TRIBULUS

Journal of the Emirates Natural History Group

Vol. 15.2 Autumn/Winter 2005

TRIBULUS

NOTES FOR CONTRIBUTORS

TRIBULUS is the Journal of the Emirates Natural History Group and was launched in 1991. The Group was founded in 1976, and over the next fourteen years, 42 issues of a duplicated Bulletin were published.

TRIBULUS is published twice a year. The aim of the publication is to create and maintain in standard form a collection of recordings, articles and analysis on topics of regional natural history, heritage, geology, palaeontology and archaeology, with the emphasis on the United Arab Emirates and adjacent areas. Papers, short notes and other contributions are welcomed from anyone but should not have been published elsewhere. Guidelines are set out below. The information carried is as accurate as can be determined, in consultation with the Journal's Advisory Panel and referees, but opinions expressed are those of the authors alone.

All manuscripts received are reviewed by the Editorial Board and appropriate Advisory Panel members and, where appropriate, are also submitted to blind peer review.

Correspondence and enquiries should be sent to:
The Editor,
TRIBULUS,
P.O. Box 45553, Abu Dhabi - U.A.E.
or by e-mail to: hellyer@emirates.net.ae

The plant motif above is of the genus Tribulus, of which there are six species in the UAE. They all have pinnate leaves, yellow flowers with free petals and distinctive five-segmented fruits. They are found throughout the country, except in coastal sabkha.

The animal motif above is of a tiny golden bull, excavated from the early Second Millennium grave at Qattarah, Al Ain. The original is on display in Al Ain Museum, and measures above 5 cm by 4 cm.

Manuscripts should be submitted in electronic form, with a printed copy, typed on one side only, and double-spaced. A short abstract should precede the article, with the address(es) of the author(s) at the end. Photographs may be submitted and should be clearly captioned. Line drawings and maps, if not submitted in electronic form, should be in black ink on strong white or translucent paper. References should give the author's name, with the year of publication in brackets, and with the list of articles, showing title and publisher, in date order. Scientific names should follow customary nomenclature in Latin, while the English and, if appropriate, available local Arabic names should also be supplied.

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Cover Illustrations:

Front: A map of Jazirat al-Hamra (Juzeerut-UI-Humra or UI-Humra Island) produced in February 1820 by Lieutenant Thomas Remon of the Engineers, who was part of the 1819-1820 British military expedition to the Gulf. The note on the map states "The Town of UI-Humra has been deserted some years & most of the houses are now in Rums [Rams]." Reproduced by permission of the UK Hydrographic Office.

Back: Qurrayah pools, Fujairah - a man-made wetland on the UAE East Coast that is now one of the country's top sites for birds. (Peter Hellyer)

The Editorial Board of TRIBULUS and the Committee of the Emirates Natural History Group acknowledge, with thanks, the support of the Group's Corporate members, a full 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 Nahayan bin Mubarak Al Nahayan, UAE Minister of Education.

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EDITORIAL

In this issue of Tribulus, once again, there is something of a focus on aspects of the country's history, with two papers dealing with events of the relatively recent past. One, by former British Royal Navy Lieutenant-Commander Andrew David, deals with the history of the charting of the Arabian Gulf waters of the UAE in the early nineteenth century by vessels of the 'Bombay Marine', the navy of the British East India Company. Commander David himself served in the Gulf on a mapping exercise over fifty years ago, and we are delighted to be able to include several illustrations obtained from the Hydrographic Office of the Royal Navy. These were drawn in the 1820s, and are an important part of the documentary history of the Emirates.

The second, shorter, paper by Peter Hellyer and Laurence Garey, adds more information to that contained in two earlier papers on World War Two plane crashes in the UAE, and draws heavily on data obtained from the historical archives of Britain's Royal Air Force. Both provide evidence, yet again, that there is much about the UAE's history that is held in archives overseas, particularly in Britain, because of the long-standing relationship between the two countries, that has still to see the light of day in terms of being made accessible to those studying the country.

This applies, of course, not only to mapping of the Emirates and plane crashes but to aspects of the country's natural history as well. The earliest records of the fauna and flora of the Emirates were collected by visitors, not by residents, and the information on these is often held in scientific institutions overseas, such as the UK's Natural History Museum, or is available only in old publications that are not known to UAE-based researchers. Much of this data is relatively recent, having been collected from the 1960s onwards, but some dates much further back. The first records of reptiles and mammals for the Emirates, for example, can be traced from the 1850s onwards.

Besides the work being undertaken today, the study of the natural history, history and cultural heritage of the UAE also includes a study of the work undertaken by the researchers of the past and by those who, albeit not concentrating on these aspects, recorded information relating to them. We hope that these two papers will help to stimulate more research into foreign archives and will lead to the publication of further papers of this type.

Other contributions to this issue are more directly related to the conventional series of topics covered in previous issues of the journal. The continuing investigations into the archaeology of the UAE produce not only information about the past lifestyle of the country's inhabitants but also, as shown in the paper by Anja Zander and Helmut Bruckner, valuable information about the evolution of the country's landscape and environment. It has long been known that the country's Arabian Gulf coastline has changed greatly, but their paper on the discovery of evidence of the former presence of mangrove forests and tidal lagoons in the area between Dubai City and Jebel Ali is an important contribution to our knowledge.

It is appropriate, perhaps, to ask whether the major changes to the environment in this particular area, being undertaken both onshore and offshore, are something that will prove, in the long run, not only to have a devastating effect on the currently-existing environment but will also be unsustainable if the process of global environmental change, such as a rise in sea level, continues as predicted. While development of residential property, marinas and such like may very well be part of the price that the UAE has to pay for its continued economic growth, one does wonder whether the apparent assumption that the existing landscapes can simply be altered in accordance with the plans of engineers may not one day be proven misguided. It would, after all, only take a medium-sized earthquake on the other side of the Gulf to create a mini-tsunami that could have a devastating effect on much of the current beach-front and near-beach development along much of the Arabian Gulf coastline of the Emirates. The recent earthquake that shook the tower blocks of Dubai will, we hope, prompt a re-thinking on this issue.

Another paper that follows up on previous work is a further contribution by Richard Hornby on the status and distribution of spoon worms in the tidal lagoons around the island of Abu Dhabi. Until his earlier paper, in the previous issue, Volume 15.1, there was no published record of these intriguing organisms being present in the UAE. Now not only have previously-unrecorded sites been identified but also the earlier publication has brought to light a much-earlier record, from over thirty years ago.

The paper by Drew Gardner deals with the discovery of a new species of lizard for the Emirates. Another major discovery, to be published in a forthcoming issue, was that earlier in 2005 of sightings of honey badger, or ratel, in the Western UAE. The at least occasional presence of this secretive, but distinctive, animal in the Emirates had long been suspected – possible tracks having been reported by the British explorer Sir Wilfred Thesiger over fifty years ago. Together, these two new discoveries show that there is still much about the fauna of the Emirates, including colonisation and fluctuating status, in particular, yet to be discovered.

Other contributions deal with the ghaf, the most characteristic tree to be found in the UAE's northern desert areas, and with discovery of albino tadpoles in a wadi of the Hajar Mountains, a curiosity that had not previously been noted.

We look forward to publishing further new material in forthcoming issues.

Corporate Members of the ENHG

Production of ***Tribulus,*** and many of the other activities of the Emirates Natural History Group, including the grant programme of the Group's Conservation Fund, would not be possible without the generous support of the the Group's Corporate Members, many of whom have provided consistent assistance over many years. The Editorial Board and the Group Committee acknowledge, with thanks, the invaluable support of the following companies and bodies, currently Corporate members of the Group, and all past Corporate sponsors:

Abu Dhabi Company for Onshore Oil Operation, ADCO; Al Fahim Group; Al Nasser Holdings; BP; Environment Agency - Abu Dhabi, EAD; Kanoo Group; Al Masaood; Intercontinental Hotels; Jashanmal National Company; METCO; Motivate Publishing; Nama Development; National Bank of Abu Dhabi; Omeir Travel Agency; Richards Butler; Rotana Beach Hotel; URS Dames and Moore.

Status of *Prosopis cineraria* (ghaf) tree clusters in the Dubai Desert Conservation Reserve

by Dr David Gallacher and Dr Jeffrey Hill

Introduction

The ghaf tree (Prosopis cineraria) is an integral part of the cultural heritage of the United Arab Emirates (UAE) and to natural desert ecology. It occurs mainly in 'open forests' of sparsely distributed trees, but can also be observed in clusters (Aspinall 2001) or in isolation. Land owners and scientists agree that numbers in the UAE have been reduced over the last few decades, due to overgrazing, coppicing, urban expansion, and reduced access to ground water. It also appears that regeneration is limited, indicating that species survival could be threatened in localised areas.

The recently established Dubai .Desert Conservation Reserve (DDCR) contains several isolated trees, and four tree clusters that range in size from four to 456 trees. The tree clusters are of particular interest to the reserve since they provide a unique natural habitat (see Figure *1).* The isolated trees, on the other hand, are all associated with human settlement in some way. Each cluster is located on a sand dune adjacent to a gravel plain. Even to the casual observer, clusters appear to contain trees of uniform size, and the boundaries of the two largest clusters appear to be distinct. These observations indicate that the population biology of clusters may be different to that of trees in open forests. A sound understanding of these clusters is essential to ensure their survival for future generations. The aim of this paper is to report initial observations in our studies of the DDCR ghaf tree clusters and at the same time identify gaps in our current knowledge.

Study site & data collection

The DDCR encloses 225 sq. km of sand sea, interspersed with several gravel plains. It has the dual role of preserving a part of the natural desert for future generations, and providing a resource for the tourism industry. Trees are subjected to grazing pressure from a herd of approximately 1,200 camels, which remove all lower foliage from adult trees. Arabian oryx and several species of gazelle have been introduced to the reserve in stages over the last year. Like the camels, oryx are regularly observed in or near a cluster, but the foliage of adult trees is out of their reach, due to the camels.

Data collection involved recording the circumference of all trees at chest height, and their location using GPS. This data was used to generate spatial maps of trees within clusters (Figure 2), and to assess the distribution of tree sizes within each cluster. Location information was also collected for Acacia tortilis and Calligonum comosum in the area of the forests, for comparison. Data collection and observations occurred during the winter of 2004 and 2005, and summer 2005. In a parallel study, a Zayed University graduate was employed to conduct telephone interviews of Emirati farmers in the DDCR. The survey included land management and ecology questions. Nine farmers were interviewed in Arabic, their comments then being transcribed into English.

The two largest clusters both have small groups of Acacia tortilis nearby on a gravel plain. An association between the two species has been reported previously (Sandison & Harris 1991; Ghazanfar 2004), but has not been investigated. Our data neither support nor refute the notion of a biological link between the species. The two species might simply prefer similar habitats.

Distribution and genetics

Prosopis cineraria or ghaf is centered on the Thar desert of India and Pakistan, but occurs in Afghanistan, Iran and the Arabian peninsula (Pasiecznik et al. 2004). The Arabian population consists of large, isolated populations that could be a relic from a former wetter period. Ghaf exists mostly in the UAE and Oman (Jongbloed et al. 2003), though it has also been reported as an infrequent species in the eastern and southern margins of the Rub' al-Khali of Saudi Arabia (Mandaville 1990). Within the UAE, it is common in the inland sand plains and dunes of the Northern Emirates and eastern rim of Abu Dhabi emirate, and can also be found in wide wadi beds throughout the Hajar Mountains (Jongbloed et al. 2003).

There has been almost no molecular genetic work conducted intra-specifically on P cineraria. People have considered the Arabian population to be highly genetically variable (e.g. Sandison & Harris 1991), based on vegetative morphological characteristics. However, morphological variation within all Prosopis species is typically high (Pasiecznik et al. 2004). In Oman, Brown (1988) attempted to relate observed morphological differences to esterase isoenzyme expression, but results were inconclusive due to the small amount of the genome surveyed.

P Cinerariamay hybridise with other Prosopis species. P juliflora has been reported to hybridise with several other species in the genus, though not specifically with P cineraria (Pasiecznik et al. 2004). Since P juliflora is also present within the DDCR, there is a possible threat of genetic contamination to the present population.

