* slow growth, long maturity, high longevity but low fecundity) and ecology (selective food, segregation of breeding and feeding grounds), sharks and rays are very sensitive to overfishing, and albeit not targeted *per se*, they form a significant part of the by-catch from commercial fisheries (Camhi *et al.* 1998, Pauly *et al*. 2005).

Populations of Elasmobranches are declining worldwide and some of them are already at the brink of extinction (Camhi *et al*. 1998, Baum *et al*. 2003, Myers and Worm 2003, Pauly *et al*. 2005).

In the UAE, the Whale Shark (*Rhincodon typus*) is the only Elasmobranche species protected by the law under the CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) as listed in the Appendix II of the convention *(ìtrade in specimens of such species subject to strict regulation in order to avoid utilization incompatible with their survivalî).* Catching and trading sharks (and rays) is thus legal in the UAE, and Oman, the latter being not yet being a signatory of the CITES convention. However absence of trawl-net practices reduces the risk for these species in UAE and Omani territorial waters. Most of the shark parts are suitable for consumption, although the carcass is often discarded because of the high price for fins (E. Grandcourt, *pers. comm*). Whereas it is not rare to see at the bottom of the sea in some parts of the world finned dead or dying sharks that have been thrown back alive into the sea, finning (the cutting of fins from live sharks) is strictly prohibited by UAE and Omani laws, as is bringing shark fins to shore separate from the body (Al-Janahi and Cherian 2007), although one of the authors (CT) observed shark fins drying on the deck of dhows mooring at Sharjah Port in February 2002. Nevertheless, whereas in the past, they were considered a non-commercial or low value item of the catch, sharks have been more and more targeted in UAE waters (as is the case worldwide) because of the increasing value of their fins on the Asian market.

Data from the recent fish resource assessment in UAE Waters by EAD-Abu Dhabi and Shallard & Associates (2003) suggest a seasonal pattern in the catch of some species of sharks and rays (EAD, unpublished data). Seasonal gatherings of Sphyrnidae (hammerhead sharks) and other shark species in the Hormuz Strait and Arabian Gulf are regularly reported by divers and professional fishermen (Algate, Bowles, and Al Suwaidi, *pers. comm.*). We do not know if the fact that the pelagic sharks observed (*G. cuvier* and *C. brevipinna*) were all females measuring the same size suggests the occurrence of seasonal movements with a seasonal and/or spatial segregation of populations in this region.

A segregation of the populations by sex (adult males vs females) and/or age (neonates and juveniles) in different geographic areas and habitats has been observed for other species of sharks. For example, the blue shark (*Prionace glauca*) is a highly migratory species, with complex movement patterns related to reproduction (with a segregation of the population by age and sex for much of the year) and the distribution of prey. Trans-Atlantic and Trans-Pacific migrations have been demonstrated from tagging studies, showing movements of up to 4,000 km annually. Pupping takes place in offshore nursery areas in the Mediterranean and off Portugal in the Atlantic, and in the sub-Arctic boundary of the Pacific, where there is a large prey biomass for the juveniles. Juvenile blue sharks remain in these nursery areas and do not take part in the extensive adult migrations until they reach a length of 1.30m. (Camhi *et al.* 1998, Compagno *et al.* 2005). Such segregation of populations by age and sex is already known in *C. brevipinna* (Compagno 1984a, Compagno *et al.* 2005). Therefore, we can not exclude the possibility that the Arabian Sea could be an area of primary conservation interest for these species, and perhaps for other Elasmobranches in general.

A systematic compilation and collection of data on sex, age and date of Elasmobranches observation/capture in the whole country would be a first step for a proper conservation of shark and rays populations in the Arabian Gulf and the Arabian Sea / Gulf of Oman. For some species, like the Bowmouth Guitarfish, nothing is known of their biology and they may well disappear before we reach an understanding of their reproductive cycle and ecology that will permit the proposing of stock management solutions. And for a healthy sea, we need healthy teeth…

Acknowledgements

The authors would like to thank Ali Al Danhani, Head of the Dibba Marine Centre of the Ministry of Environment and Water and the Dibba-Fujairah Municipality for their technical support. Sarah Fowler and Leonard Compagno, IUCN Shark Specialists Group, Edwin Grandcourt, Environment Agency Abu Dhabi, Dr. Mark Beech, Abu Dhabi Authority for Culture and Heritage, Nick Bowles, Ocean Active Ltd., Dubai, Paul Algate, SEACOR Fujairah, and Major Ali Al Suwaidi, Chairman of the Emirates Marine Environment Group, Dubai, are thanked for their data sharing, help in the determination of individuals and constructive comments on the manuscript. Thanks also to Cecile Manini for providing us pictures of sharks at Dubai Fishmarket.

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Photographic essay: The versatile date palm (*Phoenix dactylifera*)

by Michele C Ziolkowski

Abstract

The following essay was inspired by the work of art critic John Berger. "Seeing comes before words. The child looks and recognises before it can speak" (Berger 1972: 7)[1].

This essay quite literally depicts the importance of the date palm in Southeastern Arabia. It also illustrates the high degree of ingenuity on the part of those who developed and constructed the following creations. In no way does this essay attempt to illustrate the multitude of uses for the date palm. It does, however, aim to depict the diverse nature in which it was used.

Plate 1: The date palm (*Phoenix dactylifera*) with fruit.

Plate 2: Kerin type house, Madha, Sultanate of Oman[2].

[1] This is not a purely pictorial/photographic essay. An abstract, captions and references have been used.

[2] The date palm was used extensively throughout Southeastern Arabia in building construction. It is especially notable in such structures as the *khaimah* and *'arish*.

Plate 3: Sohar, Sultanate of Oman, weaving a braid of date palm leaves.

Plate 4: Mr Ali Ahmed Sa'adi stitching together braids to form a basket used to collect dates, Sharm, Fujairah, U.A.E[3].

Plate 5: Ma'ahlaj boat, Sohar, Sultanate of Oman[4].

[3] This basket type is called *mizmah* in Arabic.
[4] A small boat made from woven date palm leaves and wood. This boat was attached to the side of a small fishing vessel (sometimes a *shasha*). It was partially submerged in water and contained live bait.

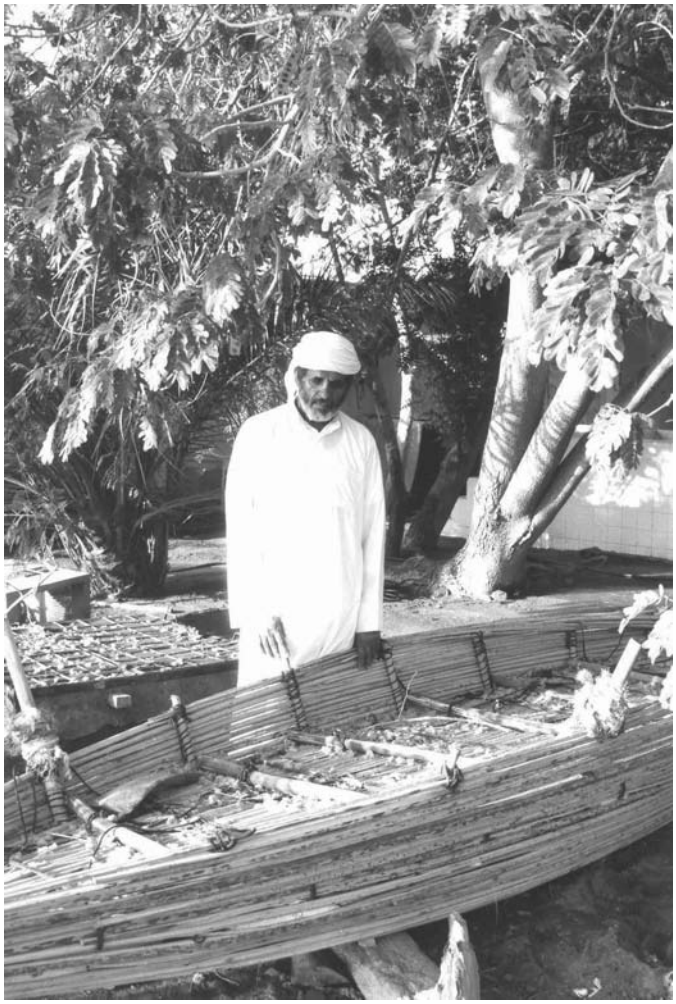

Plate 6: Master Shasha builder, Mr Abdullah Mohammed Sulaiman, with one of his craft, Fujairah, U.A.E.

Plate 7: Colourful woven braid, Social Development Centre for Women, Fujairah, U.A.E[5] .

Plate 8: A brightly coloured braid, Social Development Centre for Women, Fujairah, U.A.E.

[5] The colourful braids shown in Plates 7 and 8 are later stitched together to form various utliltarian objects such as baskets, mats, food covers, fans etc.

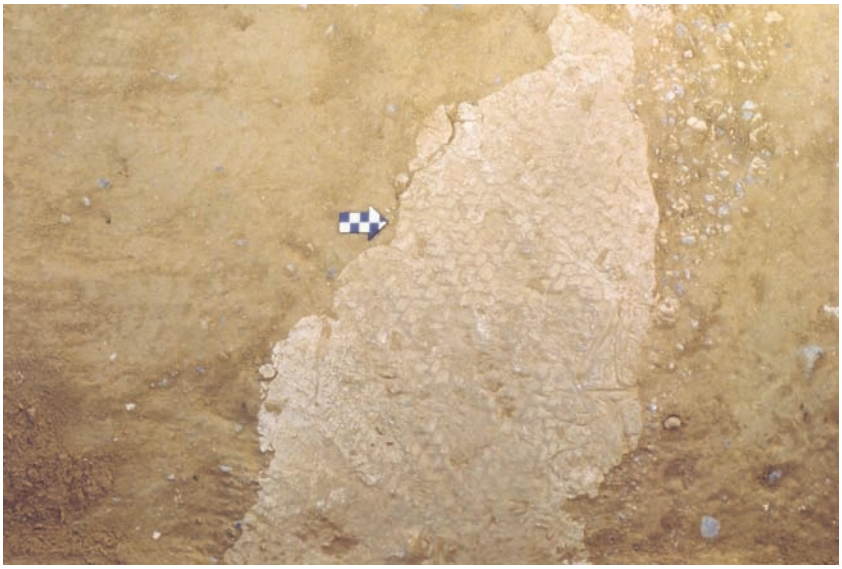

Plate 9: Woven mat-weave impression in plaster, Bidyah Portuguese Fort, Fujairah, U.A.E[6].

Plate 10: Small woven mat, Fujairah Fort, U.A.E[7].

Plate 11: Woven mat fragments, Fujairah Fort, U.A.E[8].

Plate 12: Baskets for storing and transporting dates, Sohar Souq, Sultanate of Oman[9].

[6] Kennet has noted evidence of palm-frond matting at the Sasanian-Islamic period site of Kush in Ras al-Khaimah, U.A.E. For details see, Kennet 1997: 285.
[7] These small mats, used for the placement of food, are known as *ak-Far/sarood*.
[8] These large mats are known as *haseer/simah* in Arabic.
[9] This basket type is known as *khasaf* in Arabic.

Plate 13: Islamic grave marker with petroglyph of a date palm tree, Wadi Bih (Musandam Peninsula), Sultanate of Oman.

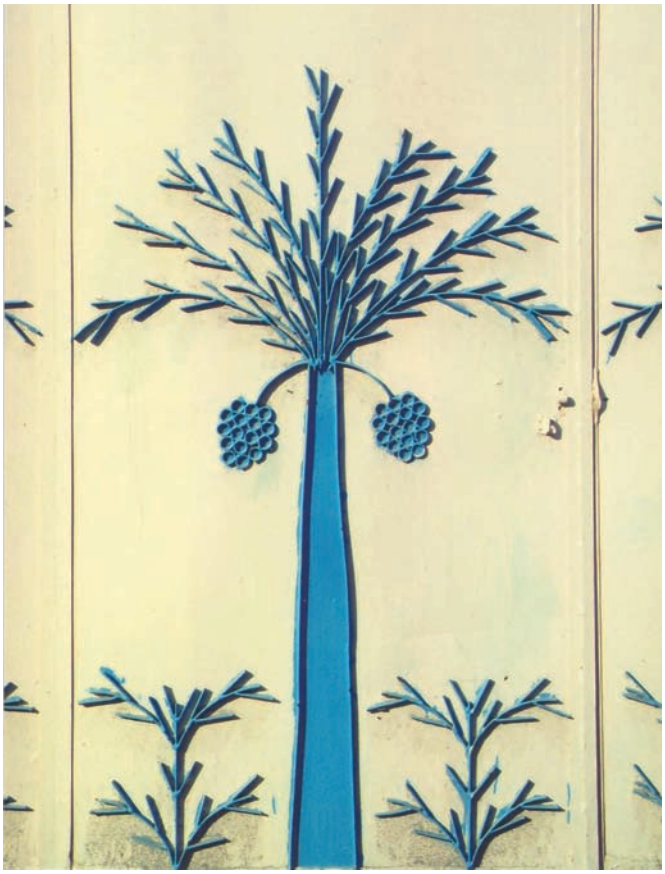

Plate 14: Detail of decoration on a metal gate, Fujairah, U.A.E.

Acknowledgements:

Fujairah Social Development Centre for Women. Thank you to all the women who agreed to be interviewed and photographed and Ms N al-Sharqi in particular for assisting with the author's many enquiries.

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A note on molluscs from a Late Islamic desert site in Abu Dhabi

by Peter Hellyer and Richard Hornby

Over the last fifteen years or so, an extensive amount of archaeological survey work has been undertaken in the desert areas of the Emirate of Abu Dhabi, This was carried out initially largely by the Abu Dhabi Islands Archaeological Survey, ADIAS, with some work also being undertaken by the former Department of Antiquities and Tourism in Al Ain, now part of the Abu Dhabi Authority for Culture and Heritage, ADACH, and by members of the Abu Dhabi and Al Ain chapters of the Emirates Natural History Group. Since 2006, most, though not all, survey work has been undertaken by ADACH.

During these surveys, numerous sites have been identified. These are, for the most part, small scatters of worked flint from the Arabian Neolithic (Late Stone Age) period or scatters of pottery from the Late Islamic period, although a very few sites have been identified that suggest possible use of the deserts of the Western Region of Abu Dhabi during the early to mid-Islamic periods and a number of sites in the vicinity of Al Ain, in the Eastern Region, are of Iron Age or later date.

Little information has been published on most of these inland sites, with the exception of the well-reported Arabian Neolithic sites at Kharimat Khor al-Manahil and Khor al-Manahil, in south-eastern Abu Dhabi (e.g. Kallweit *et al*., 2005, Beech *et al*., 2006, Kallweit 2006. Cuttler *et al*. 2007). Summary information on some Late Islamic sites can be found in Czastka and Hellyer (1994), Hellyer (1998 and 1999) and King & Hellyer (2002), with Harris (1998) reporting on a Late Stone Age site south of Liwa and Holmes (2001) on an Iron Age site near Al Ain.

Gardner (2005) has reported on mollusc shells found at two sites close to Al Ain, but just across the border into Oman, one of which is a now-abandoned terraced field system but the other, Qarn Safwan, being a desert site comparable, at least in its Late Islamic component, to many desert sites in Abu Dhabi.

Published information on the Late Islamic sites relates primarily to the pottery, with unglazed wares from the Julfar horizon and glazed Khunj/Bahla and 'Manganese Purple' wares being those most commonly present. Coinage is known to have been found on several Late Islamic sites close to Al Ain, (e.g. Gardner 2005) but the information has not yet been published. Little data appears to have been published on environmental remains associated with these Late Islamic sites, with the exception of Gardner (2005). This paper, although dealing with an area that lies just outside the borders of the UAE, in neighbouring Oman, deals extensively with the molluscs found at two sites, and provides a useful yardstick against which to measure data from other sites.

As far as the sites in Abu Dhabi's Western Region are concerned, the lack of publication of environmental data is due largely to the fact that in many cases the sites recorded have produced very few potsherds (10 or less sherds each), probably representing single usage, with no visible environmental remains. In this area, sites with extensive pottery scatters are rare. The sites with the most substantial number of sherds, often well in excess of 1,000, a group near the Al-Shbayka area, north-east of the Sahil oilfield, where both mollusc shells and fish-bones are present, have not been studied in detail.

Studies of environmental remains of a marine origin on archaeological sites in Abu Dhabi Emirate have previously been confined primarily to sites in coastal areas or on islands (e.g. Beech 2004).

It may, therefore, be useful to place on record a note of the marine mollusc species found at an extensively-used desert campsite south-west of Al Wathba, at Tawi Beduwa Shwaiba, which was first visited by the authors in 1997, with the assistance of the Ruler's Representative in the Western Region of Abu Dhabi, H.E. Sheikh Mohammed bin Butti Al Hamed, following the recovery from the area of a number of complete Late Islamic pottery vessels, both glazed and unglazed.

The site was described to us as having formerly been a campsite five days distant from the eastern end of the Liwa Oasis, on an old cross-desert route to Abu Dhabi. We were advised by a guide from the Manasir tribe, provided by Sheikh Mohammed bin Butti, that there was formerly a water well at the site, and that it had been in use until around fifty or sixty years ago. The extensive amount of pottery present on the surface at the site indicated that it had certainly been in use from the late 18th Century AD onwards, with Julfar ware, Khunj/Bahla ware and 'Manganese Purple' ware all being present.

Species of marine molluscs collected from the site included the following:

Gastropods:
Trochus erithreus
Euchelus asper
Osilinus kotschyi
Hexaplex kuesterianus
Strombus persicus
Oliva bulbosa
Ancilla castanea

Bivalves
Pinctada radiata
Acrosterigma lacunosa
Tivela ponderosa

Some species, such as *Pinctada radiata* and *Hexaplex kuesterianus*, are of a sufficient size to have been of value for food, and are known to have been used as such and could have been easily transported inland from the coast. The presence of small species such as *Euchelus asper* and *Osilinus kotschyi* is, however, somewhat surprising, since they are quite small (the maximum diameter of both is 20 mm, but 15 mm is more normal). Presumably they must have been considered as something of a delicacy.

Some of the *Pinctada radiata* shells were very large. There were several pieces of shell which we estimate must have been between 80 and 120 mm diameter when they were intact. Bosch *et al.* (1995) gives a maximum size of 65 mm. The largest *P. radiata* shells seen by RH in natural surroundings on the coast of the UAE would have been about 70 cm in diameter. Shells of up to 75 mm in diameter have been noted (by RH) on archaeological shell middens on the Arabian Gulf coast of the UAE, although the middens concerned have not been dated and could pre-date the Late Islamic period.

It would seem, therefore, that either there may have formerly been access to a good supply of larger *P. radiata* along the Abu Dhabi coastline than appear to be present today or that these larger shells were harvested offshore, perhaps in connection with the pearling industry, with some then being collected intact and taken inland for use as food.

A comparison with the marine mollusc shells recorded by Gardner (2005) at the desert site at Qarn Safwan, near Al Ain, is appropriate. Although most of the molluscs from this site are generally in a good state of preservation, suggesting a fairly recent origin, it should be noted that this site appears, from other finds, to have been in use, at least intermittently, from the Arabian Neolithic period to the Late Islamic period. A minimum of at least 44 species were recorded from the Qarn Safwan site, compared to only 10 from the Tawi Beduwa Shwaiba site. *Euchelus asper*, *Osilinus kotschyi* and *Ancilla castanea* were not recorded at Qarn Safwan, all of the other species from Tawi Beduwa Shwaiba being present in some numbers, except for *Trochus erithreus*, of which only two specimens were noted. Specimens from Tawi Beduwa Shwaiba were not counted.

Qarn Safwan is closer to the Gulf of Oman than to the Arabian Gulf, and species present at this site may well have been brought through the mountains from the East, while the much smaller number of species at the Tawi Beduwa Shwaiba site are more likely to have been brought from the Arabian Gulf coast, less than 40 kilometres away. It should be noted, however, that only one of the species identified at Qarn Safwan, *Cardia crassicosta*, is present in the Gulf of Oman, but not, according to Bosch *et al*. (1995) in the Arabian Gulf, at least today.

No conclusions can yet be drawn about the contrast between the number of species collected at the two sites, although possible reasons could include the relative abundance, or lack of abundance, of the species concerned on the Gulf of Oman and Arabian Gulf coasts.

The purpose of the collection of the shells and of transporting them inland would appear to be two-fold. In some cases at Qarn Safwan, the shells appear to have been collected from beaches, when the animals would already have been dead. These were presumably collected for use as decoration, or perhaps as items to keep. Of the others, some species were probably collected for food, but it would appear unlikely that this was the reason in all cases, particularly for the smaller species.

Further information on species of marine molluscs collected on archaeological sites in the inland areas of Abu Dhabi and other parts of the United Arab Emirates would be of interest.

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Survey of Breeding Osprey *Pandion haliaetus* in Abu Dhabi Emirate

by Shahid Khan, S·lim Javed and Junid Nazeer

Ospreys on the nest in western Abu Dhabi (Picture: Salim Javed)

Osprey *Pandion haliaetus*, a resident breeding bird in the UAE, is a regional priority species in the Middle East. During the 2006-2007 breeding season, extensive surveys were conducted at key islands and coastal sites in Abu Dhabi emirate to determine its breeding status and to compare changes in numbers from previous surveys. The latest survey, carried out by the Terrestrial Environment Research Centre of the Environment Agency – Abu Dhabi (EAD), is part of the Agency's programme to monitor wild birds and assess the status of important breeding bird species in the Emirate.

In the Arabian Peninsula, Osprey is a common breeding species in the Red Sea, the Arabian Gulf and the Gulf of Oman. In the Arabian Gulf, important breeding populations are found in Bahrain, the western islands of the United Arab Emirates (UAE) and Musandam (Oman) (Jennings, 1995).

Surveys were conducted on islands and along the mainland coast from west of Abu Dhabi to Ra's Ghumais, near Sila, and also eastwards to Taweelah. Particular effort was made to visit those islands for which no prior information on nesting was available. Unfortunately fresh surveys could not be undertaken of Aryam and Futaisi islands or of neighbouring localities (especially rocky islets *ëqasasir*'), an area known to have supported an additional 10-12 breeding pairs in recent years (Aspinall & Hellyer, *pers. comm*.) and thought still to do so at the present time.

Altogether 138 adult birds were seen during the survey period and a total of 117 nests were recorded, of which 61 were active and the rest either inactive or attended by non-breeding birds (Khan *et al.*, 2007). Out of the 61 active nest sites, 75% were on islands, with 25% being coastal sites.

Overall, it is estimated that approximately 71-73 breeding pairs are present in the emirate of Abu Dhabi at the present time, this being the entire UAE population (no nesting pairs are currently known in any other emirate or were known at the time of earlier survey).

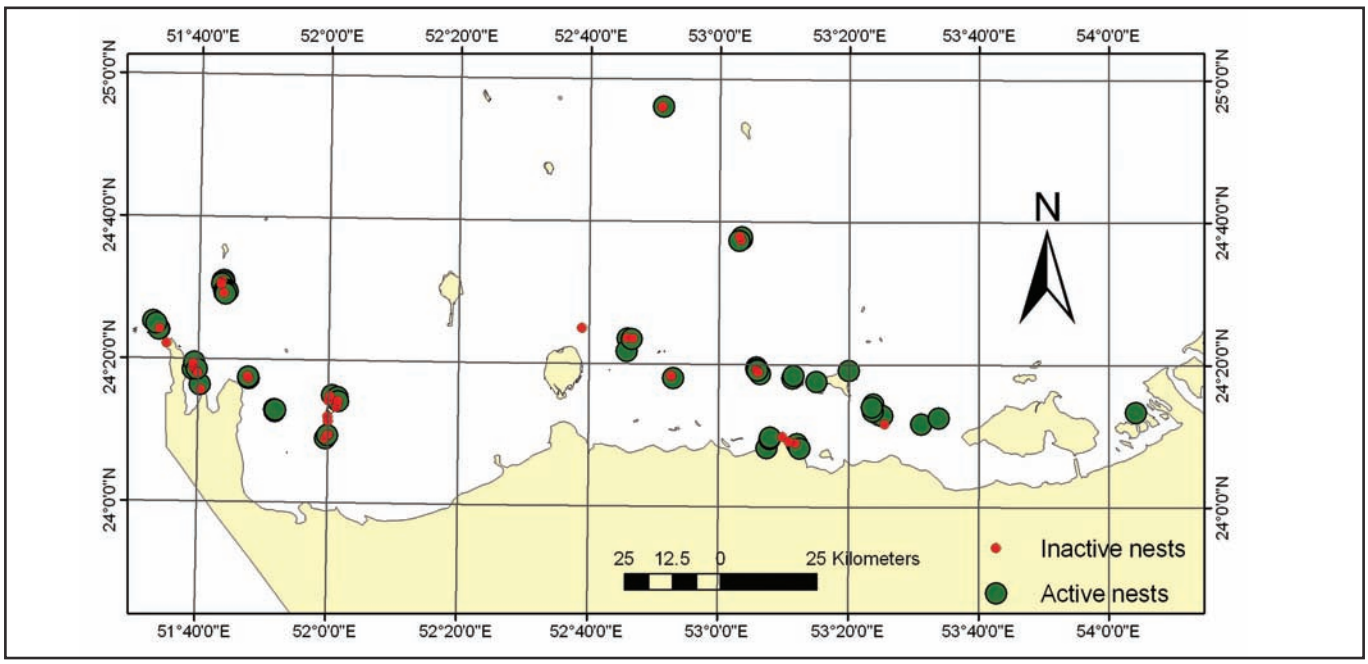
The 2007 survey was more complete than that of 1993 (Aspinall, 1994), with many additional sites having been visited, and it is thus not possible to assess any change in the species' UAE population, even though the total of 70+ pairs estimated in 1994 is close to that found in 2007.

Young ospreys near Bu Tini (Picture: Salim Javed)

Despite this, it is apparent, for example, that nearly 80% of the active nests have been lost from some former island strongholds during the last decade. On the Yasat archipelago only four nests were active in 2007, some 29 pairs having been present in 1994 (***Table 1***). Nonetheless the Al Yasat group remains of considerable importance for the species. The largest number of active nests (nine) in 2007 came from Muhayyimat.

Disturbance at the nest may cause pairs to abort breeding attempts, particularly during the early stages of nesting. In 2007, nearly 40% of nests on islands were inactive, in some instances this certainly being due to abandonment of the site as a result of development activities and disturbance from continuous human presence. North Yasat has been developed extensively and presumably disturbance from such development and human presence has resulted in nearly 50% decline in the number of total nests on the island. In 1993 about 77% of nests were active (Aspinall, 1994), while in 2007 only 18% were active or attended; a decline of nearly 88% from 1994 to 2007. South Yasat has also undergone marked changes in the habitat due to development and disturbance. This has resulted in a 70% decrease in the number of nests on the island.

In 1993, 90% of nests recorded were active while only one of the three nests recorded was occupied by a breeding pair in 2007.