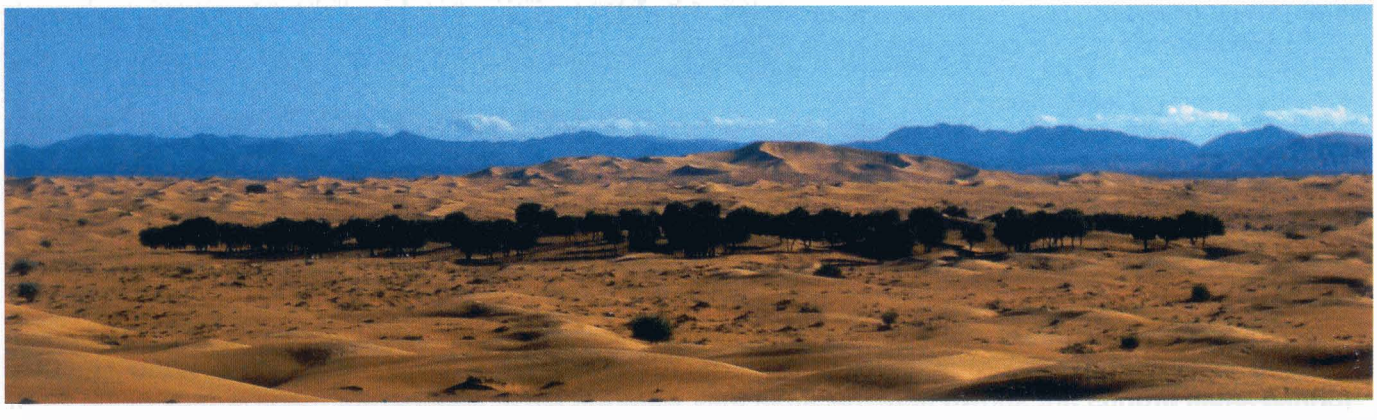
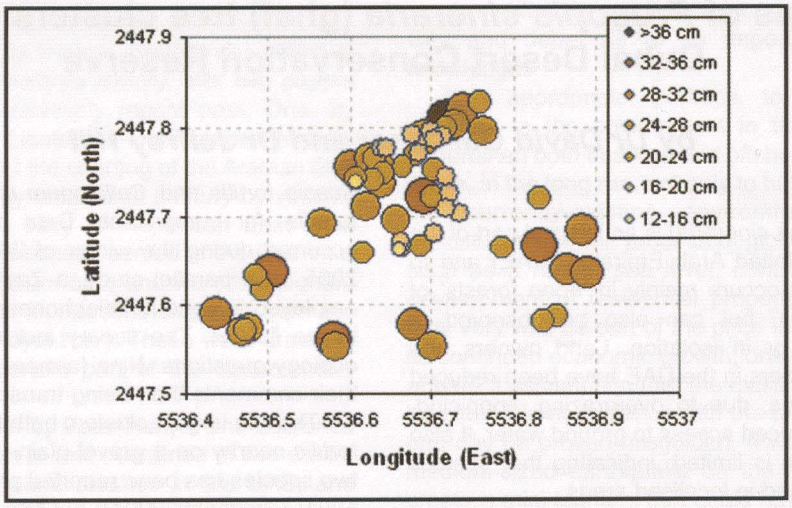


Figure 1: South Eastern Prosopis cinerariacluster in the Dubai Desert Conservation Reserve, showing the tight arrangement of trees without outliers.



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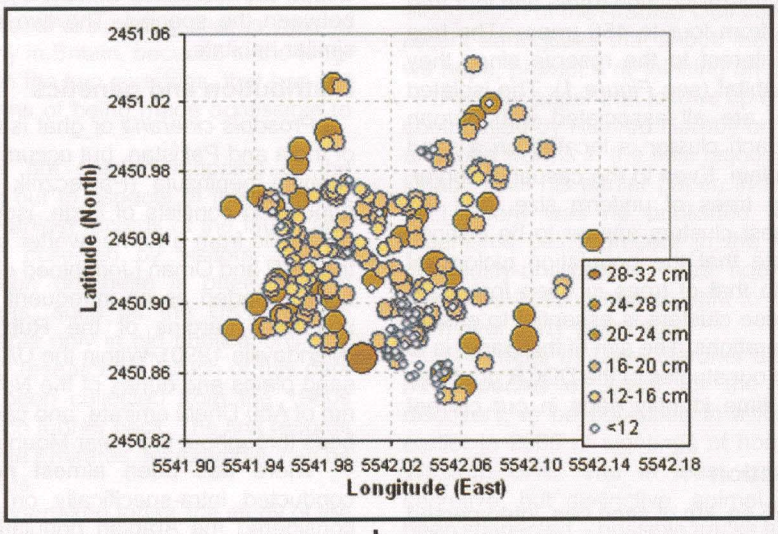

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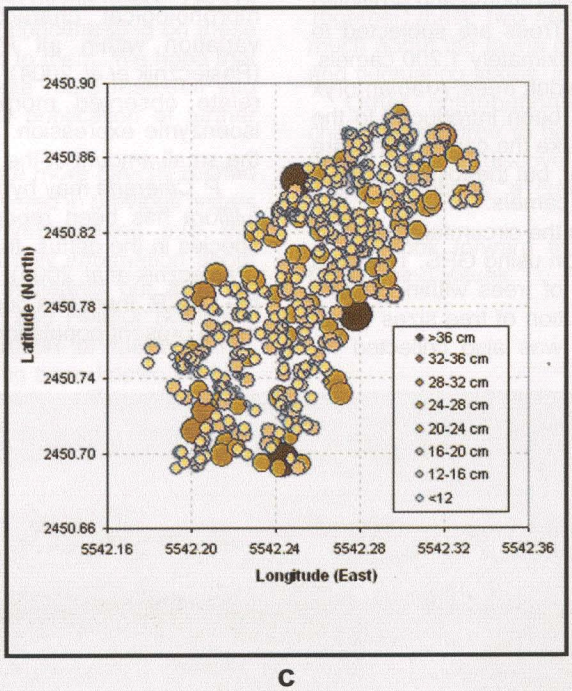

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Figure 2: Maps of three clusters of *Prosopis cineraria* (ghaf) trees in the Dubai Desert Conservation Reserve. (a) Western large group (b) North Eastern group (c) South Eastern group. Trees within clusters formed small groups not shown here, because they were too close together for the accuracy of the GPS to record. Circle sizes indicate the radius of trees at chest height.

Importance

P. cineraria is mainly valued for its highly nutritious livestock fodder (Pasiecznik et al. 2004) of leaves and immature seed pods. The species has been used for many other purposes, as is common in a region of limited, sparse resources. Bedu have been reported to eat both leaves and immature pods in the UAE (Jongbloed et al. 2003). Mature dry pods which are biscuit-like are sometimes eaten in Abu Dhabi too and in Oman (Brown 1988), while in Rajasthan, India the pods are boiled and dried, then eaten as a vegetable (Anonymous 1991). Gum within the bark can also be eaten if food is in short supply (National Academy of Sciences 1980).

Several medicinal uses are reported in Jongbloed et al. (2003), including an ingredient of eye drops for cataracts (pods), treatment of toothache and dyspepsia (leaves), pain relief (burnt bark) and antiseptic (sap). A study by Rai et al. (1999) indicated that oil from the species had poorly developed antifungal properties. Wood, with a calorific value of around 5000 kcal per kg, is often the best local choice for firewood and making charcoal (Mahoney, 1990). DDCR farmers have reported using it for this purpose. The tree provides reasonably durable timber for construction, but is not a preferred species due to a twisted growth pattern (Sandison & Harris, 1991). Post-harvest decay of wood through pest and insect attack is also a limitation (Jain et al. 2005).

The tree is one of many species used for revegetation of the UAE desert (Kiriiwa et al. 2002). An advantage of this species is that it can withstand partial burial (Gates & Brown 1988). Living trees whose trunks have been covered by two or three metres of sand are common in the UAE (Figure 3). Just as importantly, it is common to see trees that survive after losing up to two metres of sand from around their base.

Shade is important to the survival of ***Oryx*** leucoryx under natural conditions, since their daily foraging time is restricted by high body temperature (Seddon & Ismail 2002). In the DDCR, oryx and gazelles use trees of any species, and Leptadenia pyrotechnica shrubs, for shade. The Reserve also provides fresh water and supplementary feed at several locations, so shading may not be as important for survival within the Reserve.

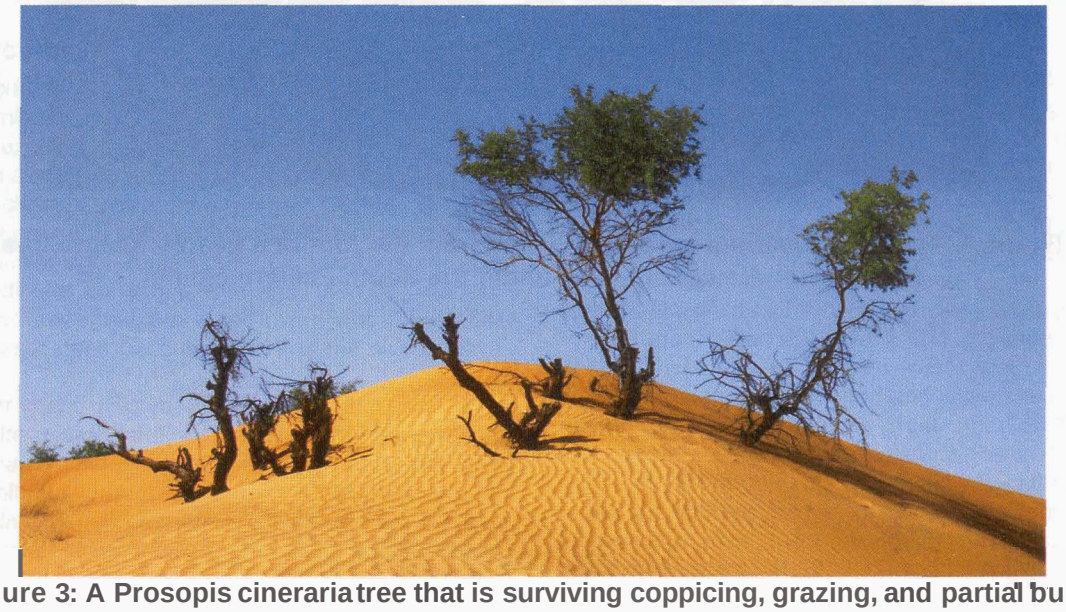

Figure 3: A Prosopis cineraria tree that is surviving coppicing, grazing, and partial burial to approximately 3 m.

Morphological growth

Most of the existing *P.* cineraria trees in the UAE have a morphology that has been shaped by grazing pressures. In the DDCR, all the observed trees could be easily classified into three groups;

- Sprouts: Twenty four sprouts were observed during the winter of the study, growing from the rootstock of established trees. They typically grew laterally to about 30 cm, but some were erect (Figure ***4).*** They were difficult to see among the sand and leaf trash, so many more sprouts were probably present. By the summer, they had mostly disappeared, presumably eaten by herbivores. No seedlings were observed, though if they existed away from the clusters they would not have been found.

- Shrubs: Twenty five shrubs were observed, all of them within the same section of one cluster. This location had been fenced in the past, but it is not known when the fence became ineffective at preventing camel grazing Shrubs were around **2.5** m high and similarly wide, usually with two or more main trunks ***(Figure 5).*** The outer surfaces of shrubs were woody and thorny, and as winter moved to summer, foliage receded from the outer surface. Shrubs appeared to have emerged from sprouts rather than seeds. The similarity in size indicates that they all emerged during one or two seasons. The ratio of thorns to foliage was much higher in these shrubs than in the higher branches of adult trees.

- Adult trees: Trees typically consist of a single trunk supporting a dome shaped canopy. Often, they appear in clumps of 2 to 4 trees with a linked root system. The rounded crown is a result of repeated coppicing (Pasiecznik et al. 2004). The practice of coppicing has been banned in the DDCR, so over time the canopy may change shape.

The species growth pattern under grazing appears to be as follows. The plant grows as a woody shrub, adding to its thorny exterior until its surface area is large and impenetrable enough to protect one of the central trunks from grazing. When this occurs, the bulk of the growth resources are put into the central bunk. so that the shrub transforms into a tree. Camels were observed to rip higher lateral branches of up to cm diameter from the trunks of adult trees, thus maintaining the characteristic shape. A two-stage growth pattern (i.e. shrub to tree) has also been reported in Acacia tortilis in response to grazing (Jongbloed et al. 2003, Ghazanfar *Oo4).