Distribution of osprey nests in Western Abu Dhabi - 2007

The UAE's Osprey population remains of international importance, representing the bulk of the Arabian Gulf breeding population, perhaps over 75% at the present time and also estimated to be some 20% of the non-breeding population of the Middle East. The western islands of Abu Dhabi support the majority of the Gulf's breeding Ospreys and every effort must thus be made to protect key sites and keep them free from any form of disturbance. Muhayyimat, Gerain Al Aish, Al Bazm al-Gharbi, Umm Amim, Ghaghah, Bu Tinah, Faza'iyya, (Al Ufzai'yya). Umm Al Hatab and Al Yasat are those sites of particular importance Some of these sites are already protected; however, protection of the Muhayyimat island complex and of Umm Al Hatab as well as keeping disturbance to a minimum at other sites are urgent priorities. Ospreys readily use man-made nest platforms at many of the sites. Nearly 26% of all the 117 nests recorded were on nesting platforms, these having been installed by owners to encourage nesting, and are a valuable conservation tool in facilitating successful breeding, helping expansion (including to other emirates), recolonisation or simply maintenance of breeding populations.

Recommendations to protect key sites have already been made for a number of species of breeding seabird (Javed & Khan, 2003), many of these also being significant for nesting Ospreys, and it is thus critical that these are formally designated.

Acknowledgements

We thank Majid al Mansouri, Secretary General, EAD, for his support and encouragement and Abdulnasser Al Shamsi, Director of EAD's Terrestrial Environment Research Centre, TERC, for his support and help in facilitating this study.

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Site	Nests	
	1994	2007
North Yasat	22 (17)*	11 (2)
South Yasat	10 (9)	3 (1)
Yasat Saghirah	1 (1)	4 (1)
Judairah	2 (2)	2 (1)
Ghaghah	21 (16)	7 (4)

Table 1. Comparison of number of nests recorded in 1993 (Aspinall 1994) and the 2007 survey. (*Figures in parentheses are active nests)

The first record of Ashy Drongo *Dicrurus leucophaeus* for the UAE and Arabia

by Nick Moran

Picture by Nick Moran

At about 11.45am on 16th December 2006 I wandered across the road from the Spinney's supermarket, in the Khalidiya district of Abu Dhabi, capital of the United Arab Emirates, to an area of parkland opposite the police station and Ministry of Justice buildings. As the sprinklers were on, I could not complete the circuit of the radio tower, so I rolled under a fence surrounding an area scheduled for construction and headed towards some mature trees. Suddenly a black, long-tailed bird shot out of the tree in front of me and disappeared into another tree.

Shortly after, the bird flew out again and perched in the tree from which it had originally emerged. It was immediately apparent that it was a species of drongo *Dicrurus* sp. I watched it for around a minute then telephoned the news to other birdwatchers resident in Abu Dhabi. The only member of the family previously recorded in the UAE, Black Drongo *Dicrurus macrocercus*, is itself very rare, with less than ten accepted records to date.

My initial thought that the bird must be of this species was rapidly replaced by the feeling that some of the features seemed different. It lacked, for example, the glossy black underparts of that species and the head shape and jizz did not quite match my recollection of the many Black Drongos I had seen previously in Asia. However, no other species of drongo had ever been recorded in Arabia.

A number of other birdwatchers quickly arrived, including Maarten Verhage, Oscar Campbell and Simon Aspinall, and, after a further two hours of watching the bird, I returned home to consult reference books and the Internet for pictures of both Black Drongo and of Ashy Drongo *Dicrurus leucophaeus*, which appeared to be a strong possibility.

This research convinced us that we had, indeed, been watching an Ashy Drongo. A description and accompanying photographs were subsequently submitted to the Emirates Bird Records Committee, which accepted the bird as the first record of the species for the United Arab Emirates and, therefore, for the Arabian peninsula.

Picture by Oscar Campbell

Picture by Oscar Campbell

The pictures taken and field notes of the bird were consistent with the *longicaudatus* race of Ashy Drongo, which breeds from north-east Afghanistan and Pakistan to the western Himalayas, usually wintering in southern India and Sri Lanka. It is, therefore, a plausible vagrant to the UAE.

Prior to the discovery of the bird, the weather had been cool but settled. There were no accompanying records on Abu Dhabi island, or elsewhere in the Emirates, of other more regularly occurring species of a similar provenance or from further afield, as is sometimes the case when extreme vagrants are recorded in the country.

Before considering the key features used to separate this bird from Black Drongo the age of the bird needed to be established. The active primary moult was a potential indication of a 1st winter bird, although it could not be determined whether this is conclusive evidence, due to a lack of literature on the ageing of drongos. However, Bill Harvey (*pers. comm.*) states that the neat pale tips to the under-tail coverts are indicative of 1st winter Ashy Drongo.

Bearing this in mind, the following features were used to eliminate Black Drongo:

- Fairly bright red eye (although adult Black Drongo can show a reddish eye, this would be highly unlikely in a 1st winter bird)
- Relatively long, narrow bill
- Matt smoky-grey underparts, without any trace of iridescence and without any white tips/blotching, except the under-tail coverts (all Internet pictures of 1st winter Black Drongos viewed, and the Indian fieldguide (Grimmett *et al.* 1999), show messy white blotching on the lower belly)
- Lack of white rictal spot
- Crown either flattish with a very shallowly sloping forehead or 'tufted' rather like a monarch flycatcher sp. *Monachus* sp., never showing the more smoothly rounded 'Alpine Chough-like' crown of Black Drongo.
- Many flycatching sallies were made from *within* the crown of trees, especially during the midday observations on 16th December. This is consistent with the forest habitat preference & feeding behaviour observed in Ashy Drongo, contrasting with the open country preference of Black (although the bird did occasionally use exposed tree-top perches later in the day)
- No white fringes were present on any upperpart feathers – 1st winter Black Drongo should show such fringing.

The bird was seen by at least sixteen birdwatchers from around the country, including one visiting group, and was last recorded on the afternoon of Tuesday 19th December 2006. No other Middle Eastern records of this species are known or published to date.

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Postscript
Remarkably a second individual was found in Al Ain at the end of February 2008, remaining here until at least March. (S.L. James *pers.comm)*

The first record of Jouanin's Petrel *Bulweria fallax* in the United Arab Emirates

by Stephen L. James and Simon Aspinall

On 18th October 2004, the authors were conducting a sea-watch from the tip of Al Ghurfa breakwater in Fujairah, on the eastern coast of the United Arab Emirates. At 16.12 hours, SJA alerted SLJ, to the fact that he had seen a *Pterodroma* petrel, probably a Jouanin's Petrel flying south, slightly towards us. We watched the petrel flying low over the sea with a typical *Pterodroma* flight pattern, occasionally rising upwards, to glide down low again, towards the surface of the sea. We watched the bird flying around for between three and four minutes, before it landed on the sea and, soon after, it was lost to view. Viewing conditions were very good, with backlighting and only a slight onshore wind. Both observers viewed the bird through 30x magnification telescopes.

Description

The bird was an all dark brown petrel, about the same size as a Persian Shearwater (*Puffinus lherminieri persicus*), but with longer, more pointed wings and a pointed tapering tail. The head was quite bulky for the bird's size, with an all dark bill, sometimes held parallel to the sea's surface, and at other times held pointing downwards. The body was torpedo-shaped, but the long wings and long pointed tail gave it a distinctive flight silhouette. Jouanin's Petrel is smaller, has longer, narrower wings and tail than Wedge-tailed Shearwater (*Puffinus pacificus*) and a quite different flight.

The flight of this bird was quick and powerful, with the long bowed wings held forward. There were a few quick wing beats, followed by a swooping glide, sometimes from side to side, occasionally gliding upwards up to five or six metres above the surface of the sea. When the bird settled on the sea it was quickly lost to view.

Jouanin's Petrel was given the name *fallax*, which means deceitful, deceptive or false, in having evaded identification for many years (being mistaken for another species, the Reunion Petrel) until finally described in 1955.

Distribution

This species is rather poorly known, although it is a relatively common bird in the north-west Indian Ocean (Bailey, 1966). It is common off southern Omani headlands from late May - November, (Erikson *et. al*.) and, although much rarer there, is seen regularly off headlands further north, including both Ra's al Khabbah and Ra's al Hadd. It is also recorded regularly offshore as far north as Muscat. It is much scarcer in Omani waters between December and April. The present known range includes the area around the southern Red Sea and the Gulf of Aden.

It is a truly pelagic species, usually keeping well offshore and wandering widely, but approaches the coast where deepwater is close inshore (as in Dhofar, and north to Ra's al Hadd). There is some evidence that it moves south following the breeding season, at least as far south as Somalia and rarely to Kenya (Boothroyd, 1986). It also moves eastwards and is recorded both from India and Sri Lanka (Enticott and Tipling, 1997). It occasionally crosses the Equator and there have been at least twelve occurrences in and around the Seychelles (Skerrett, 2000). Vagrants have been recorded as far as the Adriatic Sea in Europe (Warham, 1990) and, more amazingly, Sand Island, Midway Atoll in the Pacific Ocean (Seto *et al* 1996). It is, therefore, not that surprising to have finally found it slightly north of its known range within UAE waters.

The absence of deep water inshore leads us to suspect that any individuals reaching UAE would merely be passing through. Some effort is now being made to survey territorial waters further offshore on the UAE's East Coast, primarily to establish the status of this and other typically pelagic seabird species in these areas.

Breeding & population

There are no accurate population figures for this species and its breeding grounds remained a mystery until recently discovered on Socotra Island, Yemen (Taleb, 2002). Taleb (2002) also described what is known of the breeding biology, with nesting now being known to take place, at least on Socotra, from July to November, itself commencing during the SW monsoon or *khareef*.

Although several thousand pairs would seem a reasonable population estimate, it may well be that other breeding grounds remain to be discovered in the region. Certainly, the numbers seen both off the southern coast of Oman and offshore would support this view, with Hirschfeld (1992) speculating that the size of the population could run into tens of thousands.

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Snakes Alive: Gray's Racer Snake *Platyceps* cf. *ventromaculatus*, (Gray 1834) sensu Schätti and Schmitz 2006, on Sir Bani Yas and Dalma islands

by Simon Aspinall and Drew Gardner

Platyceps ventromaculatus in a rock crevice on Dalma

During the course of a wildlife survey on 30 May 2007, a live Gray's racer snake *Platyceps* cf. *ventromaculatus* (sensu Schätti and Schmitz 2006, formerly named *Coluber ventromaculatus*) was observed by Simon Aspinall and Andrew Haig on the island of Sir Bani Yas, western Abu Dhabi. This constituted only the second confirmed record of the species in the United Arab Emirates. The earlier record, also from Sir Bani Yas, concerned several dead specimens recorded in August 1989, one of which was collected by Bish Brown and identified by Franz Tiedmann (Brown, 1991; Tiedmann, 1991). Furthermore, on 5 April 2008, a juvenile of the same species was observed and photographed on Dalma island, also in western Abu Dhabi, by Drew Gardner and Brigitte Howarth.

This colubrid species, which is harmless to humans and readily arboreal, is known within the Arabian Gulf region from Kuwait, eastern Saudi Arabia, Qatar and Bahrain (Gallagher, 1971; Gasperetti, 1988; Gillespie, 2006). Its world range extends from Iraq to northern India (Gasperetti, 1988). The continued presence of this species on Sir Bani Yas and its recent discovery on Dalma is of some interest.

It is possible that the species has been introduced to Sir Bani Yas and Dalma, but if so, one might expect it also to occur on the nearby UAE mainland. A bounty scheme was formerly operated for any snakes caught on Sir Bani Yas, and this may have encouraged the import of snakes. However, although the sand racer (*Psammophis schokari*) is well known on the adjacent mainland (Baha El Din, 1996), there are no records of *P. ventromaculatus*, the closest known mainland locality for which is Doha (Gillespie, 2006). Brown (1991) considered the species likely to have been on Sir Bani Yas before development started. The discovery of the species on Dalma, in the hilly area of the island well away from cultivation, also lends support to the species being native to the islands.

The individual on Sir Bani Yas was located when the agitated alarm calls of several White-cheeked Bulbuls *Pycnonotus leucogenys* led the observers to expect they might have encountered a roosting migrant Scops Owl *Otus scops*. Instead, it was the snake that was cause of the commotion, coiled in the foliage about two metres up a planted 'sidr' (*Ziziphus spina-christi*) tree, just above the bulbul's nest. Although the nest's contents were not visible, *P. ventromaculatus* is reported to take birds sometimes (Gallagher, 1971; Khan, 2002) and the bulbul chicks would doubtless also be a suitable prey item. The

A P. ventromaculatus on Dalma

Dalma individual was in a rocky gulley amongst haematite outcrops in the central part of the island.

Recently, the morphology and distribution of the snakes presently classified as *Platyceps ventromaculatus* (Gray, 1834) has been reassessed (Schätti & Schmitz, 2006). Schätti & Schmitz suggest that the snakes from the Gulf region and parts of Iran may be specifically distinct from Gray's racer, based on hemipenal structure and preliminary mitochondrial DNA analysis. If further molecular studies support this, these populations would then be recognised as *Platyceps chesneii* (Martin, 1838).

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The early stages and larval food-plants of *Bufoidia larseni* Wiltshire and Legrain, 1997 (Lepidoptera: Lasiocampidae)

by Michael P.T. Gillett

Figure 1. The light coloured and commoner form of the caterpillar or larva of *B. larseni* bred on *Fagonia ovalifolia* in the UAE from moths obtained as larvae in the Sumail Gap, Oman.

Figure 2. The dark form of the larva of *B. larseni* from the same batch of eggs as the light form shown in Fig. 1

The family Lasiocampidae includes the eggar, lackey or lappet moths, a characteristic group of medium-sized, stout-bodied and often sombre-coloured insects that are related to the silk moths (Bombycidae) and moon and atlas moths (Saturnidae). They are not just tropical in their distribution, but are also found in temperate zones, particularly in wooded country and heathland. Altogether over 1200 species of Lasiocampidae have so far been described, less than 20 are known from the Arabian Peninsula (Wiltshire, 1994).

Recently the new genus *Bufoidia* (Wiltshire and Legrain, 1997) was erected to include three previously undescribed Arabian species: *B. pittawayi* from the Asir Mountain region of Saudi Arabia, northern Yemen and southern Oman; *B. larseni* from northern Oman and the United Arab Emirates and *B. gallagheri* from central Oman.

At the same time, three species originally assigned to other genera were transferred to this new genus: *Dendrolimus lederi* Kocak, 1981 from Lebanon, Palestine and Jordan; *D. alfierii* Andres & Seitz, 1925 from Egypt and *Bombycopsis hyatti* Tams, 1931 from Somalia.

All six species were clearly shown to be congeneric and distinct from *Dendrolimus* and *Bombycopsis* not just on the basis of male foreleg structure, wing venation and the morphology of the male and female genitalia, but also in their ecology. Furthermore, Wiltshire and Legrain provided an additional key based on the structure of the male genitalia to differentiate *Bufoidia* from the other genera of Lasiocampidae found in the Arabian Peninsula, including *Chilena*, *Lasiocampa* and *Streblote*, all three of which occur in the UAE.

In dealing with the ecology of these moths, Wiltshire and Legrain (1997) characterised *Dendrolimus* as containing Palaearctic arboreal species and *Bombycosis* as including Afrotropical forest and savannah wetland species. On the other hand, *Bufoidia* species were portrayed as Eremic steppe or montane moths with polyphagous habits.

However, whilst the distribution of all six *Bufoidia* species is reasonably clear, the larval food plant preferences are not so well known. Indeed, at the time

that the genus was first proposed, the larvae of at least two forms were unknown – *B. larseni* and *B. gallagheri*. The purpose of this present note is to record properly the existence of two colour forms of the final instar of the larva of *B. larseni* and to provide other information on the immature stages of this insect, including its larval food plants. An illustration of these caterpillars was given by Gillett and Howarth (2004), but without further details.

In April 1996 whilst the author was travelling in northern Oman, a series of six grey moth larvae marked with red and black and each about 2.5 - 3 cm in length were found in a dry wadi near to Al Ayn in the Sumail Gap. Five of the caterpillars were feeding on a large bush of *Ochradenus aucheri* (Resedaceae) and the sixth was on a nearby, but altogether different plant, *Fagonia indica* (Zygophyllaceae). Despite further searching, no more larvae were found. Although belonging to an unknown species, the larvae were recognised as belonging to the Lasiocampidae, some members of which had previously been bred successfully by the author, including *Chilena laristana* Daniel, 1949 (Gillett, 1997). It was decided to retain the larvae in the expectation of rearing the adult moths. During the remainder of the trip, they were fed on fresh shoots of *O. aucheri*, but on returning to Al Ain, it proved impossible to obtain this plant on a regular basis. As an alternative, the larvae were transferred to fresh shoots of *Fagonia ovalifolia*, on which they continued to feed, mainly at night. After a single ecdysis (skin change) in late April, all six larvae fed further and then spun up rather open white or grayish silken cocoons amongst the sprigs of the food plant in early May. These cocoons were much more loosely woven than cocoons of related Arabian genera such as *Chilena* and *Streblote* (see below also). Adult moths, three females and three males, hatched some two weeks later and were tentatively identified as a species near to *Dendrolimus bufo* Lederer (= *Dendrolimus ledereri* Kocak) as shown by Wiltshire (1986). Only in 1997, were they eventually confidently identified as *Bufoidia larseni* Wiltshire and Legrain, 1997.

During the hatching process, one pair was found engaged in copulation before they could be removed from the breeding cage. The female involved was later moved to a small cardboard box and left for two days to see if eggs could be procured. Some 25 to 30 eggs were found to have been deposited individually or in small clutches on the bottom and sides of the box. These were greyish-green in colour and about 2mm high and 2mm in diameter without any obvious sculptural features. After about 10 days, the eggs darkened and some 20 small dark grey caterpillars emerged and were transferred to fresh shoots of *F. ovalifolia.* Four larvae died during the early stages, but as the remainder grew it became obvious, after the second moult, that there were two colour forms.

After the final larval moult, these differences were very conspicuous (***Figures 1 and 2***). The commoner form was similar to, but lighter than, the original wild-found caterpillars and overall light grey with a conspicuous white side stripe overlaid with red and black markings on each abdominal segment and a very faint parallel yellow stripe below. Just three of the surviving larvae were a much darker grey, almost black, with a thin yellow side stripe below the broader white stripe and with much more prominent red and black markings. Both forms displayed red bristly transverse bands on the second and third thoracic segments, but these were more pronounced and highlighted with black in the darker caterpillars. Unfortunately by the time that the caterpillars had reached the fifth instar and were almost ready to pupate (about four weeks), the author was due to go on leave and the caterpillars had to be released into the wild. They were taken to the Mubazzarah area of Jebel Hafit, near Al Ain, where the adult moth had already been recorded, and left on plants of *Fagonia*. Their subsequent fate is unknown.

Both forms of the larvae of *B. larseni* shown here differ in the disposition of their stripes and in colour from the caterpillar of *B. pittawayi* as shown by Wiltshire (1986) and also of from those of *B. ledereri* and *B. alfierii* described in the same publication. Nevertheless, they are easily recognisable as belonging to the same genus because of the two brick-red transverse bristly patches on the second and third thoracic segments, although somewhat similar patches are found in other genera such as *Streblote*.

Short note on rearing *Bufoidea larseni* in Europe

A single female *Bufoidea larseni* was taken during mercury vapour light trapping in Wadi Shik (Oman) in late April 2005. The moth was placed overnight in a stoppered tube to see if any eggs could be obtained. By the next morning, about 20 eggs had been laid in small batches on the walls of the tube. The moth was retained for inclusion in the Al Ain Emirates Natural History Group Collection, whilst the eggs were put aside for rearing. However, the tube with eggs was inadvertently taken back to the United Kingdom at the end of my stay in the UAE and, because I was due to leave straight away for an extended trip to Brazil, the eggs were turned over to two of my children for rearing. Neither Conrad nor Caroline had had any experience of looking after caterpillars. However, in the absence of either *Fagonia* or *Ochradenus* for use as food-plants, I suggested that if any caterpillars hatched, they should try feeding them with hawthorn leaves (*Crataegus*).

All the eggs hatched out at the beginning of May and the tiny larvae were successfully transferred to sprigs of hawthorn on which they hesitatingly began to feed. Development was slow, but by late June, most had survived to the third instar. At this stage, the caterpillars seemed to be intermediate in colouration between the two forms described above, but perhaps more closer to the dark form and similar to the caterpillars collected in the wild in Oman in 1996. Unfortunately at this stage, they began to reject the hawthorn leaves and although a few fed for a time on lettuce leaves, by the time that I arrived back in UK in early July, all but one had died of unknown causes. I immediately tried to get the remaining caterpillar to accept other available possible food-plants, including Elm (*Ulmus*), Holly (*Ilex*), Nightshade (*Solanum*), Blackberry (*Rubus*) and Elder (*Sambucus*) amongst others. Surprisingly, the sprigs of Elder were accepted and the caterpillar resumed feeding at night, although I am aware that very few European

Figure 3. Caterpillar of *B. larseni* on leaves of Blackberry in England. It did not eat these, but fed on leaves of Elder seen in the background.

Figure 4. Cocoon of *B. larseni* attached to dead Elder leaves and to the sides of the glass rearing tank. The pupa inside hatched out into a male moth; this being the sole survivor of about 20 eggs accidentally taken to England.

Figure 5. The original wild-caught female *B. larseni* (top) with the cocoon, last larval skin and emerged male *B. larseni* (bottom).

species of Lepidoptera ever utilise the leaves of this plant as larval food. The caterpillar (***Figure 3***) eventually pupated on 28 July 2005, spinning up a rather flimsy white silken cocoon amongst leaves but which was also fastened to the glass walls of the breeding tank (***Figure 4***). Larval development, therefore, took about 13 weeks in the United Kingdom, which is about three times as long as in the UAE, but this is probably attributable to both the non-ideal food-plants and to lower temperatures particularly at night when feeding takes place. In due course, a perfect male moth emerged on 23 August 2005 and actually escaped to fly around lights in the house until recaptured two days later. It will also be incorporated into the Al Ain ENHG Collection, together with mother moth, the cocoon and last larval skin (***Figure 5***).

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A record of a micro-moth pest, the Teak Defoliator, *Hyblaea puera* (Cramer, 1777), apparently new to the Gulf Region (Lepidoptera: Hyblaeidae)

by Michael P.T. Gillett

Three specimens of an unknown diurnal moth were captured in Wadi Musah, northern Oman, in September 1997 whilst collecting butterflies. The moths were flying around mature bushes of *Vitex agnus-castus* and visiting their bright blue flowers, which were also attracting a variety of butterflies, including Lime (*Papilio demoleus demoleus*), African Emigrant (*Catopsilia florella*), Desert White (*Pontia glaucoma*), Salmon Arab (*Madais fausta*), Pea Blue (*Lampides boeticus*), Mediterranean Pierrot (*Tarucus rosaceus*), Small Cupid (*Chilades parrhasius*), Blue Pansy (*Junonia orithya here*), Plain Tiger (*Danaus chrysippus chrysippus*), Painted Lady (*Vanessa cardui cardui*) and Millet Skipper (*Pelopidas thrax thrax*).

On examination, the moths were found to be stout-bodied with a wingspan of 3.5 – 4.0 cm. The dark forewings were indistinctly marked in shades of chocolate brown and grey and the hindwings were black with two irregular and variable bands of bright orange-yellow (***Figure 1***). Superficially, the moths resembled members of the large macro-moth family Noctuidae (owlet moths), particularly those of the subfamily Catocalinae, many of which have brightly contrasting underwings coloured black and red, yellow or orange. However, besides not matching any known catocaline moth from the region, the shape of the wings and other features did not look quite right for the Noctuidae and suggested that the moths probably belonged to one of the lesser known families of micro-moths despite their relatively large size.

The specimens remained unidentified until December 2004, when quite by chance an illustration of an Australian moth, *Hyblaea sanguinea*, was seen in an encyclopedia dealing with the biology of the Lepidoptera (Sbordoni and Forestiero, 1985). The illustration was of a moth that was clearly similar to the Omani specimens in wing shape, general colouration and pattern of markings. Further study of the encyclopedia and an internet search yielded information that the genus *Hyblaea* contains only a few species and is the only genus making up the family Hyblaeidae. The systematic position of this family is uncertain and at times, it has been placed in various superfamilies including Noctuoidea (indicating a supposed relationship with Noctuidae) and in the micro-moth superfamily Yponomeutoidea (underscoring a possible link with the clearwing moths, family Sesiidae). Currently, it is retained in the micro-moths, but is included in the Pyraloidea. However, its relationship to the Pyralidae and other families of this superfamily remains unclear. Comparison of the Wadi Musah moths with illustrations of material displayed on the internet indicate convincingly that they are examples of *H. puera* (Cramer, 1777), a rather well known pest species, but one whose geographical origin is now obscured (Schneider, 1999). The larvae of this moth feed on the leaves of the teak tree, *Tectona grandis*, hence the commonly applied name of Teak Defoliator moth. Possibly originating in Java, this moth is now distributed throughout the tropical and sub-tropical regions of the world, including Australia, the Indian Sub-continent, Africa and the Americas, including the Antilles (*see Note*) (Barnes, 2002; CSIRO Entomology, 2004; Peres-Filho *et al*., 2002).

Figure 1. Habitus of the Teak Defoliator moth *Hyblaea puera* from Wadi Musah, Oman. The top specimen is a female with a male of slightly smaller size shown below. (Photograph by Ashok Prasad, Department of Medical Education, FMHS, UAE University).

The larval food is not confined to the leaves of the teak tree since other members of the family Verbenaceae are also eaten, including *Vitex* spp. In the United Arab Emirates and northern Oman, *Vitex agnus-castus* is commonly planted in towns and gardens and has become naturalised in wadis in the Hajar Mountains, possibly as a result of its long-established use as a medicinal plant. Another possible food-plant from this family is *Clerodendrum inerme*, a common hedging plant in the region. Other recorded food-plants for *H. puera* (Herbison-Evans and Common, 2004) are the genera *Bigonia*, *Catalapa*, *Spathodea* and *Millingtonia* (Bigoniaceae) and the Grey Mangrove, *Avicennia marina* (Avicenniaceae), which is locally common along the coasts of the UAE and Oman.

Given the widespread occurrence of the Teak Defoliator and the availability of at least two suitable larval food-plants in the Gulf Region, the moth's presence there should perhaps come as no surprise. However, it does not seem to have been previously recorded from the region and its apparently isolated occurrence to date only in Wadi Musah seems to pose something of a mystery. It has not been recorded since 1997 in Wadi Musah and, therefore, any further records of its occurrence in the Gulf Region, whether from Hajar Mountain localities, towns with planted *Vitex agnus-castus* or from the vicinity of coastal mangrove areas would be of great interest. Potentially this species, if permanently established in the region, could inflict significant damage both on mangroves and on selected landscaping plants.

In summary, the discovery of *H. puera* in northern Oman represents not only a new species record for the Gulf Region, albeit a potentially pestiferous one, but also a newly recorded family for the area for the Lepidoptera. Altogether over 20 families and nearly 300 species of butterflies and moths are now known from the UAE and northern Oman, making the Lepidoptera indisputably the best-known major order of insects in the region. However, in particular the micro-moths of the region still remain poorly collected and little studied and much more work will be required before even a reasonably complete account of the lepidopterous fauna of this important region can be accomplished.

Note: Whilst working on this account of *H. puera*, I took two examples of the moth at light on Saba island, Netherlands Antilles, during November 2006.