Figure **4:** Prosopis cineraria sprouts growing from the root of a nearby mature tree. Photo taken November **2004** under the South Eastern cluster.

Figure 5: Prosopis cineraria shrubs that arose in a previously fenced 'farm' area within the **Dubai** Desert Conservation Reserve. Note that shrubs are all the same size, indicating that they probably all emerged during the same season. Photo taken December **2004.**

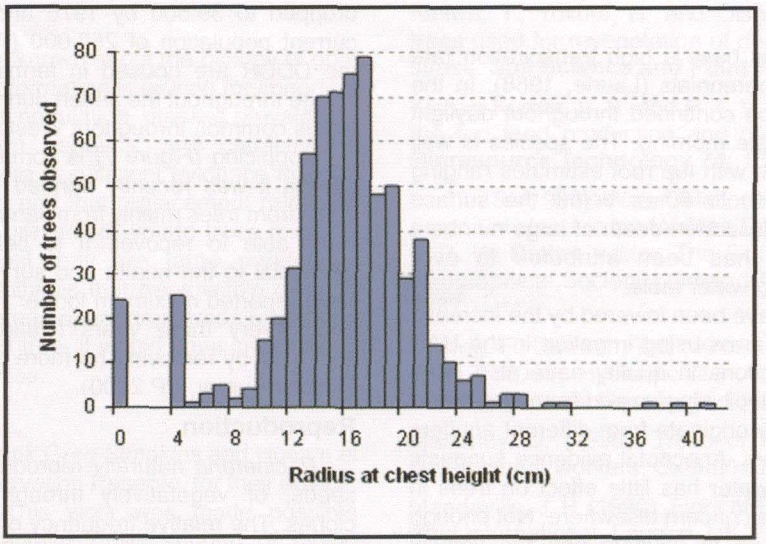

Figure 6: Size distribution of *Prosopis cineraria* trees in the eastern clusters (North Eastern and South Eastern) of the Dubai Desert Conservation Reserve. There were probably more trees in the <1 cm category that were overlooked.

Cluster structure

The distribution of trunk radii within clusters followed a lognormal distribution in all three clusters when saplings and sprouts were excluded *(Figure 6)*. The two eastern clusters were similar in average radius and distribution, while those of the western clusters were much larger (**Table 1).** This distribution is consistent with the hypothesis that most of the trees are of similar age, though other explanations are also possible. If radius is correlated with age, then the western cluster contains trees that are much older, and the cluster may have sparser trees because others in the cluster have died.

The cluster maps *(Figure 2)* show that the edge of a cluster is quite clearly defined. There are some thinly populated areas within clusters, possibly where the tree density has thinned through attrition or variable access to groundwater. In other places, there is a protrusion of trees from the edge of a cluster, indicating growth of the cluster. In all three clusters measured, the biggest trees were located on the edges of the cluster. These trees could be older than the others, or they might just be facing less competition for resources. If they are older, they may have provided the rootstock for the other trees to grow from vegetative sprouts.

Understory vegetation

In Pakistan and India, crops are grown right to the trunk of *P. cineraria* (Mann & Shankarnarayan 1980) and are said to benefit from the tree. In Oman, Brown (1988) described prolific growth of ephemeral species under the tree canopy following periods of rain, and the presence of perennial species throughout the rest of the year. He offered several hypotheses to explain the observation, but did not test them. In the DDCR during the unusually wet 2005 winter, germination of ephemerals and perennial shrubs was conspicuously absent underneath the canopy of the trees, despite being present elsewhere. Hence, it appeared that the trees in the DDCR were having the exact opposite effect on understorey vegetation.

The species produces allelopathic chemicals but they appear to be relatively weak (Goel *et al.* 1989). In contrast, allelochemicals are relatively strong in the invasive alien species *P. juliflora*, inhibiting both germination and growth of *P. cineraria* (Al-Rawahy *et al.* 2003). *Prosopis cineraria* is a phreatophytic (seeks ground water) legume and could therefore obtain both nitrogen and water without competing directly with other plants. Root nodulation has been observed in the species (Sandison & Harris 1991), but has not been confirmed in the DDCR. In a Rajasthani study, soil under the canopy had a higher fungal biomass than the surrounding area, with maximum biomass during rainy months (Purohit *et al.* 2002). This observation suggests that the higher fungal biomass under the trees may be due to increased soil moisture. An extensive review of the ecological interactions between ghaf trees and other species is provided in Brown (1988), much of which is relevant to the UAE.

P. cineraria is unusual in that the greatest density of its fine roots is found well below the surface. In a study of 9-year old plantation trees, Singh (1994) observed the greatest density of roots at 30 to 60 cm below the surface. Whether this is consistent across soil types is not clear. Although deep lateral roots could be a response to shifting sands, there are other possible reasons for their evolution.

Table 1: Mean radius of trees in each cluster (excluding suckers and saplings)

Group	Tree number	Average radius (cm)	Standard Error	Regeneration observations
North East	247	16.94	0.29	Sprouts (0.5 cm) and saplings (30 cm)
South East	456	16.84	0.20	Sprouts (0.5 cm) only
West Large	64	23.83	0.52	None
West Small	4	20.69	2.07	None

Water

Prosopis cineraria leaves have a high transpiration rate compared to other desert perennials (Laurie, 1988). In the study by Laurie, transpiration continued throughout daylight hours but was greatest in late morning. The species is well known to be a phreatophyte, with tap root estimates ranging from 20 m (Mahoney 1990) to 60 m below the surface (Jongbloed et al. 2003). The sudden death of large numbers of mature trees in India has been attributed to over exploitation of the underlying water table.

Groundwater supplies have been lowered by the increase in the number and size of farms using irrigation in the UAE (see Aspinall 2001). Reductions in quality have also been reported. Irrigation water is typically pumped from well below the root zone, and thus may originate from different aquifers than those used by the trees. Anecdotal evidence suggests that the removal of groundwater has little effect on trees in some locations, but can be a concern elsewhere. Not enough is known about the structure of aquifers and the vertical movement of ground water to be able to predict the long-term effects of pumping in any location. In the DDCR, farmers reported that the water table has fallen, but they attribute this to a series of very dry years. Five of six farmers reported that the water has become saltier and have ceased using it for human consumption, despite perceived health benefits.

In Oman, an extensive study of dewfall found that it was greater in the general vicinity of a P. cineraria forest, but that it was dramatically lower underneath the canopy of individual trees (Anderson 1988). Dewfall is the most frequently occurring form of freshwater for plants in the desert, so these microclimatic modifications could have a significant effect on plant communities near P. cineraria clusters.

Hydraulic lift, which has been convincingly reported in Acacia tortilis (Ludwig et al. 2003), has not been reported in P. cineraria. In this process, roots enable dry topsoil to be re-hydrated with water from deeper in the soil profile, thus enabling nutrient uptake to continue during dry periods.

Grazing and coppicing

Fodder removal through both grazing and coppicing has a significant effect on the morphological structure of ***P.*** cineraria. The main herbivore is the camel, which exists in large numbers in the UAE. Before the creation of the Emirates in 1971 there were estimated to be 100,000 camels. This dropped to 39,500 by 1976 and then rose steadily to the current population of 250,000 (FAOSTAT 2004). Camels in the DDCR are housed in farms overnight, but allowed to forage throughout the desert during daylight. This form of land use is common throughout West Asia (Ferguson ef al. 1998).

Coppicing (Figure 7) is commonly practiced in the UAE, though it was recently banned in the DDCR. Farmers cut limbs from trees mainly from January to March when trees are most able to recover. It is believed that the practice is beneficial to the health and survival of trees. Indian studies have reported maximum fodder yields by complete coppicing once every three years (National Academy of Sciences 1980), or by removing no more than two thirds of the crown (Kishan Kumar, VP 2000).

Reproduction

P. cineraria naturally reproduces either sexually through seeds, or vegetatively through root suckers to produce clones. The relative frequency of each method under natural conditions is not known, but could be determined through genetic analysis of a population. DDCR flower and seed production was very low during this study. Flowers appear in March and April (Khan 1980), and farmers reported that they typically feed al henbel (dried seed pods) to livestock in June. Seed dispersal is thought to occur mainly through grazing domestic & wild animals and possibly through birds (Al-Rawahy et al. 2003). No seedlings were observed during the study.

Most Prosopis species are self-incompatible (Pasiecznik et al. 2004), meaning they must be fertilised by a genetically different tree to produce fruit. If this is true of P. cineraria, and if a cluster were entirely clonal, then this would reduce the opportunity for pollination in a cluster.

Many of the individuals at shoot, shrub and tree stage were observed to be sharing roots with an adult tree, indicating vegetative reproduction. The distinct boundaries of the clusters are also indicative of vegetative reproduction, raising the possibility that each cluster represents one clonal unit. Commercial propagators have reported that the species suckers easily, but that cuttings do not readily root (Sandison & Harris 1991, Puri & Kumar 1995). This indicates that suckers rely on the parent plant for longer than other species. Optimised tissue culture conditions were reported in Shekhawat et al. (1993).

Conversely 'open forests' may result from sexual reproduction.

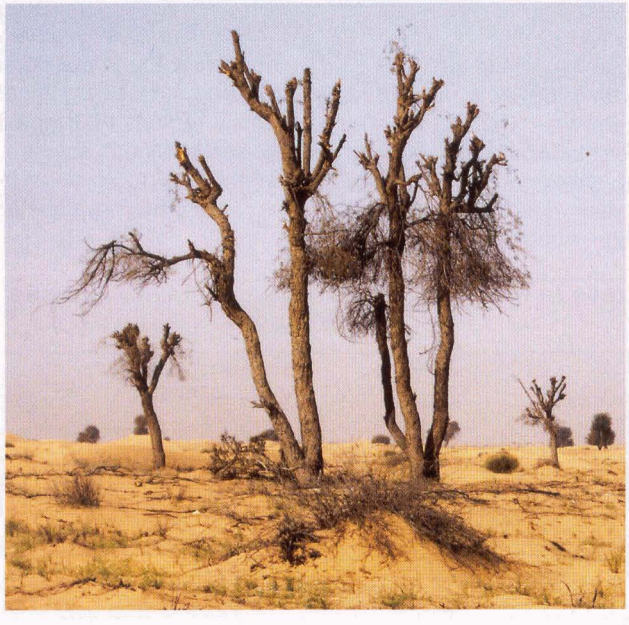

Figure 7: Coppiced *Prosopis* cineraria, showing removal of most of the crown leaf

Conclusion

There is much that is not known about the biology of ghaf trees in the UAE. Detailed information is lacking for important management issues such as nodulation, disease prevalence, age distribution, population genetics, and capacity for hydraulic lift. In contrast, there is sufficient evidence that the current populating is ageing and that replacement rates are too low. For clusters to be preserved, young trees must be protected from camels until they are large enough to withstand grazing. The hypothesis that trees within clusters reproduce vegetatively, whereas open forest trees reproduce sexually, should be tested. If true, it would have implications for management of the species.