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Three species of snout moths previously unrecorded for the United Arab Emirates (Lepidoptera: Noctuidae: Hypeninae)

by Michael P.T. Gillett

The larger moths (Macro-Heterocera) are one of the best known of the major groups of insects in the UAE. This is due almost entirely to the indefatigable collecting efforts of Belgium-based Albert Legrain during the 1990s. Legrain's strategy was to make almost annual one- or two-week intensive collecting trips to the country. At different seasons, he visited much of the national territory used nocturnal light-trapping as well as other techniques to collect and record moths. His results have yielded an apparently remarkably complete inventory of the macro-moth fauna of the UAE (Legrain and Wiltshire, 1998).

However, much of Legrain's work was concentrated in the northern emirates with little attention being paid to collecting in Abu Dhabi Emirate. It has thus been possible to complement this list with a few other species from the Al Ain region of Abu Dhabi that have, in most cases, been found quite by chance. They include single specimens of a carpenter moth (family Cossidae) (Gillett, 1998a) and of two migratory species of Plusiinae (family Noctuidae) (Gillett, 1998b*), and, most recently, the Savannah Hawkmoth, *Sphingonaepiopsis nana* (family Sphingidae) (Gillett and Howarth 2007). The Hummingbird Hawkmoth (*Macroglossum stellatarum*), recorded by Legrain and Wiltshire only from Oman, is also known from the UAE (Gillett, 1993). A few other species from Abu Dhabi, mainly from the family Noctuidae, in the collection of the Environment Agency – Abu Dhabi, EAD, formerly the Environmental Research and Wildlife Development Agency, ERWDA, will also eventually be recorded as additions to the national list.

In the present note, three further species from the family Noctuidae are recorded for the first time for the UAE, all from the Al Ain region. All three are rather drab-coloured snout moths belonging to the genus *Hypena*, subfamily Hypeninae.

***Hypena laceratalis* Walker, 1858**

There is a single record of this small brown moth with lighter markings on the forewing: it is from Al Muwaiji, Al Ain (at light on 6 July 1998), otherwise this species is known in the Arabian Peninsula only from Fifa and Al Qatif in Saudi Arabia (Wiltshire, 1990). Outside of Arabia, this moth is well known and Kenyan strains have been introduced into Australia and elsewhere for control of the weed *Lantana camara* (Verbenaceae) (QNRM, 2003), which is presumably the larval foodplant in the UAE.

***Hypena obsitalis* (Hübner, 1813)**

This brown moth is slightly larger than the preceding species and has fewer and less distinct lighter markings. There is a single record from Al Muwaiji, Al Ain (at light on 13 March 1998), otherwise this moth is recorded in the Arabian Peninsula only from the Jeddah region of Saudi Arabia (Wiltshire, 1990). Elsewhere, this moth is widespread in Europe, being known as the Bloxworth Snout in English. Until recently, it was considered as a rare immigrant to mainland Britain, but is now thought to be established in Devon (Kimber, 2006). Foodplants in Europe include Urticaceae such as Pellitory-of-the-wall (*Parietaria judaica*) and probably Stinging Nettle (*Urtica dioica*), suggesting *Forsskaolea tenacissima* as a possible larval host in the UAE.

***Hypena abyssinalis* (Guenée, 1854)**

Individual moths were recorded several times at light in the Al Ain region and at Al Lisaili (Dubai) in the early 1990s, but no more recent records are at hand. It is similar to *H. obsitialis*, but has more pointed forewings, is darker brown and has barely discernable lighter markings. Wiltshire (1990) mentions specimens collected from Jizan and eastern Saudi Arabia and states that the species is common at coastal localities in Oman. Elsewhere, the moth is restricted to Kenya, Somalia and Ethiopia.

These records actually double the number of species from this subfamily known from the UAE. Legrain and Wiltshire recorded *Rhynchodontes revolutalis* (Zeller, 1752), *R. orientis* (Brandt, 1938) ssp. *richteri* Wiltshire, 1961 and *Hypena lividalis* (Hübner, 1790). Compared to the other UAE species, this last mentioned is much more attractively and distinctively marked with a large chestnut brown area at the base of the forewing delimited by a diagonal white line. It is also known from the Al Ain region, a single individual having been collected at light on 11 March 1998 at Al Muwaiji. Compared to most noctuids, the members of the genus *Hypena* are delicate moths and their wings are easily damaged. None of the specimens of the three species newly recorded were encountered in perfect condition and all were unsuitable for photography. However, typical specimens of all three species, together with *H. lividalis* (as *Ophiuche lividalis*), are illustrated in the catalogue of macro-moths from Saudi Arabia (Wiltshire, 1990). All species, except *H. abyssinalis*, are also well illustrated at various sites on the internet.

The published list of Legrain and Wiltshire (1998) included 200 species of macro-moths from the UAE, plus 19 others known only from adjacent areas of Oman. In comparison, the number known from Saudi Arabia is much greater at 641 (Wiltshire, 1994). The number of UAE species can now be increased to 208. However, the additions mentioned above or included here are relatively few and mostly consist only of fortuitous captures of single specimens by enthusiasts resident in the UAE and in all cases, the moths have previously been recorded from Saudi Arabia or elsewhere in the Arabian

Peninsula (Wiltshire, 1991). Nevertheless, the activities of such individuals and of the Emirates Natural History Group and affiliated groups are likely to bring further recording successes for macro-moths, especially since more focused collecting activities including mercury-vapour lamp trapping are coming into wider use.

*Since this record, a second specimen of *Autographa gamma* (L.) has been captured in the UAE (Al Muwaiji, Al Ain, 9 December 1998).

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The Hawklet or Savannah Hawkmoth, *Sphingonaepiopsis nana* (Walker, 1856), new to the United Arab Emirates (Lepidoptera: Sphingidae)

by Michael P.T. Gillett and Brigitte Howarth

An unidentified moth was collected by one of the authors in April 2001 at rest on a wall at the Faculty of Medicine and Health Sciences of the UAE University at Tawam, Al Ain, Emirate of Abu Dhabi. It was placed in a container in a freezer and was not looked at again until November 2004. On close examination, the moth was found to be a hawkmoth (family **Sphingidae**; subfamily **Microglossinae**), albeit a species completely unknown to the authors and an improbable one due to its diminutive size and dull reddish brown colouration. The moth was relaxed and set for display with its wings spread and allowed to dry before being critically re-examined.

It was easily identified using several internet resources, including the excellent website on Western Palaearctic Hawkmoths (Pittaway, 2004). The species is *Sphingonaepiopsis nana* (Walker, 1856), originally described from Natal, South Africa.

Some six species belonging to the genus *Sphingonaepopsis* Wallengren, 1858 are found in southern and eastern Africa and in western and central Asia. Probably because of its South African occurrence, *S. nana* is one of only two moths in the genus that has been given a common name in English. In fact two such names are in use: the name Savannah Hawkmoth obviously refers to its typical habitat in savannah, steppe-land and semi-desert whilst the name Hawklet (Savella, 2002) alludes to the dwarf size of this moth compared to typical hawkmoths as too does the specific name. The other named *Sphingonaepiopsis* is Ansorge's Hawklet, *S. ansorgei* Rothschild, 1904, which also flies in Africa (Savella, 2002).

The Al Ain specimen of *S. nana* has a wingspan of 2.5 cm, which is at the lower end of the size range for the species. Other hawkmoths found in the United Arab Emirates are much larger and range from the 4 - 5 cm wingspan of the Hummingbird Hawkmoth to 12 or 13 cm in the three largest species in the subfamily *Sphinginae* (***see Table 1***).

The specimen is depicted in ***Figure 1*** and is rather worn and of a somewhat more red-brown overall colouration than the one shown in the Western Palaearctic Hawkmoths website, but the pattern of markings is similar in both. The moth's small size and relative drabness suggest that it might easily be overlooked in the UAE.

It should be noted that although very small, *S. nana* is not the smallest known hawkmoth. That distinction goes to another member of the genus, *S. obscurus* found on Madagascar with a wingspan of only 1 cm (Sbordoni and Forestiero, 1985). Probably the largest species known is *Cocytius antaeus* (Drury, 1773) from the Americas (Ferguson *et al*., 1999) with a maximum wingspan approaching 20 cm.

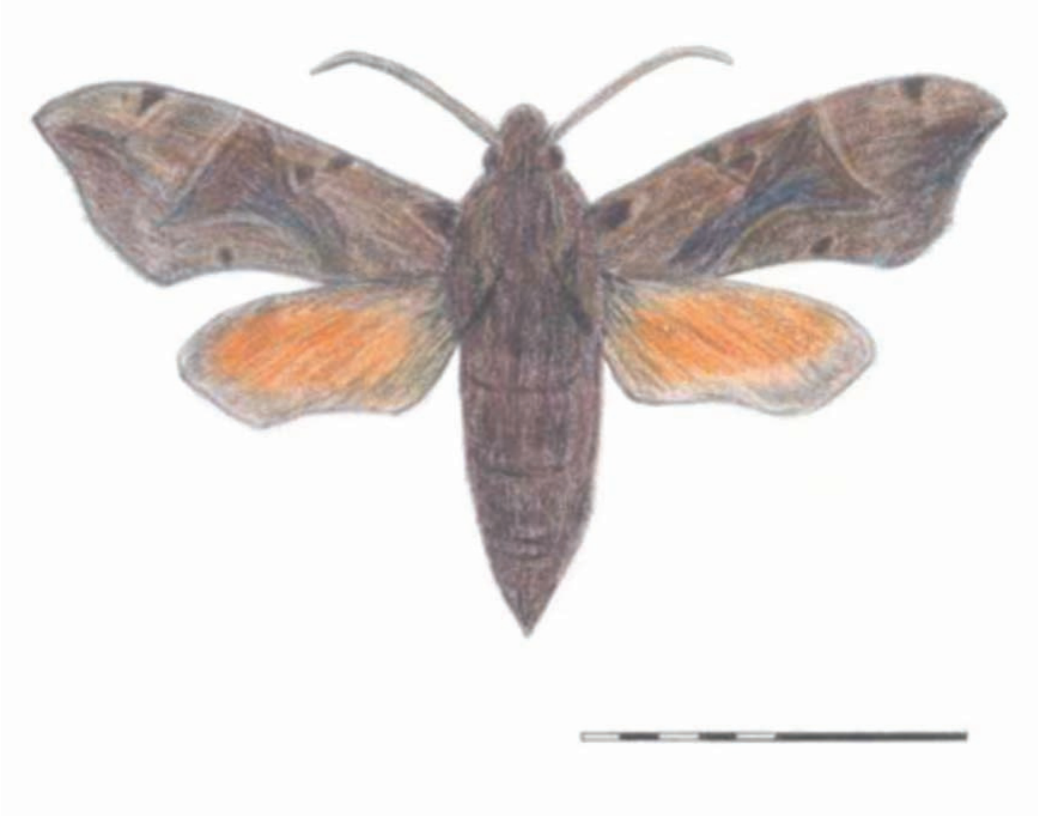

Fig 1. Habitus of *Sphingonaepiopsis nana*. The total scale bar length is 10 mm.

Table 1. Systematic list of known and suspected hawkmoths in the United Arab Emirates

Subfamily and Species	Common name	Occurrence	Wingspan
Sphinginae			
Agriusconvolvuli (L.)	Convolvulus Hawkmoth	Migrant from Oman and possible resident	9.5 – 13.0 cm
Acherontia atropos (L.)	Death's Head Hawkmoth	Unconfirmed migrant from N or SW	9.0 – 13.0 cm
Acherontia styx styx (Westwood)	Eastern Death's Head Hawkmoth	Common resident* and migrant from Oman	9.0 – 12.0 cm
Macroglossinae			
Cephonodes hylas virescens (Wallengren)	Coffee Clearwing Hawkmoth	Irregular and unconfirmed migrant from SW	4.5 – 7.0 cm
Sphingonaepiopsis nana (Walker)	Savannah Hawkmoth/Hawklet	First record for the UAE	2.5 – 3.0 cm
Daphnis nerii (L.)	Oleander Hawkmoth	Common resident* and migrant from Oman	9.0 – 11.0 cm
Macroglossum stellatarum (L.)	Hummingbird Hawkmoth	Regular migrant from Oman	4.0 – 5.0 cm
Hyles livornica (Esper)	Striped Hawkmoth	Commonest species: resident* and migrant	6.0 – 8.5 cm
Hippotion celerio (L.)	Silver-striped Hawkmoth	Infrequent migrant from Oman, common 2005	6.0 – 8.0 cm

*Species are claimed as resident on the basis of confirmed breeding records (larvae or pupae) in the UAE. However, to retain viable populations in the UAE, these species probably require periodic influxes of new migrants.

The range of *S. nana* is shown in *Figure 2* and includes South Africa, Zimbabwe, east Africa, western Saudi Arabia and Aden in southern Yemen, as well as southern Iran and Baluchistan in mainland Asia. It is mentioned on the basis of two specimens from the Jeddah area, but without other details, by Wiltshire (1990) in his catalogue of the Saudi Arabian Macro-heterocera. The moth flies in April and May in Africa and is crepuscular in its behaviour, visiting flowers in late afternoon and at dusk. Unlike other UAE hawkmoths, it is not a noted migrant. The known larval foodplants are all species of the family Rubiaceae, including *Galium*, *Kohautia* and *Jaubertia*. Several members of this plant family occur in the UAE and probably are used as foodplants, including, in the Al Ain area, *Gaillonia* (= *Jaubertia*) *aucheri, Kohautia caespitosa* and *Pseudogallonia hymenostephana* (Jongbloed, 2003).

The finding of *S. nana* at Al Ain is of interest not just because it adds a new species and a new genus to the fauna of the UAE, but also because it fills the gap in its previously known disjunctive distribution (***Figure 2***). It brings to seven the total number of hawkmoth species definitely known from Al Ain and the UAE (*Table 1*). Two other migratory species are likely to visit the UAE from time to time. Thus there is an unconfirmed record of the Death's Head Hawkmoth, *Acherontia atropos* (Linnaeus, 1758) from Abu Dhabi and another of the Coffee Clearwing Hawkmoth, *Cephonodes hylas virescens* (Wallengren, 1865), from the Hajar Mountains of the Northern Emirates. There is an outside chance that other migratory species might appear in the UAE as vagrants either from Southern Oman, e.g. Rebel's Striped Hawkmoth, *Hippotion rebeli* Rothschild and Jordan, 1903, or from Iran, e.g. the Levant Hawkmoth, *Theretra alecto* (Linnaeus, 1758) or the Southern Eyed Hawkmoth, *Smerinthus kindermannii* Lederer, 1853, but there are no records, confirmed or otherwise, as yet.

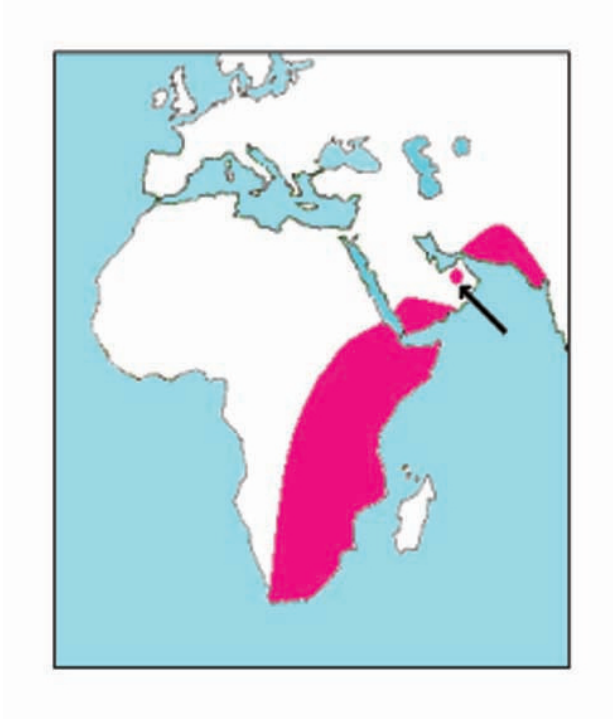

Fig 2. The present record of the Savannah Hawkmoth or Hawklet, *Sphingonaepiopsis nana*, from Al Ain in the UAE (arrow) fills a gap in the reported distribution of this small and easily overlooked species previously known from southern and eastern Africa, SW Arabia, southern Iran and Baluchistan.

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A Butterfly Migration: Blue-spotted Arabs at Jebel Barakah, western Abu Dhabi

by Drew Gardner and Brigitte Howarth

Migrations of butterflies are a widely recognised phenomenon, yet one that is still little studied. Larsen (1984) reported that 57% of the 28 species then recorded in Eastern Arabia (i.e. the UAE and the eastern seaboard of Arabia, running along the Gulf) showed evidence of migratory behaviour. One of these species is the Blue-spotted Arab (*Colotis phisadia*), a common species in the Pieridae. The larval food plant is *Salvadora persica*, a species both native to Arabia and also very widely planted alongside roads and in plantations.

On 24th October 2006, it was noted that large numbers of Blue-spotted Arabs were flying ashore at Jebel Barakah, western Abu Dhabi. They were first noted at around 10.00, and were still streaming in at 13.00 when we departed the area. The day was cloudless with a slight onshore breeze, and an air temperature at 13.00 of 37°C. The behaviour of the butterflies was quite distinctive. They were flying in over the sea from the north-west, either singly or in twos or threes. Their flight was relatively fast and direct, and varied from a few centimetres to about one metre above the sea surface. At the time the sea was very calm, with a wave height of no more than 15 cm. When the butterflies reached the cliffs, most flew up and over without varying direction. However many did land on the scattered plants of *Salsola imbricata* in the gulleys in the cliffs. These butterflies tended to shelter in the shade and appeared to be seeking moisture with unrolled probosci.

It was estimated that the butterflies were arriving at a rate of about 5 per minute within 10 metres either side of an observer, which gives an approximate arrival rate of 15,000 butterflies per hour per kilometre of coast. How wide the migration front was is not known, though on driving towards Abu Dhabi along the highway, it was noted that Blue-spotted Arabs were exceptionally abundant for almost 100 km eastwards from Jebel Barakah. In any case the numbers of butterflies involved was certainly massive, and possibly numbering millions. Assuming the butterflies flew in a constant direction over the sea, the closest land was the Qatar peninsula, approximately 120 km away.

An abundance of Blue-spotted Arabs, estimated in hundreds of thousands, was also noted on 18 September 2005 in the Baynounah and Ruwais area. They too appeared to be moving south and east through the Baynounah plantation and Ghiyathi (Simon Aspinall, *pers. comm.*).

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An unexpected resident butterfly of northern Oman: the Arabian Grizzled Skipper *Spialia mangana* (Lepidoptera: Hesperiidae)

by Gary R. Feulner

Figure 1. The Arabian Grizzled Skipper *Spialia mangana* on the slopes of Jebel Kawr, northern Oman.

In early December 2007, on my first visit to the middle slopes of Jebel Kawr in northern Oman, a formidable limestone massif adjacent to the Jebel Akhdar, I encountered a small skipper butterfly that was evidently the Arabian Grizzled Skipper *Spialia mangan*a (Rebel) 1899 (***Figure 1***).

S. mangana is an uncommon and little known butterfly principally recorded from arid parts of the Horn of Africa (southern Ethiopia, northern Somalia and neighbouring areas) and southern Yemen (Larsen 1983, 1984a, 1984b). It has also been collected at least twice from Dhofar, by P. Granville White at 'Ayun (an arid site on the inland side of the coastal mountains) and A.R. Pittaway at 'Ayn Razat (beside a stream at the base of the coastal escarpment) (Larsen & Larsen 1982; Larsen 1980, 1983). Torben Larsen himself failed to find *S. mangana* in either Yemen or Dhofar, despite searching for it (Larsen 1983).

Because identification of skipper butterflies is generally difficult and because my record of *S. mangana* represents a considerable extension of its known range, I sought expert confirmation as soon as my photographs were available. Larsen wrote back immediately and enthusiastically: "How unexpected ... and how absolutely amazing! There are several Dhofar and Yemen butterflies that I could imagine in northern Oman/UAE, but *Spialia mangan*a was not one of them. But your pix are unequivocal and well capture the 'essence' of the butterfly."

My observation was made at ca. 1100m on a gently sloping pavement of limestone bedrock with scattered and rather heavily grazed plants (***Figure 2***), ca. 1.5 km above the remote village of Sant (today somewhat less remote, with a relatively good graded road and regular minibus traffic for primary and secondary school students). Approximate geographic coordinates are: Lat. 23º06'30"N, Long. 57º04'30"E.

The arid, rocky habitat is apparently typical for the species (Larsen & Larsen 1982; Larsen 1983, 1984b). My sighting was in early afternoon on a sunny day, with the ambient temperature estimated at ca. 27ºC. The *S. mangana* (I saw only one) was tiny and behaved in a manner typical for many skippers, perching on the open bedrock and making occasional sorties before returning to the same or a nearby perch. It remained within the same 6m radius during the 10-15 minutes that I observed and photographed it.

I remarked on the presence of traditional agriculture at Sant and speculated that this could be the source of one or another crop plants that might be supporting the butterfly, but Larsen was confident that this was not the case: "I can imagine few species less likely to be an agricultural import than *Spialia mangana* and it is definitely a non-migrant. So it has to be a hold-over from times when the Afrotropical fauna was more widely distributed." See Larsen (1984a) for a more comprehensive discussion of the biogeography of Arabian butterflies generally.

Figure 2. The barren, rocky habitat of *Spialia mangana* at Jebel Kawr.

In the immediate area there were several plant species new to me and/or uncommon in northern Oman, including the Jebel Akhdar. It is possibly significant that among these was *Melhania muricata*, *Melhania* being a known larval food plant of the related Zebra Grizzled Skipper *Spialia zebra*, which ranges from East Africa through Southern Arabia to Baluchistan and the Punjab (Larsen & Larsen 1982; Larsen 1983).

At the time of the initial sighting I observed only two other butterflies on the nearby slopes (a Pierrot Tarucus sp. that could not be further identified and a Grass Jewel *Chilades* (*Freyeria*) *trochylus*) despite spending some three and a half hours in the area, although in a more wooded wadi bed environment nearby the following were abundant: Caper White *Anaphaeis aurota*, Giant Skipper *Coeliades anchises* and Desert Orange Tip *Colotis liagore*.

On a repeat visit to the same area two and a half weeks later, I again encountered a single *S. mangana*, only about 25m from my original observation site. On the second occasion a modest number of Giant Skippers *C. anchises* were also present on the slopes, and the *S. mangana* several times reacted, when a Giant Skipper violated its 'airspace', by darting up and briefly giving chase. The effect was somewhat comical, given the disparity in size between the two. Also observed on the same slopes on the second occasion were single individuals of Salmon Arab *Colotis fausta*, Blue Spotted Arab *Colotis phisadia*, Small Cupid *Chilades parrhasius* and Pomegranate Playboy *Deudorix livia*.

Additional butterfly species were observed beside the *falaj* immediately above Sant, including Desert Orange Tip *Colotis liagore*, Mediterranean Pierrot *Tarucus rosaceus*, African Babul Blue *Azanus jesous* and Plain Tiger *Danaus chrysippus*, as well as most of the other species already mentioned above. Some 8 km away, another *Spialia* sp., probably *S. doris* (the Desert Grizzled Skipper) or *S. mafa* (the Mafa Grizzled Skipper) was observed on the barren, stony slope of a low, eroded terrace.

Five species of Grizzled Skippers (*Spialia* spp.) have been recognised in Oman. Apart from *S. mangana*, all of them have also been found in the UAE or immediately adjacent areas (Wilayat Mahdhah, Wilayat Musandam) (Larsen & Larsen 1982; Larsen 1983; Gillett 1995). All are relatively small butterflies and males and females are alike. All have dark brown uppersides with relatively extensive white spotting. The undersides are paler brown or khaki-coloured with diffuse white spotting and/or banding. *S. mangana* is perhaps the easiest to distinguish in the field, if seen well. Diagnostic features include fewer and smaller white spots overall on the upperside of the wings, the absence of any tiny marginal white spots on the upperside (present in each of the other *Spialia* spp.) and a well defined white band across the underside of each hindwing.

The discovery of *S. mangana* continues the progressive recognition in Northern Oman of small populations of arid Afro-tropical 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 agricultural cultivation, but must be considered a previously unrecognised relict species.

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Dugong agreement signed

A Memorandum of Understanding (MoU) concerning the Conservation and Management of Dugongs *Dugong dugon* and their Habitats throughout their Range was signed by seven countries, including the United Arab Emirates, at a meeting held in Abu Dhabi in late October 2007. Other signatories included Madagascar, Australia, Burma, Tanzania, Eritrea and France, with Iran and Kenya having indicated that they would sign later.

The signing of the MoU came at the end of a meeting, organised by the Environment Agency – Abu Dhabi, EAD, and the Convention on Migratory Species, CMS, to discuss and adopt a Conservation and Management Action Plan for the dugong, and was attended by representatives of over thirty countries. The meeting, sponsored by the oil company, TOTAL ABK, which has also funded earlier research into dugongs in UAE waters, followed earlier meetings held in Bangkok, Thailand (in August 2005 and in May 2006) and in Abu Dhabi, UAE (in May 2006).

The meeting consisted of two concurrent workshops concerning the implementation of the Dugong Conservation and Management Plan in the East Indian Ocean and the Pacific Ocean and West Indian Ocean sub-regions.

Dugongs are one of only four species of the order Sirenia, all of which are listed as vulnerable to extinction by the World Conservation Union (IUCN). The dugong has a large range of distribution that spans at least 37 countries and territories encompassing tropical, sub-tropical coastal and inland waters of the Indian and Pacific Ocean. A significant proportion of the world's dugongs occur in the Arabian Gulf. Other important areas of dugong occurrence in the Western Indian Ocean region include the Red Sea and the East African coast. The Arabian Gulf and Red Sea host an estimated population of more than 7,000 dugongs, which constitutes the largest population outside Australia. About 40 percent of this population occurs in Abu Dhabi waters in the UAE, making the UAE particularly significant in terms of global dugong conservation efforts.

(Source: EAD press releases, 27, 28 and 31 October 2007)

Marawah becomes UAE's first Biosphere Reserve

The Marawah Marine Protected Area, MMPA, managed by the Environment Agency, Abu Dhabi, EAD, has been accepted and accredited as a Biosphere Reserve within the Man and Biosphere, MAB, network of Global Biosphere Reserves maintained by the United Nations Educational, Scientific and Cultural Organisation, UNESCO. This announcement makes Marawah the first Biosphere Reserve in the UAE.

The Marawah Marine Biosphere Reserve, situated west of Abu Dhabi island, is home to important marine and coastal ecosystems including seagrass beds, coral reefs and mangroves. The Reserve also hosts 60% of the second largest population of dugongs in the world. Marawah is also of great cultural and archaeological significance in the UAE, with archaeological sites dating back to the Arabian Neolithic (Late Stone Age) period, around 5,500 years ago, having been identified on Marawah island, one of several in the reserve, as well as sites from later periods, including the Bronze Age, Iron Age, late pre-Islamic and Islamic periods.

The announcement, made in Abu Dhabi at the beginning of November 2007, followed a meeting of the Bureau of the International Coordinating Council of the Man and Biosphere (MAB) Programme at UNESCO Headquarters in France in September 2007.