Acknowledgements

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Chronology and evolution of submerged mangrove swamps buried in the subsoil of Dubai

by Anja Zander & Helmut Briickner

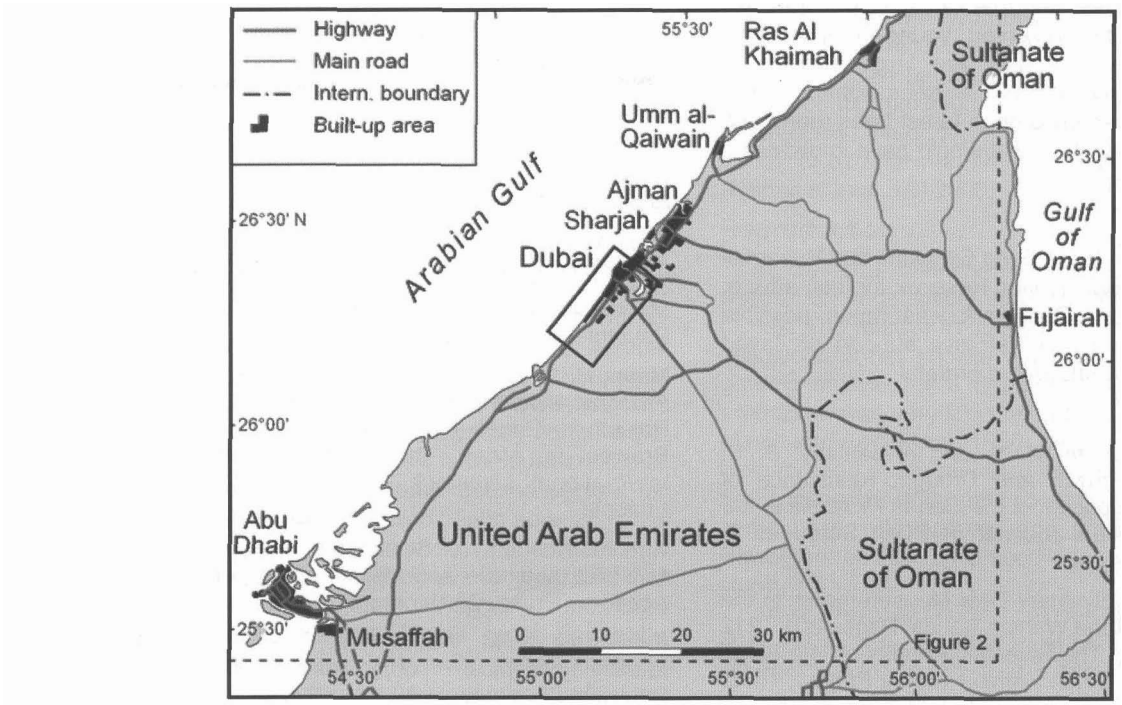

Figure 1: Schematic map of the UAE. Black rectangle indicates the position of Fig. 3, dotted line that of Fig. 2.

Abstract

The focus of this paper is the evolution of the coastal environment of Dubai over the last few thousand years. In 2002, a buried former mangrove swamp and a muddy tidal channel system were discovered in the vicinity of the Emirates Golf Club and the Dubai Marina housing estate, south-west of the city of Dubai and of Dubai City, about 3 km inland from the modern coast. Over the next two years, more well-preserved mangrove trunks of up to 60 cm diameter were unearthed in several construction pits around the Golf Club. The mangrove-bearing stratum is embedded in marine sands. Oysters and other mollusc shells, specialised in shallow marine and muddy habitats, are attached to the stems and interspersed in the marine sediments.

Radiocarbon dating of plant remains and mollusc shells and luminescence dating of the surrounding sediments both yielded an middle Holocene age of 7200 - 7000 cal. BP for the mangrove swamp. The subsequent marine sedimentation continued until about 5900 years before today. The early Holocene coastline of Dubai differed considerably from that of today. It was dissected by intertidal channels and shallow lagoons before it was submerged during the terminal phase of the Holocene transgression. This study demonstrates that the combination of the radiocarbon and luminescence dating techniques provides a solid database for the reconstruction of time-resolved scenarios of coastal and environmental changes. These investigations were timely in another sense too, since, due to the progress of construction, all of the sites described have now been sealed by tons of concrete.

Introduction

A enormous amount of construction work has been undertaken in Dubai over the last few years. Between downtown Dubai and Jebel Ali, large pits and trenches were excavated for the building of Internet City, Dubai Marina and attached housing estates south-east of Sheikh Zayed Road and around the Emirates Golf Club. These excavations allowed a comprehensive investigation to be made into the geomorphological, ecological and sedimentological past of the coastal environments of Dubai.

The study presented here was carried out in cooperation with the Department of Tourism and Commerce Marketing (DTCM) of the Government of Dubai and the Institute for Near Eastern Archaeology of the University of Munich. The main focus of this collaboration was the excavation of the Al Sufouh 2 archaeological site within Dubai Internet City and the reconstruction of the environmental conditions during the time of occupation (Gruber et al. 2005). In November 2002, the remains of a fossil mangrove swamp with well- preserved stems and trunks embedded in marine sands were discovered close to the Emirates Golf Club and the archaeological site *(Figs. 1*, 2, *3).* During the following two years, further construction pits were opened in this area, exposing similar sedimentological records. Dark brown, organic-rich, muddy lagoonal and tidal sediments with mangrove remains were found at Dubai Marina housing estate next to Sheikh Zayed Road and east of the Emirates Golf Club. The spatial distribution of this submerged mangrove swamp ecosystem extends to about 3 km inland from the modern coast. This suggests that the shape of the early Holocene shoreline was very similar to the appearance of the present shorelines in some areas of Abu Dhabi and Umm al-Qaiwain *(Fig. 2*).

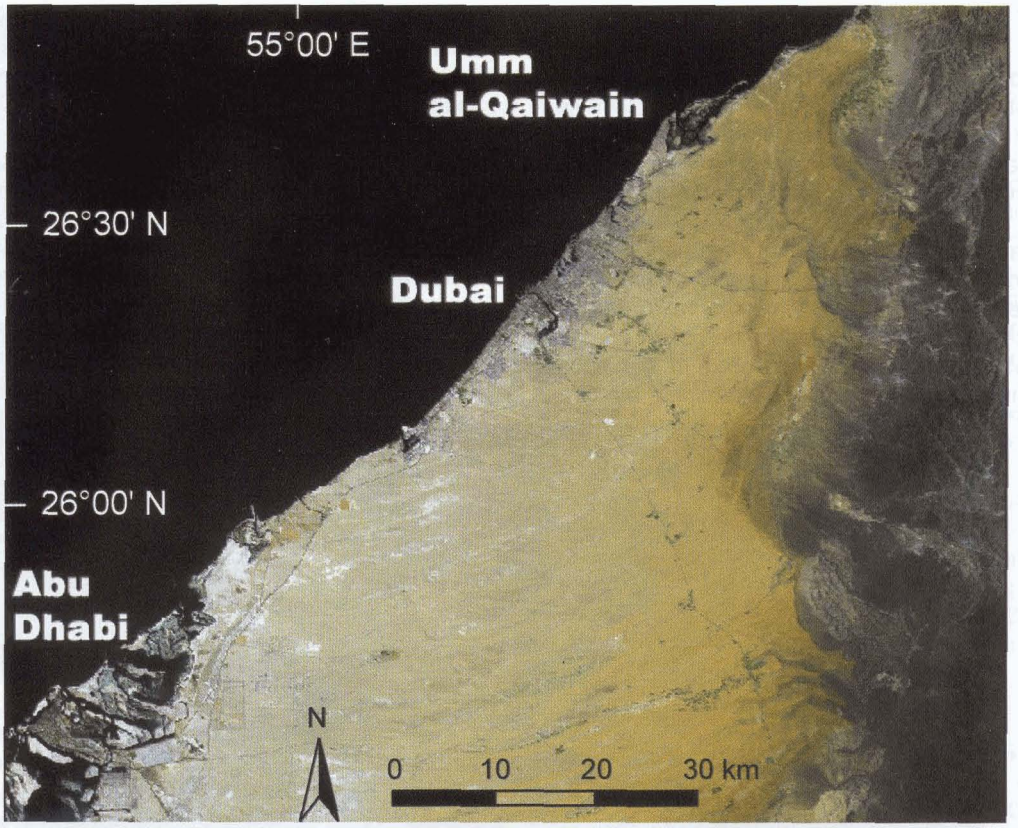

Figure 2: Landsat 7 ETM - Satellite image of the northwestern part of the UAE between Abu Dhabi and Umm-al-Qaiwain (23 August, 2000).

Coastal development and sea level changes

Today the Arabian Gulf is a shallow marginal sea, measuring some 1000 km in length and 200-300 km in width. It is a downwarped basin of late Pliocene to Pleistocene age with an average depth of 35 m and maximum depths of 50-100 m near the Iranian coast and the Strait of Hormuz. The Arabian side of the basin constitutes part of the relatively stable Arabian Platform and is characterised by smooth morphology and shallow water depths (Kassler 1973, Purser & Seibold 1973). The complex geomorphology of the Dubai coastal plain is controlled by a combination of late Pleistocene global sea level rise, climate change, subsequent dune migration and fluvial activity.

During the Last Glacial Maximum **(LGM)** about 20,000 years ago, global sea Level was approximately 120 m lower than today (Shackleton 1987) and hence the basin of the Arabian Gulf was more or less dry until 14,000 years before present (Lambeck 1996). With the progressive marine incursion, the central basin stretching along the Iranian coast was slowly flooded around 12,500 years ago and the western basin about 1000 years later. The present sea level was reached between 7000 and 6000 years ago.

Today, the coast south-west of Dubai is a typically graded shoreline with gently sloping sandy beaches and ***sabkhas*** of even and homogeneous shape ***(Fig.*** 2). To the north of Dubai and in the vicinity of Abu Dhabi the modern coastline shows a far less uniform profile. Shallow tidal creeks and lagoons dissect the coastal plain and extensive mangrove swamps, sand bars and small islands characterise the beaches and the near offshore area (Vine 1996, Goudie ***et al.*** 2000a, Al-Farraj 2002, Alsharhan & Kendall 2003).

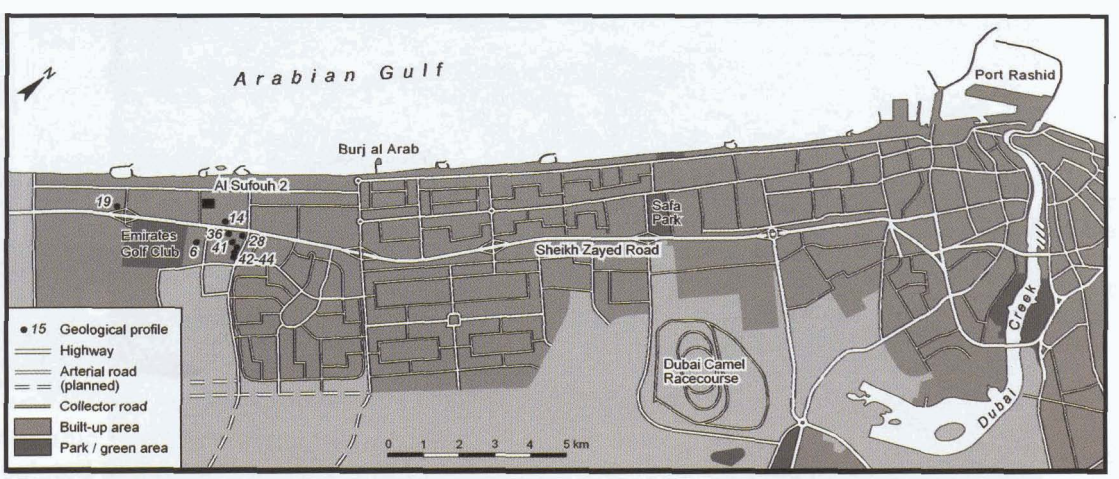

Figure 3: City map of Dubai as of the year 2000. Black cirdes with numbers show geological profiles with intercalated mangrove stems *(Avicenniamarina)* and associated organic horizons. The black rectangle indicates the archaeological excavation site Al Sufouh 2.

Mangroves of the UAE

Mangroves display a wide distribution along the coasts in tropical and subtropical regions and represent excellent sea-level indicators (Pirazzoli 1996). They are best developed on low-gradient intertidal zones with abundant supply of fine-grained sediment, but some also grow on hard substrates like coral or rock. In areas with high rainfall or fresh-water supply from river discharge mangrove forests are luxuriant, but in the Arabian Gulf both abundance and diversity of mangroves have always been very low. Avicennia marina is the only mangrove species that was recorded in the pollen spectrum of the fossil mangrove swamp discovered in the subsoil around the Emirates Golf Course (determined by Dr. J. Grindrod, Monash University, Australia). This species is tolerant of temperature extremes at higher latitudes and of highly saline and evaporitic conditions (Tomlinson 1986). ***A.*** marina remains the only mangrove species known from the Arabian Gulf and the Gulf of Oman today. Natural occurrences are limited to small patches on the tidal mudflats at Ra's al Khaimah, Umm al-Qaiwain and Ajman, the lagoons and islands of Abu Dhabi (Figs. ***4*** and ***5)*** and a handful of small inlets and lagoons on the coast of Oman. There is evidence that a species of Rhizophora formerly occurred at some sites on the south coast of Oman (Lezine ***et*** al. **2002),** but in the subtropical desert zone of the Arabian Peninsula coast only Avicennia has survived.