The Biosphere Reserve concept provides context-specific opportunities to combine scientific knowledge and governance modalities to reduce biodiversity loss; improve livelihoods; enhance social, economic and cultural conditions for environmental sustainability. Biosphere reserves can also serve as learning sites for the public.

The Marawah MPA, the largest Marine Protected Area in the Arabian Gulf, was established as a reserve in 2001. Situated west of the city of Abu Dhabi, it includes the islands of Marawah, Liffiyah, Umm Amim, Junanah, Salahah, Halat Hail, Halat Mubarraz, Bazm al-Gharbi and Bu Tini and covers an area of 4,255 sq. km.

The marine areas of the MPA include important seagrass beds and populations of dolphins, turtles and dugongs, as well as coral reefs.

(Source: EAD press release, 1 November 2007)

Controls on groundwater wells

A new by-law for Abu Dhabi Emirate Law No. 6 for 1996 has been issued to regulate the management of groundwater wells in the Emirate.

The by-law will help control groundwater abstraction within the Emirate. It presents a mechanism for issuing permits to those who wish to dig wells. A committee has been formed within the Environment Agency – Abu Dhabi, EAD, which has been responsible since 2005 for groundwater resources management in Abu Dhabi, to study and assess all requests received for digging new wells. It is estimated that there are currently around 100,000 wells within the Emirate of Abu Dhabi, with the location of only about a quarter of these having been determined to date. Activities such as digging new wells, maintaining existing wells and replacing old wells with new ones will now require permits.

According to EAD, Abu Dhabi Emirate's groundwater supply has been reduced by 18% since 2003. This has meant that the Emirate has increasingly relied on unconventional water resources, such as desalination and re-use of treated wastewater. EAD estimates that 641 cubic metres of groundwater resources are still available, but less than 3% of this is fresh and, based on current abstraction rates, both fresh and brackish reserves will be depleted within 50 years. Groundwater contributes 71.2% to the total water demand, followed by desalinated water (24%) and treated wastewater (4.8%).

(Source: EAD press release, 7 November 2007)

Christmas whales

A rare sighting of three killer whales (*Orcinus orca*), the largest member of the dolphin family, was reported by fishermen around 12 kilometres offshore from the village of Rams, in Ra's al-Khaimah, on 25th December 2007. The three animals were said to be around 10-12 metres in length. They were seen by two Emirati fishermen, who followed them for around a kilometre and said that they had never previously seen the species, in ten years of fishing in Ra's al-Khaimah waters.

Killer whales were first reported in UAE waters, off the coast of Abu Dhabi, only a few years ago by a research team from the Abu Dhabi-based Emirates Heritage Club, although they are more frequently seen off the coast of Oman and can be expected to occur occasionally off the UAE's East Coast.

(Source: Gulf News, 26th December 2007).

Zoology in the Middle East

The publishers of the journal *Zoology in the Middle East* have completed a compilation of the Index for the first 40 issues of the journal.

Copies of the Index, together with abstracts of all full papers, can be downloaded, free of charge, from their website, www.kasparek-verlag.de

With 660 articles on more than 5,200 printed pages from 731 authors coming from 50 countries, *Zoology in the Middle East* is a unique information source for all zoologists and ecologists interested in this part of the world and also documents twenty years of the development of scientific research throughout the region.

UAE Specimens Clarify Marine Gastropod Taxonomy

Specimens from the United Arab Emirates have contributed to two recent scientific studies of the molecular phylogeny (DNA taxonomy) of marine gastropod groups in the Indo-West Pacific region, including the recognition of two new species found locally.

Specimens of UAE *Turbo* and *Lunella* spp. from both coasts were examined as part of a study of the broader class of Turbinid (turban-shaped) gastropods.◊ A subsequent paper will focus more narrowly on the two genera *Turbo* and *Lunella* in particular, and is expected to confirm the existence of a hitherto unrecognised species in the UAE, first suspected by local naturalists on the basis of consistent morphological differences observed in the course of the collection effort.

In a second study, DNA analysis of specimens from Khor Julfar in Ra's al-Khaimah of the common large bubble shell, previously considered to be *Bulla ampulla*, has helped to confirm that the species present in the extreme north-western Indian Ocean, including the seashores of Arabia, is in fact a distinct species. It has been named *Bulla arabica* and the type specimens are those from Ra's al-Khaimah.≈

B. ampulla has a broad range throughout most of the Indo-West Pacific, from the shores of East Africa to Asia, Northern Australia and New Caledonia, but it appears to be absent from Arabian shores. Instead, it is the newly recognised *B. arabic*a that is the large bubble shell found in the Red Sea, Yemen, Oman and the Arabian Gulf, and eastwards to Karachi. Beached shells of *B. arabica*, but so far not living animals, have also been found in the eastern Mediterranean.

Both of the foregoing studies were conducted by researchers at the Molluscan Research Unit of the Department of Zoology at The Natural History Museum in London.

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≈ Malaquias, M. (*in press*).

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Reviews

Snakes of Arabia: A Field Guide to the Snakes of the Arabian Peninsula and its Shores' by Damien Egan. 2007. Published Motivate Publishing, Dubai. ISBN 978 1 86063 239 6 208 pp.

This book is exactly what the title indicates. It is an exceptionally user-friendly field guide that enables virtually any snake encountered on the Arabian Peninsula to be identified with ease, even by naturalists not familiar with the more esoteric aspects of snake morphology. The format is small enough to be carried to the field, and the quality of the binding appears adequate, though only time will tell if it can stand field usage without falling apart! This is a much needed volume for both professional and amateur naturalists, and for anyone whose work or play takes them into the Arabian outdoors. The guide covers all 55 species of land and sea snakes recorded.

The first quarter of the book provides valuable information on the main geographical regions of Arabia, snake biology and adaptations, venomous snakes, snake venoms and good, advice on snakebites. There is information on how to identify snakes from their shape, form, colour, scalation, and tracks and traces. The remainder of the book is taken up by detailed and standardised species accounts providing a description of the species including diagnostic features and possible confusion with similar species, information on distributions and aspects of natural history as far as these are known. A distribution map based on records is provided for each species. Some species are included despite their Arabian records being suspect, but this does

ensure that the treatment is comprehensive.

The Guide is exceptionally well illustrated with high quality photos of many species (including some different colour morphs and geographical variants), and with excellent coloured illustrations (by the author, who is an artist of considerable accomplishment) of the side and top of the head and the overall body shape and pattern. The scalation is accurately portrayed in these and this feature makes the book particularly valuable and unusual in guides of this type.

The book is aimed at a general audience and there are no citations of sources of the information in the text. While this makes the book much more readable, it is frustrating for serious snake students as there is no way of knowing which information and observations are new. This is especially true for some of the aspects of natural history such as clutch sizes and incubation times and diet.

A minor criticism is that the photographs are in some cases sited opposite different species accounts, which may cause some confusion, especially where the snake is not named in the legend. Hence the species on page 156 is the Yellow Sea Snake and not the Short Sea Snake described on the facing page. The photo of a Sindh Saw-scaled viper on Pg 9 is above the description of the Hijaz mountains, well out of its distributional range. Some of the thumbnail photos, particularly those illustrating habitats are rather too small to be of real use. Understandably, the provenance of the photos and geographic descriptions have a bias towards those areas more familiar to the author, such as the UAE, Dhofar, and Yemen. In discussing the eastern mountain chain, the discussion is mainly of Musandam, whereas the higher and arguably more significant Al Jebel al Akhdar is not mentioned. Note that the back cover picture is an Arabian cat snake, and not a Sindh Saw-scaled viper as indicated on page 2. A few of the photos are of African species or forms not found in Arabia (e.g. the nominate form of *Cerastes cerastes* on pg 173 and the North African carpet viper from Sudan on page 180), and the space may have been better used illustrating more Arabian snakes.

The section on antivenoms, while warning of the potential dangers of antivenom use, is potentially confusing in suggesting that antivenom should be in a first aid kit carried by 'anyone who is active in the outdoors'. Given that the antivenom needs to be kept chilled, that many ampoules may be needed in the case of a serious bite, and also that adrenaline must also be on hand, this advice is only practical for a professional snake researcher who is likely to be handling venomous snakes. Moreover it needs to be strongly stressed that antivenoms have to be raised against the correct species for a given area. The antivenoms are quite specific, and snake venoms may be geographically variable, even within a species. Also there are no effective antivenoms available for some Arabian species. For the UAE the most effective antivenoms are those produced by the Saudi National Guard. For the general naturalist, the car keys are the most valuable first aid device for snake bite!

A few comments are merited on the distribution maps and descriptions, as they illustrate Oman and UAE species. *Lytorhynchus diadem*a (pg 99) is found in the Wahiba sands. *Spalerosophis diadema* (pg 122) is found on Masirah. *Echis coloratus* is found on the Huqf escarpment in central Oman. *Echis omanensis* (pg 188) certainly occurs as high as 1900 metres above sea level on Jebel Shams. The comment that Hardwick's rat snake (*Platyceps ventromaculatus*) is found on "a few of the islands off the United Arab Emirates" is not substantiated in the literature. The only published records from the UAE are from Sir Bani Yas and Dalma (see Aspinall and Gardner in this volume). The Arabian cat snake (pg 124) can reach a larger size than indicated, as I have measured one from 113.2 cm long from Nizwa. There are likely to be similar range adjustments required, but this does represent a very valuable first effort to map the Arabian snake distributions.

As in any first edition, there are some printing and factual errors, and while it may seem churlish to point some of these out, this may help with a second edition! On Pg 47, spiny tailed lizards do have faeces with an accompanying uric acid mass. On Pg 57, the Nurse's thread snake was photographed at Dibab (not Dibdab), and Pg 64, the family Boidae is misspelt. The photograph of Thomas' Racer on Page 81 is not the type specimen as stated (the type was collected by Bertram Thomas in 1931,) but of a specimen collected by Nick Arnold in Dhofar in 1977. *Pseudotrapelus* is spelt incorrectly on page 191. The references could have been edited more carefully as there are specific names capitalised, others not in italics; Gasperetti (1988) is out of its alphabetic sequence; Podarcis is misspelt in Van der Kooij (2001) and Beat Schätti's name is also misspelt.

Niggles aside, Damien Egan must be congratulated on producing such a useful, accurate, inexpensive and beautiful guide. This will certainly be a requirement on any Arabian naturalist's bookshelf and in the field bag.

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Dolphin. By Robert Baldwin and Thabit Al Abdessalaam. Published 2007 by Seawords Ltd., 95, Wilton Road, Suite 3, London SW1V 1BZ. www.seawordsbooks.com Sponsored by Dolphin Energy Ltd., Abu Dhabi, UAE. ISBN (10) 0-9551550-1-0, ISBN(13) 978-0-9551550-1-7. 147 pp., English and Arabic text.

'Dolphin' aims to 'portray the interest and wonder that dolphins evoke within human culture, the sense of mystery and well-being they induce, and the serious conservation message they embody'. Quite appropriately, the book was published in the year that the United Nations and the Whale and Dolphin Conservation Society designated as the 'Year of the Dolphin'.

The authors hold a wealth of experience in the field which is reflected throughout the text. Robert Baldwin has been involved in the study of whales and dolphins since 1988, particularly in the UAE and Oman, and has

written several other illustrated books on marine life, including three on whales and dolphins. Thabit Zahran Al Abdessalaam has had an extensive career in marine research and conservation in the region and has also authored a number of books on fisheries and marine biology.

The subject matter embraces representative aspects of the biology, physiology and behavioural ecology of dolphins and includes a section on conservation. Specifically, the content includes chapters on: the dolphin family, distribution and habitats, the dolphin body, swimming and diving, senses and communication, social life, feeding, captivity and conservation. Whilst the book is written in such a way as to be readily understood by the layman, it contains a wealth of interesting factual information that will appeal to a more specialised and discerning audience.

The format and layout of 'Dolphins' also makes the book a delight to read. The photographs are stunning and it is clear that a great deal of care has gone into selecting the images. They often portray remarkable aspects of dolphin behaviour and certainly capture the 'grace, tranquillity, energy, power, teamwork, sensitivity and beauty' of dolphins, as intended by the authors.

There is no reference list or bibliography as the authors suggest that listing them all would be impossible. However, the Acknowledgements section does draw attention to selected key books for those readers interested in learning more about the natural history, ecology and conservation of dolphins. In summary, 'Dolphins' is an easy-to-read, informative and beautifully illustrated book that is a must for those with an interest in dolphins and marine conservation. Whilst the target audience is clearly general, the text is sufficiently factual to make it of use to students and researchers alike.

Dolphin Energy, sponsors of the publication, deserve credit for having made the book possible.

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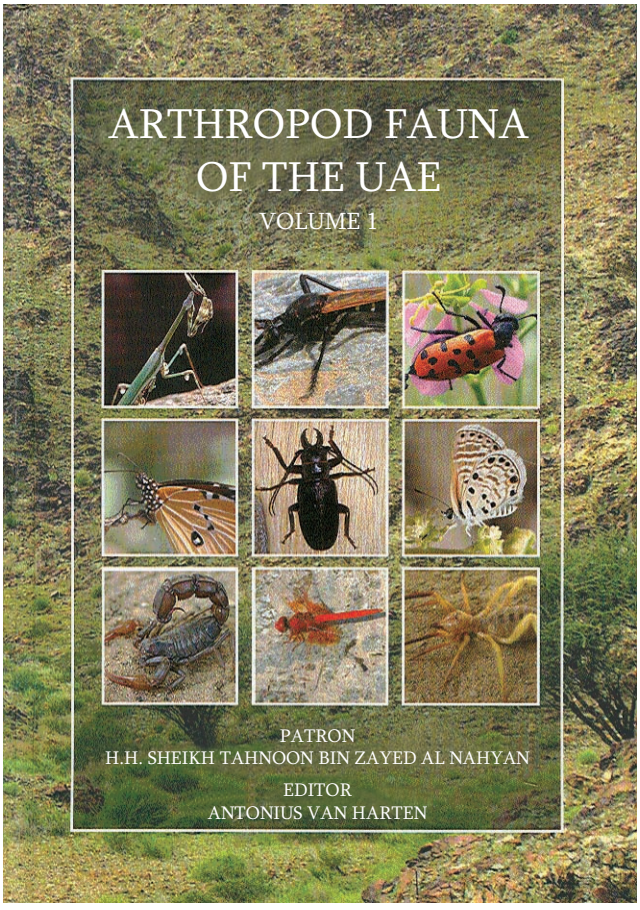
ARTHROPOD FAUNA OF THE UAE, VOLUME 1, Antonius Van Harten (editor), Multiply Marketing Consultancy Services (Publisher), Abu Dhabi, ISBN 978-9948-03-642-5 754 pages.