Figure 4: Living Avicennia marina ecosystem of Abu Dhabi Island. The root system is characterised by upright pneumatophores which originate from underground cable roots.

Figure 5: Mangrove forest north of Umm al-Qaiwain. Lateral erosion in an intertidal channel has exposed the ramified mangrove root system.

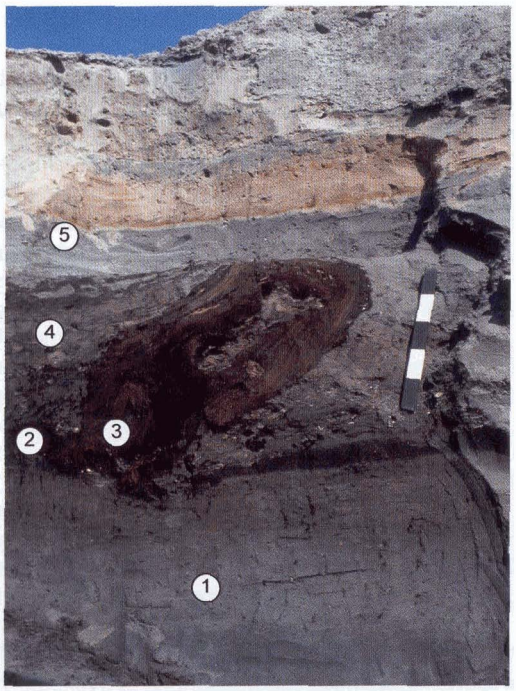

Figure 6: Profile Dub 6 northeast of the Emirates Golf Club. Organic horizon (2) and a thick mangrove stem (3) intercalated in marine sands (1 and 5) and intertidal channel sediments (4), exposed in November 2002 during construction work for a sewerage system. A slice of this stem is now on display in the Dubai National Museum.

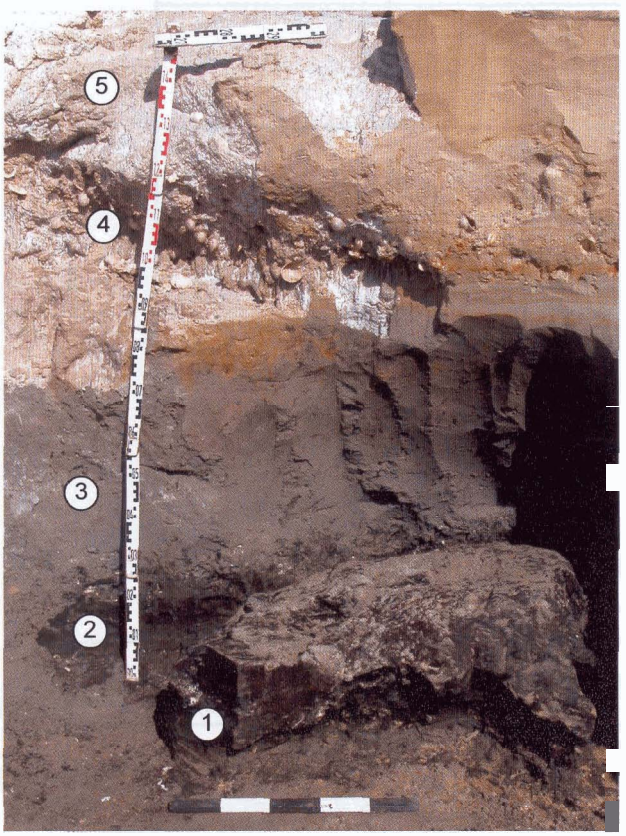

Figure 7: Organic horizon (2) with mangrove stem (1) intercalated in marine sands (3 and 5) with numerous mollusc shells (Anodontia edentula) (4), exposed in December 2004 in a construction pit northeast of the Emirates Golf Club (profile Dub 43).

Geological setting

Nine different profiles containing dark brown, organic rich remains of muddy channel sediments and buried mangrove wood have been discovered in construction pits in this area within the last three years (see Fig. 3). Four of the profiles (Dub 6, 41, 43, 44) contained well-preserved wooden stems and trunks of Avicennia marina intercalated in homogeneous marine fine sand. The biggest stem yet found has a diameter of 60 cm (Fig. 6), but most of the stems have an average diameter of about 20-40 cm. At these sites the organic horizons are up to 50 cm thick (Fig. 7); other pits along Sheikh Zayed Road and in the Dubai Marina area unearthed dark horizons of only a few centimetres. At some sites, the remains of only a few branches were found, indicating the peripheral parts of the intertidal mangrove ecosystem (Dub 14, 36; Fig. 3). The vertical position of the organic horizon varies between -2.0 m and -0.7 m below the present mean sea level (M.S.L.) or, according to the local grid, between -0.85 m and +0.45 m D.M.D. (Dubai Municipality Datum). The mangrove-bearing horizon generally overlies light to medium grey homogeneous marine sands that is partly penetrated by horizontal and vertical mangrove roots and intermingled with a few bivalves and shell debris.

Chronology

Optically-stimulated luminescence (OSL) dating was carried out on quartz grains from the strata in profile Dub 6 using a SAR protocol (Murray & Wintle 2000). Dose rate determination by gamma spectrometry yielded radioactive disequilibria in the uranium decay chain for the littoral sediments (Tab. 2). Time dependent dose rates were hence modelled (cf. Zander et al. subm.) and resulted in minimum and maximum OSL age estimates. OSL deposition ages that were calculated using a linear uptake model are in good agreement with archaeological evidence and radiocarbon datings on shells and wood. They range between 6.8 ± 1.1 ka and 7.4 ± 1.0 ka (Fig. 8, Tab. 1). Aeolian sands and aeolianites of late and early Pleistocene age underlie the whole sequence. The overlying massive mangrove stem and calcareous boring worm tubes within the stem were 14C-dated at 7008 - 7169 years cal BP (6200 ± 50 BP) for the stem and 6563 - 6765 years cal BP (6400 ± 60 BP) for the worm tube (Tab. 3). The stem is embedded in a basal dark brown organic horizon of about 5 cm thickness and a laminated, greyish-brown sandy horizon of 80 cm thickness with abundant shells of oysters (Ostrea *sp.)* and other marine molluscs. Some oyster shells were found in living position attached to the wood. The grey laminated sand surrounding the stem yielded an OSL age of 6.9 ± 0.8 ka. This is in good chronostratigraphic agreement with the radiocarbon dating results.

Two samples from the overlying greyish and brownish sands yielded OSL ages of 6.8 ± 1.1 ka and 6.4 ± 1.2 ka. These sands often contain an abundance of Anodontia edentula specimens in living position (cf. Fig. 7). This indicates a shallow marine submergence of the mangrove swamp since A. edentula occurs in mud and muddy sand habitats of the lower shore environment (Bosch et *al.* 1995). The shallow marine conditions are evidence for a sea level rise, at least until 6400 years BP.

Discussion and conclusions

From the late Pleistocene to the beginning of the Holocene about 10,000 14C-years ago, the climate of the Arabian Peninsula in general and the UAE in particular was hyper-arid. Larae dunes and sand sheets were mobilised. dominating the landscape (Weijermars 1999, Goudie et *al.* 2000b, Bray & Stokes 2003). Along with the rising sea level

Tab. 1: OSL dating results, sample positions and water contents.

Sample code	Grain size (pm)	Sample depth b.s. (m)	Measured water content (%) [3]	Applied water content (%) [4]	Cosmic dose (µGy a-1) [5]	Equivalent dose (Gy) (6)	Quartz OSL age (a) minimum age	Quartz OSL age (a) maximum age
MR0186	150-250	0.25	2.8	1 5 f 5	191 ± 19	4.05 ± 0.65	5600 ± 1000	6430 a 1160
MR0185	106-150	0.45	2.3	20 ± 5	185 ± 18	5.12 ± 0.67	5760 ± 900	6760 ± 1050
MR0184	106-150	0.90	13.5	20 ± 5	174 ± 17	6.17 ± 0.47	6100 ± 680	6890 ± 760
MR0183	106-150	1.65	11.4	20 ± 5	157 ± 16	5.70 ± 0.80	6260 ± 1020	6840 ± 1100
MR0182	106-150	1.92	4.0	20 ± 5	152 ± 15	6.11 ± 0.68	6840 ± 940	7360 ± 1010
MR0181	150-200	3.00	4.4	20 ± 5	131 ± 13	5.80 ± 0.66	6670 ± 920	7110 ± 980
MR0180	106-150	3.85	9.5	20 ± 5	118 ±12	8.31 ± 0.75	9480 ± 1180	9660 ± 1210
MR0179	106-150	4.20	19.6	27 ± 5	113 ± 11	67.30 ± 8.39	79930 ± 11710	99350 ± 15200

[3] ground water level is lowered by drainage, not representative for natural sediment water content
[4] below ground water marker in the sediments the saturation moisture was used for age calculations
[5] calculated by ADELE (Kulig et al., 2005)
(6) OSL-SAR protocol applied on coarse grain quartz, 2 sigma error

Tab. 2: Dosimetry data for OSL samples

Gamma spectrometry				
Sample code	238U from 226Ra and 186 keV	226Ra (Bq/kg)	232Th (Bq/kg)	40K (Bq/kg)
MR0186	31,07± 2,73	15,31± 0,77	2,76± 0,14	74,16± 3,71
MR0185	61,33± 4,81	16,245 0,81	4,00± 0,20	95,79± 4,79
MR0184	58,97± 4,57	14,54± 0,73	5,03± 0,25	154,50± 7,73
MR0183	34,81± 2,91	13,21± 0,66	5,25± 0,26	157,59± 7,88
MR0182	22,15± 2,07	15,22± 0,76	5,59± 0,28	157,59± 7,88
MR0181	17,24± 1,67	14,54± 0,73	5,71± 0,29	169,95± 8,50
MR0180	12,90± 1,32	14,73± 0,74	6,45± 0,32	176,132 8,81
MR0179	11,46± 1,29	26,49± 1,32	3,78± 0,19	145,23± 7,26

Tab. 3: Dosimetry data for OSL samples

Sample	Lab.-Number (12)	Material	Delta 13C	14C age BP (years)	14C age cal BP (years) (7)
DUB6/H	UtC 12195	Mangrove wood	-27.4	6200 a 50	7008 - 7169
DUB6/W	UtC 12196	Calcareous boring worm tube	-16.1	6400 ± 60	6563 - 6765 (8)

(7) Software Calib 5.0.1,
[8] marine calibration using a reservoir effect of 408 years and a delta R value of 180 ± 53 (Southon et al. 2002)

during the late Pleistocene and early Holocene, the shoreline moved inland, thereby flooding, reworking and eroding large coastal areas and dune fields. Only a small sandy horizon which represents the late Pleistocene dune sands is left at the base of the Dub 6 section above the sedimentary discontinuity at -4.15 m M.S.L. *(Fig. 8)*. Thereafter, homogeneous marine sand was accumulated as a result of the rising sea level up to the time when the mangrove ecosystem developed ca. 7100 years ago.

There is evidence that the climate on the Arabian Peninsula became more humid with a prevailing summer rain regime from 10,000 to at least 6,000 (Weijermars 1999, Glennie & Singhvi 2002) or even 5,000 years BP (Lézine 2002). Therefore, a seasonal superficial or subsurface freshwater discharge is probable in the area of the fossil mangrove channel system, similar to the environs of today's Dubai Creek. This freshwater supply, together with the decelerating sea level rise between 7200 and 6900 years ago, may have supported the development of the mangrove forest ecosystem.

Only a few hundred years later, about 6900 years ago, the transgression continued and the mangroves were submerged and buried by shell-rich marine sands. Mangrove ecosystems are very sensitive to changes in environmental conditions and geomorphological alterations linked to sea level fluctuations. If the respiratory function of the pneumatophores which project from the muddy sediment is disturbed by permanent high water conditions and/or rapid sediment accumulation due to sea level rise, the plants will die.

According to the radiocarbon ages of shells and the luminescence ages obtained from the sediments in the Dub 6 area *(Fig. 3)*, marine influence and sedimentation ended about 6400 years ago when sea level reached nearly its present position. The top of the uppermost marine sediments was localised at -0.1 m M.S.L. (+1.05 m DMD).

Details of Holocene sea level fluctuations in the Arabian Gulf remain in dispute. According to Dalongeville *et al.* (1993), sea level within the Arabian Gulf exceeded its modern level by more than 2 m about 6000 years ago; subsequently, it has fallen slowly to the present level. Other calculations from the Gulf of Oman and the Arabian Gulf have resulted in estimates of maximum sea level of less than +1 m above present at 5000 years ago (Vita-Finzi 1982), of +2 m about 4000 years ago (Weijermars 1999, Evans *et al.* 2002) and of +1 to +2 m around 6000 years ago (Lambeck 1996).

Lézine *et al.* (2002) studied mangrove development on the east coast of Oman at Quryat, Sur, and Khawr al-Jaramah some 6000 years ago. Their cores show that the marine influence strongly decreased after 5600 BP, when a brackish lagoon developed. Subsequent marine incursions occurred at 5100 and 4500 cal. BP. Their report is in good agreement with the chronological information obtained for Dubai's fossil mangrove forest and the overlying marine sediments, though the Oman mangrove swamps seem to be slightly younger.

Further profiles sampled in December 2004 near site Dub 6 are currently being processed. They are expected to yield new information about the timing of the Holocene sea level fluctuations and the coastal sedimentary processes along the Dubai sector of the Arabian Gulf coast.

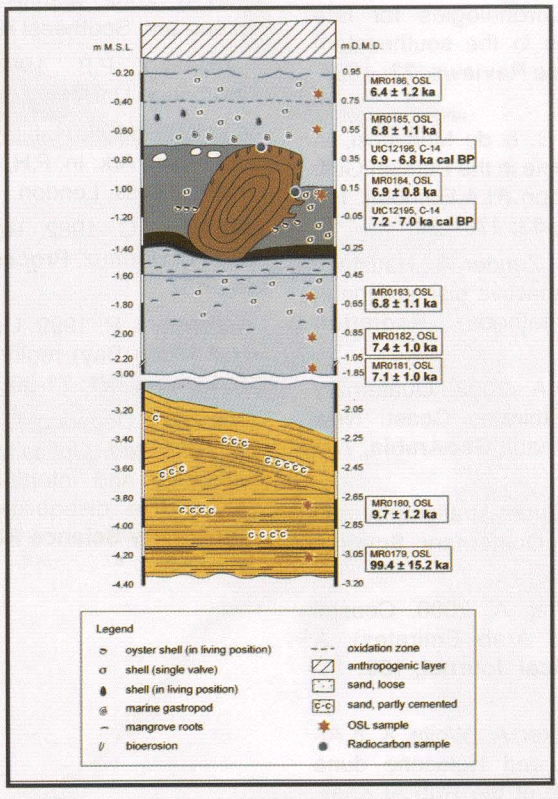

Figure 8: Dating results obtained by optically stimulated luminescence (OSL) and radiocarbon (^{14}C) dating techniques for Profile Dub 6 close to the Emirates Golf Club (55° 10' 14" E, 25° 05' 32" N; cf. Fig. 3 for location and Fig. 6 for photograph). OSL ages were calculated using a linear uptake model for dose rate calculation and represent maximum ages (*cf.* text). The results of both dating methods are in good agreement, yielding an age of about 7100 years BP for the mangrove forest. The subsequent fossilisation by shallow marine sands started around 6900 and ended around 6400 years ago (cf. Tabs. 1 and 3). Mean Sea Level (M.S.L.) = 1.15 m above Dubai Municipality Datum (D.M.D.); D.M.D. = L.A.T. (Lowest Astronomical Tide). Blue colour: shallow marine sediments; yellow colour: non marine, partly aeolian sediments; dark brown: organic horizon, mangrove swamp; light brown: mangrove stem.

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Surveying the waters of the UAE

by Andrew David

In 1953 I was serving as a watch-keeping officer on board HMS Dalrymple, carrying out a detailed survey of the waters of the UAE to the west of Sir Bani Yas, where soundings on the Admiralty chart were still based on those obtained in 1823 by Lieutenant John Michael Guy of the Bombay Marine. One afternoon I was in charge on the bridge running lines of soundings in an east-west direction in a comparatively flat bottom. At the end of my watch I retired to my cabin for a well-earned rest, but was soon woken up by a rumbling noise that lasted about thirty seconds.

Dashing up on deck, I spotted a dirty brown patch in the water astern. We had run over an uncharted isolated reef and the rumbling noise I had heard was branch coral being broken off by the ship's bottom, fortunately without doing any major damage to the ship. The following day I was sent away in a boat to examine the reef in detail, finding it very small in extent. Being a new discovery, it was named Webb Rock in honour of the senior British naval officer in the Gulf. It is now described in Admiralty sailing directions as:

> Webb Rock (24° 05' N, 52° 15' E), with less than 1.8 m over it, lying 6 miles offshore NW of Jabal Barakah, should be given a wide berth; soundings give no indication of its proximity; nor can it be seen even in good conditions, except at very close range whence the dark brown coral can be distinguished; there is no sand on it to give the usual warning of lighter coloured water.

Figure 1: Manuscript chart of the eastern Gulf coastline drawn from the work of Lieutenant Guy and Lieutenant (later Captain) George Barnes Brucks of the Bombay Marine between 1821-1823, and published in 1830. Reproduced from Documents held in the United Kingdom Hydrographic Office.

Figure 2: Contemporary watercolour: "Capture of the Piratical Ship Minerva by the Prince of Wales Sehooner and boats of the Chiffone and Caroline, before the town of Ras-ul-Khyma, 'Persian' Gulf, Nov. 1809. Reproduced from Documents held in the United Kingdom Hydrographic Office.

Although the general outline of the Arabian Gulf was known to Arab scholars from an early date, European cartographers remained largely ignorant of the area. In the earliest surviving printed maps, the Gulf has a rectangular shape, derived more from imagination than from observation, with its largest dimension being east/west rather than north-westlsouth-east. By the early sixteenth century, the general outline of the Gulf was depicted much more realistically, particularly on its north-eastern side which by then was being visited by European ships. Since such ships rarely, if ever, ventured along the southern shores of the Gulf, the coastline of the UAE continued to be based largely on imagination. When John Thorntsn published his chart 'Sinus Persicus' in The English Pilot: The Third Book in 1703 any additional information was confined mainly to the north-eastern side of the Gulf with virtually no information at all about the coast and islands now comprising the UAE.

The first detailed survey of the Gulf was carried out between 1785 and 1787 by John McCluer of the Bombay Marine, which Alexander Dalrymple, Hydrographer to the East India Company, published in 1788. This chart, however, did not cover the waters of the UAE since at the time there was no incentive for the British to examine the southern side of the Gulf since it appeared to offer little in the way of trading possibilities. The inhabitants of the coastal settlements to the east of Dubai were also viewed, with good cause, as being unfriendly to European shipping. Indeed it was as a result of attacks by Qasimi vessels, based principally on Ra's al-Khaimah, that eventually brought British warships to UAE waters. These attacks caused the British to dub the area the 'Pirate Coast', although the present Ruler of Sharjah, Dr Sheikh Sultan bin Mohammed Al Qasimi, has argued that these attacks were in fact caused by rivalry between the British and Qawasim over control of the important shipping route through the mouth of the Gulf. During these operations the Minerva, which had been captured by the Qawasim, was recaptured in November 1809 and set on fire in front of Ra's al-Khaimah by the schooner ***Prince*** of Wales, assisted by boats from the Chiffone and Caroline.

During British operations against the Qawasim in 1809 and 1810, Captain John Wainwright of HMS Chiffone acquired a great deal of hydragraphic information, which he forwarded to the Admiralty. In his report he noted that a frigate could not approach within four miles of Ra's al-Khaimah and that from Rumps (Rams) to Sharjah the coast was low and indifferently planted with dates. It was also indented with a number of creeks affording shelter to potentially hostile Qasimi vessels. To the west the land, as far as Bahrain, was called by the inhabitants the 'Coast of Danger' and was completely unknown. to Europeans, with many shoals reported to lie off it. Wainwright concluded by advocating that a survey of the whole of the Gulf was highly desirable, pointing out that although McCluer's chart was the best one available, it was erroneous in the configuration of the coast.

Attacks by the Qawasim continued in spite of the presence of British warships in the Gulf. Eventually a major British expedition was sent against the Qawasim in 1819-20. during which eight villages on the coast were destroyed. Accompanying the expedition was Lieutenant Thomas Remon of the Engineers who produced a plan showing the locations of the villages that were attacked as well as individual plans of six of them. The positions of the towers and forts destroyed during the expedition are depicted on the plans. As a result of this expedition treaties were signed in January 1820 between the British and the Rulers of the Coast, the beginning of what was to become the Trucial States (the present UAE).

Because of growing British interest in the Gulf, Captain Hurd, Hydrographer to the Admiralty, published the first British Admiralty chart of the Gulf on 21 September 1820, in which he incorporated the surveys and comments made by Wainwright, together with those of McCluer and others. At the western end of the coast of the present-day UAE the chart carries the legend 'This part of the Coast is unknown'. Some soundings are also shown on the chart between Dubai and a position some 70 miles south-west with the legend along the adjacent coastline 'Low sandy Coast with Trees some Forts and small Villages interspersed'. The only part of the coast of present-day UAE which is depicted on this chart with any accuracy is from the Musandam Peninsula to the vicinity of Sharjah.

One of the most fruitful times to carry out hydrographic surveys is immediately after the conclusion of hostilities. Thus in 1820, following the signing of the treaty with the Arab Rulers, the Bombay Marine gave instructions for a major survey of the Gulf to be carried out by Lieutenant Guy in the Discovery of 268 tons with Lieutenant George Barnes Brucks as his assistant in the Psyche. Guy started his survey the following year at Ra's Musandam and by the end of 1822 he had reached Abu Dhabi. Since by the end of 1824 Guy and Brucks had extended their survey as far as Ra's Rakan at the head of the Qatar Peninsula, it seems likely that they completed the survey of the coast of the UAE and its outlying islands by the end of 1823. While Guy endeavoured to base his surveys on a system of triangulation, this was rarely possible since in places the coast is fringed with low and featureless islands up to 20 miles offshore, making triangulation impracticable. In addition, because of the difficult terrain, many of the bases on which his survey depended were measured by sound between the two ships rather than on shore. Thus many of Guy's surveys were controlled by astronomical observations both on board ship and on shore, where Guy used a sextant on a stand or a theodolite to observe for latitude by observing the meridian altitude of the sun or a star. Guy's longitudes were obtained by chronometer measured from the meridian of the English factory at Bassadore on Kishm Island (Jazireh-ye Qeshm), whose longitude had been fixed by meridian distances from Bombay. He, therefore, had to return to Bassadore at intervals to check the errors of his chronometers, and to obtain provisions. These were also obtained during the survey from local Sheikhs, who were very civil to the officers of the surveying vessels. Soundings were obtained by lead line from which the height of the tide was subtracted to reduced them to a low water datum. In some parts of Guy's survey there are numerous soundings, but in other parts there are large areas with few soundings or even no soundings at all, inevitable in a survey which was principally aimed at discovering the correct delineation of the coastline and the positions and extent of off-lying islands. Guy was 'faced with the dilemma faced by all surveyors of his generation when surveying a completely unknown stretch of coastline. Such a survey is inevitably a compromise between absolute accuracy and completing the survey to an acceptable degree of accuracy in a reasonable length of time. In such a survey it is inevitable that not all dangers will be discovered as we discovered to our cost in the Dalrymple.