ARTHROPOD FAUNA OF THE UAE, VOLUME 1, edited by Antonius Van Harten, is the first volume of a culmination of results from extensive collecting undertaken by the editor and his visiting specialists of arthropods within the UAE by various methods including the use of light traps, malaise traps, hand-collecting, water traps, baited traps, and extracting arthropods from soil and leaf litter. Most of the habitats that occur in the UAE were sampled, some more than others. This initiative began in late 2004 when Van Harten was brought to the UAE to record the arthropod fauna and create an inventory of species. The process included collecting material, sorting it to mainly family level and then recruiting the aid of specialists from all over the world in the respective families to sort through the samples and identify to the lowest taxonomic level, mostly to species level. The identification of all insects to family level is no small task, indeed, the editor has successfully been able to process vast amounts of material. Such systematic sampling over three years therefore yielded many new species to the UAE, including some new to science.

Arthropods covered by this hardback book include mites, cockroaches, thysanurans, mayflies, booklice and barklice, thrips, twisted-wing parasites, true bugs, beetles, bees and wasps, butterflies, and flies. It should be noted that within each of the orders listed exist many families and not all families are reported here and will presumably be included in future volumes, together with reports on other arthropod orders not covered by this book. The records in this book are supposed to be new records to the UAE, of which it states there are 570 of which 87 species and subspecies are new to science. It is stated that only 25% of the collaborating taxonomists have contributed to the current volume and that only about 30% of the families collected so far have been reported in this volume.

Reporting is achieved at a high standard as seen in reputable international journals with contributions from authors written in the form of a scientific paper reporting on a particular arthropod family or order. Some contributions deal with large numbers of species, whereas others may cover only one genus. In most cases the descriptions include identification keys and descriptions of specimens, occasionally habitat notes. Much of ARTHROPOD FAUNA OF THE UAE, VOLUME 1 is well illustrated including colour photographs (of mostly pinned material), colour and



black and white drawings, and scanning electron microscope images. Illustrations ensure that identifying characters can be seen, while the inclusion of a list of taxonomic novelties and a zoological index is also worth noting.

The editor describes the methods and sampling localities, and the specialists report their identifications, although the editor is also joint author for the contribution of thrips. There are at least 50 contributing authors and so, without a doubt, ARTHROPOD FAUNA OF THE UAE, VOLUME 1 is the most authoritative text on the arthropods listed above that has been published to date of UAE arthropods.

Whilst an effort was made by specialists to refer to earlier works of published records, their literature review was not inclusive of all known material published to date, something commonly rectified during the editing process. For example, a recent publication of the fly fauna of the UAE in **Tribulus Vol. 16**.2 lists several families, genera and species of flies new to the UAE (Howarth, 2006), and regrettably these records are ignored and therefore some are repeated as new to the UAE in ARTHROPOD FAUNA OF THE UAE, VOLUME 1. This only includes one example of recently published material, whilst the review of Van Harten's *Insects of the UAE. A checklist of Published Records* pointed out that the checklist equally fell short of including records published during the early years of the ENHG in the first publication of the Abu Dhabi ENHG, namely **The Bulletin** (Howarth, 2006).

The criticism of those early records has been that without specimens to back up a published record, verification is impossible and therefore makes the record dubious. This indeed is very true, particularly when revisions of species or groups of species take place based on new information regarding distinguishing characters. Furthermore, DNA work of insects is also under way and phylogenies are constantly updated. It is also commonplace that specimens are misidentified and without a specimen to verify the record, the criticism was appropriate.

Thus, for many years it was not possible to verify the early records because the occurrence and location of specimens was unknown. Approximately two years ago a collection of arthropods was found amongst the stored items of the Abu Dhabi ENHG at a time when the storage facility was being vacated due to plans to demolish the building. The Al Ain chapter of the ENHG offered to look after all items in the store, including the insects. The collection of the Abu Dhabi ENHG has been amalgamated with the Al Ain collection and this collection is now known as the 'Joint Al Ain and Abu Dhabi Emirates Natural History Group Collection' (Howarth, 2006). This private collection was initiated by the founders of the ENHG in their efforts to observe, record and report, this mandate still being the overriding objective of the natural history groups of the UAE. The challenge some 30 years ago was that internet and swift communication was not available, keys for fauna and flora of this region were not, and remain, unavailable for many arthropods and the efforts of those amateur enthusiasts was to do the best they could, i.e. seek the advice of some specialists if they had access to them, and publish in **The Bulletin**.

The editor of ARTHROPOD FAUNA OF THE UAE, VOLUME 1 was made aware of the joint collection and whilst he has made an effort to introduce some visiting entomologists to us, verification of the specimens has not occurred thus far. It is therefore possible that efforts made early on by people such as Bish Brown, Ian Hamer and others have not received proper recognition. In discussions with the editor after the publication of ARTHROPOD FAUNA OF THE UAE, VOLUME 1, an agreement was reached that specimens from the Joint Al Ain and Abu Dhabi Emirates Natural History Group Collection should be sent for verification to the same specialists that will be investigating the material for future volumes of the book. Once those specimens have been included, and an effort has been made to exhaust all other possible sources of material and information, the inventory efforts will be as complete as possible.

Currently, ARTHROPOD FAUNA OF THE UAE, VOLUME 1 is not available in book stores, though the editor is kindly donating a copy to each of the three natural history groups in the UAE for their libraries. The price is not agreed but, once this has been done, books will be made available. The suggested price is AED270 (50 Euros), which is a reasonable price for the coverage of species.

References

Howarth, B. (2006) Book review of: A. van Harten (2005) Insects of the UAE: A Checklist of Published Records. Dar Al Ummah, Abu Dhabi, **Tribulus 16**.2: 37.

Howarth, B. (2006) Diptera of the UAE – collated records from the literature with additions of new records, accompanied by some notes on Mydidae and Stratiomyidae new to the UAE, **Tribulus 16**.2:24-29.

Van Harten, A. (2005). Insects of the UAE: A Checklist of Published Records. Dar Al Ummah, Abu Dhabi.

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Articles and Papers

The following published papers dealing with the UAE and adjacent areas have been received or noted.

Archaeology and Palaeontology

Arabian Archaeology and Epigraphy. Blackwell Publishing. Print ISSN 0905-7196. Online ISSN: 1800-0471

Website:
http://www.blackwell-synergy.com/toc/aae

May 2007 - Vol. 18 Issue 1 Page 1-122

Carl Phillips. The third-millennium tombs and settlement at Mowaihat in the Emirate of Ajman, U.A.E. 1-7

Katrien Rutten. The Roman fine wares of ed-Dur (Umm al-Qaiwain, U.A.E.) and their distribution in the Persian Gulf and the Indian Ocean. 8-24.

Anne Benoist. An Iron Age II snake cult in the Oman peninsula: evidence from Bithnah (Emirate of Fujairah). 34-54.

D. T. Potts. Revisiting the snake burials of the Late Dilmun building complex on Bahrain. 55-74.

Derek Kennet. The decline of eastern Arabia in the Sasanian period. 86-122.

November 2007 - Vol. 18 Issue 2 Page 123-264

Debra L. Martin. Bioarchaeology in the United Arab Emirates. 124-131

A.G. Parker and A.S. Goudie. Development of the Bronze Age landscape in the southeastern Arabian Gulf: new evidence from a buried shell midden in the eastern extremity of the Rub' al-Khali desert, Emirate of Ras al-Khaimah, U.A.E. 132-138.

Michele C. Ziolkowski (2007) Rock on art: petroglyph sites in the United Arab Emirates. 208–238

Proceedings of the Seminar for Arabian Studies, Vol. 37 (2007). Seminar for Arabian Studies and Archaeopress, Oxford. ISSN: 0308-8421. ISBN: 978-1-905739-10.3 Proceedings of the 2006 Seminar for Arabian Studies in London.

Papers of relevance to the UAE include:

Cuttler, R., Beech, M., Kallweit, H., Zander, A. & Al Tikriti, W.Y. Pastoral nomadic communities of the Holocene climatic optimum: excavation and research at Kharimat Khor al-Manahil and Khor al-Manahil in the Rub al-Khali, Abu Dhabi. 61-78

Delrue, P. Flip the coin. Preliminary results of compositional EDX analyses on south-east Arabian coins from ed-Dur (Umm al-Qaiwain, UAE). 79-92
Dreschler, P. Spreading the Neolithic over the Arabian peninsula. 93-109

Nash, H. Stargazing in traditional water management: a case study in northern Oman. 157-170

Rose, J. The Arabian Corridor Migration Model: archaeological evidence for hominid dispersals into Oman during the Middle and Upper Pleistocene. 219-237

Schreiber, J. Transformation processes in oasis settlements in Oman 2005 archaeological survey at the oasis of Nizwa: a preliminary report. 263-275

Scott-Jackson, J., Scott-Jackson, W. & Jasim, S. Middle Palaeolithic or what? New sites in Sharjah, UAE. 277-279

De Waele, A. The beads of ed-Dur (Umm al-Qaiwain, UAE). 297-308

Other papers and publications

Phillips, C., Irving, B., Glover, E., Czastka, J. (2005). Archaeological survey in the vicinity of Kalba: a preliminary to further research. Department of Culture and Information, Sharjah, UAE.

Medical

The following paper, published in 2000, has been drawn to our attention, and reports on tests carried out at the Allergy Clinic at Tawam Hospital, Al Ain. Results suggest that a number of flora species present in the UAE may be responsible for cases of asthma and allergic rhinitis.

Rasanen, L. Inhalant allergy in the United Arab Emirates. Allergy:
European Journal of Allergy & Clinical Immunology. Vol. 55(1):95-96, January 2000.

Ornithology

Sandgrouse – Journal of the Ornithological Society of the Middle East, the Caucasus and Central Asia. c/o The Lodge, Sandy, Beds SG19 2DL, UK. ISSN: 0260-4736

Vol. 29.1 (Spring 2007).
Simon Aspinall and Peter Hellyer – Letter to the Editor (p.111). A response to Colin Richardson (2006) 'Conservation Issues in the Untied Arab Emirates – a personal view'.

Vol. 29.2 (Autumn 2007).
G. R. Lobley. Wintering of Greater Spotted *Aquila clanga* and Eastern Imperial Eagles *A. heliaca* in the Arabian peninsula. 177-182.

Vladimir Arkhipov and Michael Blair. Skua (Catharacta, Stercorarius) occurrences in the OSME Region. 183-204
Ian Harrison. Recent decisions by the Oman Bird Records Committee – an update on first records for the Sultanate of Oman. 217-217.

Falco – The Newsletter of the Middle East Falcon Research Group. Issue No. 30, Autumn 2007. ISSN: 1608-1544. Contact details: Dr. Tom Bailey, Dubai Falcon Hospital, PO Box 23919, Dubai, UAE. tom.bailey@dfh.ae

As usual, a selection of useful papers in the latest edition of **Falco**, with several dealing with the results of veterinary studies and research undertaken by UAE-based scientists.

Combreau, O. (2007). Arabic falconry and the illegal houbara trade in Arabia. 16-17.

Molero, C., Bailey, T.A., & Di Somma, A. (2007). Anaesthesia of falcons with a combination of injectable anaesthesia (ketamine-medetomidine) and gas anaesthesia (isoflurane). 17-19.

Lloyd, C., Hebel., C. & Padrtova, R. (2007). Non-invasive indirect blood pressure measurements in Falconiformes. 20-21.

Wernery, U., Hotzel, H., Joseph, S. & Joseph, M. (2007). Mycoplasma infections in hunting falcons in the United Arab Emirates. 25-26

Other

Jennings, MC and TA Sadler. 2006. Report on the activity of the small birds of prey and owls group at the Conservation Workshop of the Fauna of Arabia held at the Breeding Centre for Endangered Arabian Wildlife - Desert Park, Sharjah, UAE; 19-23 February 2006. http://hawar-islands.com/distmaps/final.html. Accessed 21 October 2007.

Wildlife General

The on-line journal **Wildlife Middle East Newsletter** http://wmenews.com/ has continued to produce a useful series of articles and notes, all available for free download. Recent papers have included:

Volume 1, issue 3 (December 2006)

Preliminary report on the survey of the health status of the spiny-tailed lizard (Uromastyx sp.) in Warsan Farm, Al Ajban, Abu Dhabi, UAE.
Volume 1, issue 4 (March 2007)

Implementation of the CITES convention in the UAE.

Vol. 2, issue 1 (June 2007)

Education and awareness efforts on wildlife issues by the Environment Agency - Abu Dhabi.

Camera trap survey in the Dubai Desert Conservation Reserve

Vol. 2, issue 3 (December 2007)

West Nile Fever in the United Arab Emirates

Seroprevalence of H5 avian influenza virus in birds from the United Arab Emirates

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