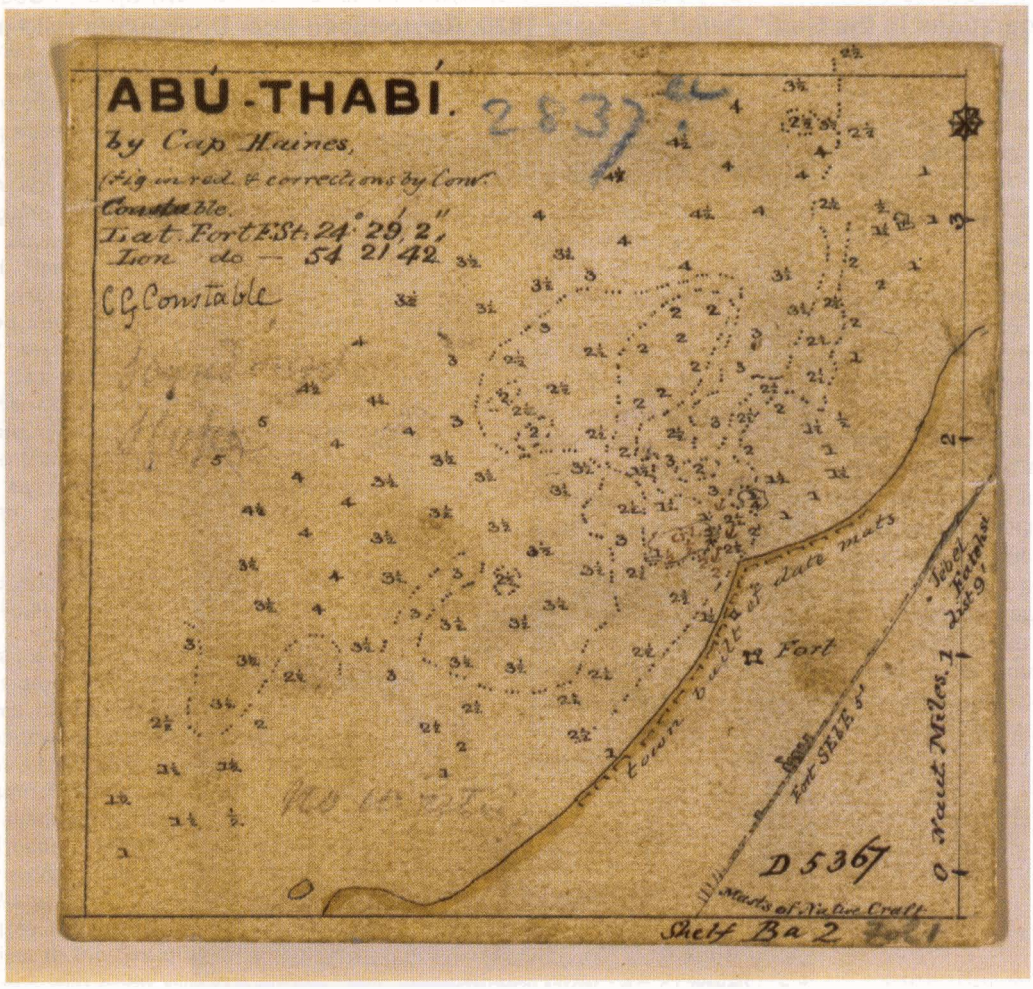

Figure 3: Chart of Abu Dhabi by Captain S.B. Haines, with corrections by Commander C.G. Constable (undated, but from the *1820s).* Reproduced from Documents held in the United Kingdom Hydrographic Office.

Figure 4: Aymaun (Ajman) and its creek. The note at bottom left signed by Lieutenant Remon, Engineers, and states that "The Gurrys and Towers at Aymaun have been blown up and destroyed during the late operations in the Gulf." Dated February 1820. Reproduced from Documents held in the United Kingdom Hydrographic Office.

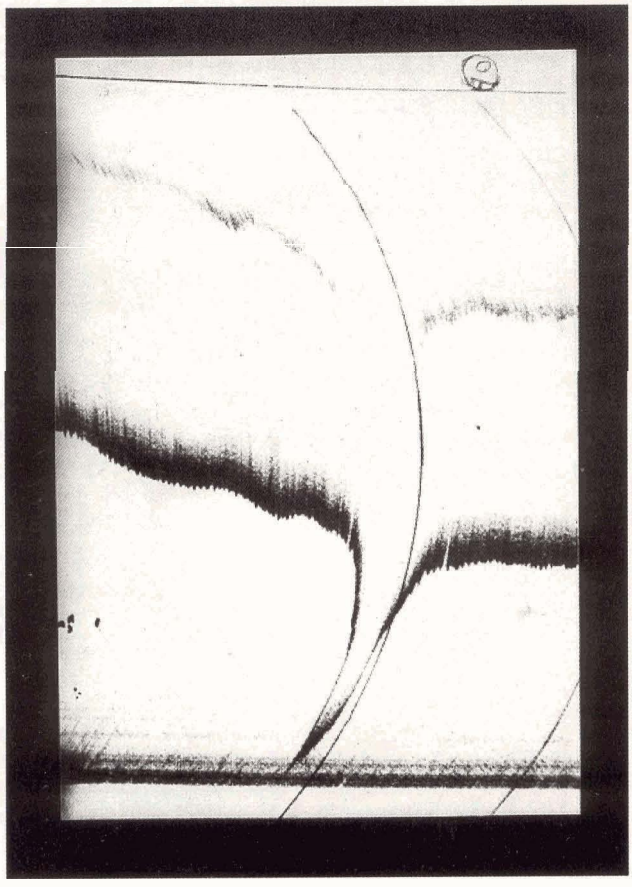

Figure 5: The echo-sounder trace recorded on HMS Dalrymple as it discovered "Webb Rock", in Western Abu Dhabi, in 1953. Copyright: Andrew David.

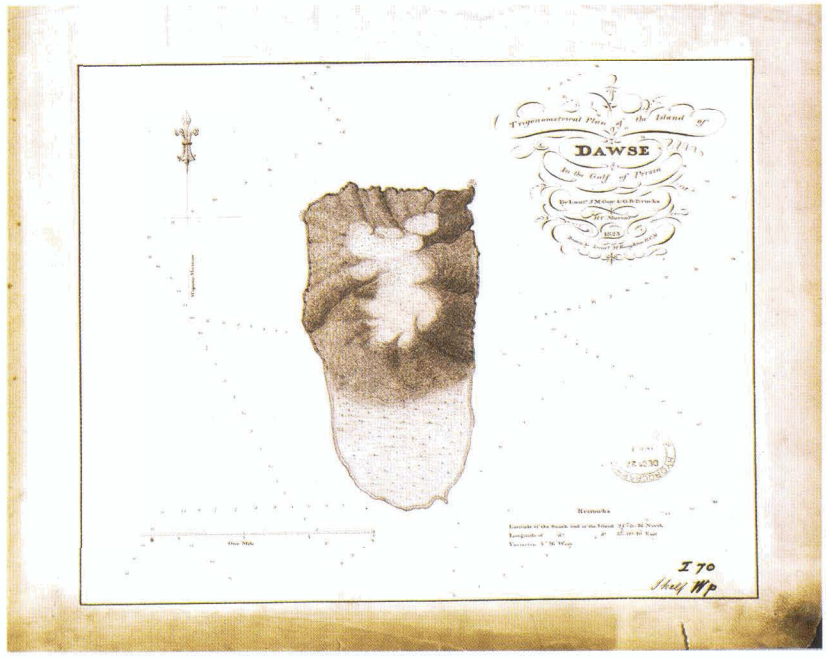

Figure 6: Trigonometrical survey of Dawse (Das) island, 1823. Produced by Lieutenants J.M. Guy and G.B. Brucks. Reproduced from Documents held in the United Kingdom Hydrographic Office.

When Guy reached Khor Abdulla, at the head of the Gulf, his health gave way and Brucks took over the survey and we must rely on the latter's memoir, published in 1856, to learn about Guy's survey. In it Brucks wrote that Ra's al-Khaimah

> ... was prior to the expedition in 1819-20 .... surrounded on three sides with a wall, flanked with towers, and to the south-westward of the town had a further defence of strong square fort or Ghuree, and was at that time supposed to be defended by between six and seven thousand men, including the auxiliaries collected from the country round about, and about eighty boats of different size, from two hundred and fifty to forty or fifty tons, some mounting eight and ten guns. They also had about sixty or seventy pieces of Cannon, of various descriptions, but most of them would be considered unserviceable by Europeans. A number of their best boats were sent to Lingah and other friendly places, by which they escaped being destroyed, and are now employed with trade.

Brucks also commented on Sharjah and Aboo Heyle (Abu Hail):

> Shargah... is long and narrow and open: the defences are a fort a little inland, mounting six pieces of Cannon together with some detached towers. In case of alarm from an enemy, it is stockaded round with Date trees and wood sufficient for repelling the attack of Arabs, although of little service against regular troops... Shargah sends from three to four hundred boats of various sizes to the pearl fishery.
>
> Aboo Heyle is a small village situated about three miles to the SW of Shargah, on the same creek with Khan village on the other bank. They jointly contain about two hundred and fifty inhabitants of various tribes, mostly fishermen, and are subject to Shargah.

Brucks described all the islands that he and Guy surveyed. According to him, Jezirat Arzanah was moderately elevated and about six and a half miles in circumference, while its south point, like most of the islands, was low and sheltered from the prevailing winds, where good anchorage could be found under the lee of the island. It had no water. He considered that Jezirat Zarakkuh (Zirku) was the highest island off the south coast of the Gulf and that it afforded good anchorage under its lee, sheltered from the prevailing wind. It too had no water. Sheltered anchorage from northerly winds was essential for the safety of the two ships since in winter the shamal can blow at times with considerable violence.

The results of the surveys carried out by Guy and Brucks, covering the waters of the UAE, were drawn at the end of the survey of the Gulf in 1830 on a small scale chart, extending from the Musandam Peninsula to Khor Abdulla, with the off-lying islands drawn on nine large scale plans. On 1 January 1832 James Horsburgh, Hydrographer to the East India Company, published a chart of the Gulf on two sheets based on these surveys. The publication of this chart led to the withdrawal of the 1820 Admiralty chart, which thus was in publication for a very short time. When the Admiralty took over the charting responsibilities of the East India Company in 1861, the Hydrographer of the Navy continued to publish Horsburgh's chart as charts 90 (a) and (b), but did not initiate further major surveys of the coastal waters of the UAE for over 100 years, although a number of minor surveys of small extent were carried out during this period. Thus it was not until after the end of World War II that Guy's survey was finally superseded, when the discovery of oil in the waters of the UAE led to the area being surveyed in detail to modern standards.

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Albino tadpoles of *Bufo arabicus* and their possible development

by Gary R. Feulner

In late afternoon on 18 February 2005, having walked a circuit in the upper reaches of Wadi Qinan, a tributary of Wadi Shawkah, I reached the uppermost of a chain of permanent pools that continue for more than a kilometre. To my surprise, in it I saw seven relatively large and distinctly white tadpoles ***(Fig. 1).*** With greater effort I could also find five normally coloured (greenish-brown) tadpoles of similar size, but no adult toads. The pool in question was set in ophiolite bedrock with some gravel fill. It was rhombus-shaped, approximately 3 metres on each side and perhaps 0.75 metres deep at the centre.

but were they also related to the other five normal tadpoles? If so, why had the albinos survived in greater numbers? And most intriguingly, if albinism did not handicap them as tadpoles, would they go on to become albino toads?

I could not hope to answer all of those questions, but I did pay a second visit to the same site five weeks later, on 26 March. Rain had fallen in the area in the interim. That was a good thing generally, but it raised the possibility that my albino tadpoles would have been dispersed by the flowing wadi. When I descended the wadi after my first visit, I had kept a lookout for additional albinos in lower pools, and I had

Figure 1: Albino tadpoles of Bufo arabicus, three of seven found in a pool near Shawkah.

I was able to manoeuver a couple of the albino tadpoles into a shallow area at the margin for closer inspection ***(Fig.*** 2). This revealed pinkish-orange tints that proved to be the colours of internal organs showing through the translucent skin. Inspection of the mouthparts permitted me to identify the tadpoles as, the Arabian toad. The black mouthparts (a central beak and surrounding teeth rows made of keratin) showed up exceptionally well against the pink-white skin. I was delighted by this novelty, but I wondered immediately what would become of these tadpoles. Conventional wisdom has it that the normal camouflage colour of the local toads helps to protect them from predation, whereas the albinos were conspicuous. Yet those I saw had survived to an advanced tadpole stage (including development of rudimentary legs). I assumed that the seven were siblings, seen none.

When I arrived for the second time at the highest pool, I found no tadpoles at all, although otherwise the pool appeared much as I had last seen it. I followed the channel downstream through a dry, shallow, gravel-filled channel cut into cemented wadi gravel. This led, after some 20 metres, to a very shallow, long, narrow pool cut into the same cemented gravel. There I found six distinctly pale - but not albino - tadpoles that I consider likely to be my original specimens ***(Fig.*** 3), although their identity remains unproven. My impression was bolstered by finding, along with the pale tadpoles, a further five normally coloured tadpoles of the same size, as if the population of the original pool had been washed downstream, with the possible loss of one of the albinos.

Figure 2: Close-up of one of the albino tadpoles.

Figure 3: Pale tadpole found just downstream from the site of the albinos, five weeks later.

Figure 4: Another pale tadpole found near the first, showing symmetrical patterning and good camouflage.

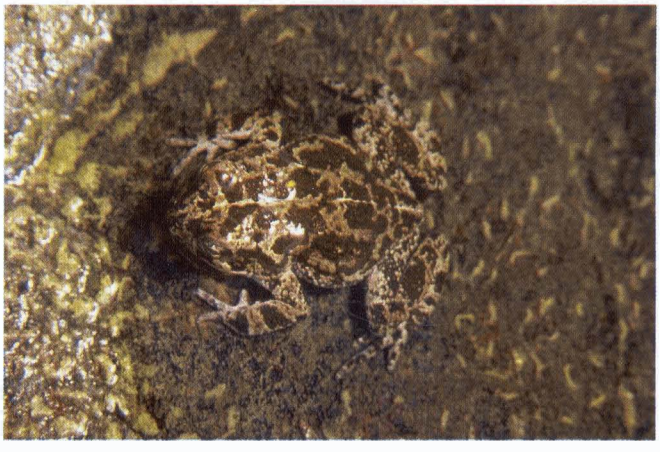

Figure 5: An adult toad found near the pale tadpoles, showing a two-tone, highly symmetrical colour pattern with a pale-coloured background and a distinct dorsal midline.

At the time, these tadpoles did not seem to me to have increased much in size or development since my earlier visit, but comparison of the photographs makes a certain amount of development clear. In any case, their growth rate could be related to the resources (or lack thereof) available in their new pool. They had, nevertheless, developed a certain colouration - a pale, creamy background with scattered darker spots in a distinctly symmetrical pattern ***(Fig. 4)*** - and this new colour pattern was very effective camouflage against a bottom environment of pale organic debris.

Also present at the same pool were several adult toads, which, by comparison with the pale tadpoles, may represent the colour pattern to which the former albinos will eventually mature. This is an intricate but very symmetrical, two-tone pattern, resembling a Rorschach test ***(Fig. 5).*** Indeed, the toad in ***Fig. 5*** exhibits a distinct dorsal centreline, as if to show where the Rorschach paper was folded, and a similar feature is suggested in both of the tadpole photos ***(Figs.*** 3 ***and 4).*** The background colour is cream on the body and off-white on the legs - at least a candidate for the legacy of an albino origin.

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Further Observations and New Records of Spoon Worms in UAE

by Richard Hornby

The paper "An Intertidal Spoon Worm (Phylum Echiura) in the UAE: Occurrence, Distribution, Taxonomy and Ecology" (Tribulus ***15.1,*** 2005, pp. 3-8) indicated that there was still a lot to learn about every aspect of this intriguing creature. That is still the case but there is a little more to report since publication of that paper.

The main site reported on in the above article, at Ra's Hanjurah, was still in good condition, as at 26 October 2005, and the Spoon Worms were observed to be feeding at a higher density than has ever previously observed by the author. At one point there would have been several hundred extended prostomia, many of them stretching up to about 60 cm from the hole. They were mostly in 5 to 15 cm of water, on a rising tide, around 9.30 a.m. The water felt surprisingly cool, so it had probably been a cool night and the seawater temperature had dropped as it passed over the cool intertidal sands during the night. The arrival of the cool flood tide must have stimulated a relatively synchronised bout of feeding.

On that occasion, while many prostomia were extended, the author and Roxana McLennan-Linklater were able to observe ejection of faecal sediment from a Spoon Worm mound. It was about 6 cm high, in a depth of about 18 cm of water, and resembled a smoking volcano. The emerging material was extremely fine (very much finer than the material taken in) but the water was very still so a lot of it would have deposited on top of the mound. The mound continued to 'smoke' for about five seconds. This observation confirms the assumption that ejection of faecal material (and development of the mound) occurs when the mounds are covered by the tide.

When physical contact is made with an extended prostomium, it retracts fairly quickly into the hole, perhaps over about five seconds if well extended, but keeps hold of the sand it has collected. This is clearly energetically efficient and may also be useful in rendering prostomia less attractive as food items to predators such as birds.

In the six months preceding publication of this note, three new sites have been. found for Spoon Worms, all in mangroves, near Abu Dhabi. Spoon Worm mounds were found at a very high density in a small area on Sadiyat Island (see Figure *1).* Mangroves and intertidal flats are very extensive on Sadiyat (about 20 square kms) but Spoon Worms apparently only occur in a tiny proportion of this area - probably less than one hectare. The main feature of the site is that it is at the head of a long creek, and, therefore, very sheltered.

Spoon Worm mounds were also noted on Reem island, between Sadiyat and Abu Dhabi island, in early June by Ms. Joanna Buckee, of Maunsell Consulting, but this site has not, as yet, been studied in detail.

Further sites may remain as yet undiscovered in the rather inaccessible lagoonal area between Abu Dhabi island and Ra's Hanjurah.

The other site where Spoon Worm mounds were noted for the first time is on the seaward edge of the mangroves on the western side of Abu Dhabi Island, i.e. the seaward side of the large patch of mangroves adjacent to Musaffah Road, where the property company ***Aldar*** are now planning to build their Al Qurm resort. The mounds were only seen in a strip about ten metres wide and 200 metres long, at a fairly low density. This site is also sheltered, being about 17 km from the open sea and protected from the west by Hodeiriyat Island.

Two further records have come to light as a result of publication of the above-mentioned article in Tribulus. Ron Loughland of the Emirates Heritage Club has reminded the author that around 1998/99 they together found Spoon Worm mounds in a small area on Sammaliyah Island, 12 km to the east of Abu Dhabi. The other sighting constitutes the first known record of Spoon Worms in the UAE. It comes from Michael Gallagher, who for many years was the curator of the natural history museum at Muscat, Sultanate of Oman. He reports finding "proboscides of spoonworms", which he "collected in Sharjah Creek on 13 February 1972; they were in 1-2 inches of water at low tide, either stationary, or (one) emerging from the substrate, wriggling as if searching and enveloping prey." They were identified for him by the late R.W. Sims at the British Museum (Natural History). (Gallacher, in ***litt.***)

It is felt unlikely that Spoon Worms would have survived until today in Sharjah Creek, and it seems probable that many such sites may have been lost in recent decades. It is hoped, however, that this piece will stimulate people to search their memories for other forgotten Spoon Worm sites, and to seek out new ones.

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Figure 1: Spoon worm mounds at Sadiyat.

Blanford's fringe-toed lizard (Lacertidae: *Acanthodactylus blanfordii* Boulenger, 1918): a new species record for the United Arab Emirates

by Drew Gardner

Introduction

The fringe-toed lizards, *Acanthodactylus* Wiegmann, 1834, are large lacertid genus of about 36 species found from Spain and Portugal, across the Sahara region, Arabia and eastwards as far as south-western India, they are typically small to medium sized, diurnal, ground-dwelling lizards of arid and semi-arid environments. They occupy substrates ranging from hard gravel plains to soft, aeolian sands, and show appropriate adaptations to these surfaces, especially in their foot morphology. Detailed treatments of the *genus* are found in Salvador (1982) and Arnold (1983).

To date, five species of *Acanthodactylus* have been recorded from within the borders of the UAE (Gardner, 2005). The most widespread and abundant is Schmidt's fringe-toed lizard *A. schmidti* which is almost ubiquitous in the sand sheets and dunes covering much of the country. Two other species of aeolian sands and sand sheets, the Saudi fringe-toed lizard *A. gongrorhynchatus* and Haas's fringe-toed lizard *A. haasi*, have more localised distributions in Abu Dhabi Emirate. The snake-tailed fringe-toed lizard *A. opheodurus* and Bosk's fringe-toed lizard *A. boskianus* prefer habitats with harder surfaces, and are found in the outwash gravel and sand plains bordering the Hajar mountains.

This note reports the occurrence of a sixth species of fringe-toed lizard from within the UAE borders: Blanford's fringe-toed lizard *A. blanfordii* Boulenger, 1918. The known distribution of this species is from south-eastern Iran, southern Afghanistan and south-western Pakistan and north Oman (Muscat area), with the type locality given as 'Perse et Beloutchistan' (Arnold, 1986). A visiting Dutch birder, Rob Felix, reported seeing this species in October 2002 near Khatmat Milaha in Oman, close to the UAE border. Therefore, it was not altogether surprising to locate a population near Kalba within the UAE.

Fig. 1: *Acanthodactylus blanfordii* in *Heliotropium bacciferum* at Kalba

Fig. 2: Female *Acanthodactylus blanfordii* from Kalba. Note the strong longitudinal striping elements in the dorsal pattern.

Fig. 3: Habitat of the *A. blanfordii* population on the Kalba spit. The plants in the foreground are *Heliiotropium bacciferum.* Note the extensive track damage.

Fig. 4: Sand dunes at the northern end of the Kalba spit. Note the extensive track damage due to recreational vehicle use. The patch of vegetation in the middle distance is inhabited by A *blanfordii.*

The Kalba Population

A. blanfordii(Figs. 1 and 2) was found by the author on 3 December 2005 on the sand spit separating the sea from the mangrove-lined khawr, at around 25.00° N, 56.37° E. The lizards were living on the seaward side of the road, in coarse, grey, shelly beach sand amongst a scattering of Heliotropium bacciferum plants (Fig. 3). Active burrow entrances were between ten and twenty metres apart. Activity was noted between 0.800 and 10.00 but no lizards were seen after that time. This area is very heavily affected by vehicle tracks, and over much of the sand spit, virtually no vegetation remains. Lizards were not observed in areas lacking vegetation cover. At the north end of the spit, near the bridge crossing the khawr, is an area of low dunes (Fig. ***4).*** This habitat too is severely degraded by vehicles, but there are some small areas with a good growth of large Suaeda vermiculata and Haloxylon salicornicum clumps. Numerous tracks and burrows indicate that A. blanfordii lives in this habitat too. There were also numerous tracks of rats and cats on the dunes, attracted no doubt by the quantities of picnic litter left on the sand.

Khawr Kalba is widely recognised to be of prime conservation importance in view of its mature mangrove habitat, the principal locality of the endemic kalbaensisrace of the White-collared Kingfisher Halcyon chloris and has a resident population of Sykes's Warbler Hippolais (caligata) rama.

The lizards were active and inquisitive. When disturbed they would dart for between one and five metres and then stop, their colouration giving them excellent camouflage both against the sand and within the Heliotropiumclumps. Animals that retreated into their burrows re-emerged within a few minutes, remaining alert at the burrow entrance for a minute or so before resuming foraging. One individual was observed entering a burrow 15 metres away from the one it emerged from.

Two other lizard species were recorded in the area: the gecko Bunopus tuberculatus is very common, sheltering under pieces of beach rock during the day. Under one of these rock slabs, I found a juvenile sandfish Scincus sp. The prominent ear opening and lack of dark bars on the flanks suggests Scincus scincus conirostris rather than S. mitranus, but further study of adults is required to confirm this record.

Discussion

Around Muscat, A. blanfordii lives in dense populations on the coastal sands behind the beach crest and in aeolian sand dunes on the Batinah. It has been recorded as far as 32 km inland to the south of Ra's Suwadi. The earlier unpublished record of A. blanfordii from Khatmat Milaha, and now from Kalba, represent an extension of the known Arabian range for this species by some 190 km to the north west.

The considerable pectination of the hind toes and its close systematic relationships with other psammophilous species within the A. cantoris species group (Arnold, 1983) indicate that this is a specialist sand-dwelling species. Indeed, no A. blanfordii were observed on the vegetated sabkha on the inland side of the Kalba khawr, nor on the Acacia tortilis dominated plain between the khawr towards the base of the mountains. On most of the UAE east coast, the mountains approach the sea, and considerable stretches of the coast are now developed for urban, residential or industrial purposes. This indicates that the amount of suitable habitat available for this species is very limited. While other populations may be located in the future on the east coast, the species is likely to be one of the most restricted and rare lizard species in the UAE. As such, its presence here adds considerable weight to the need to preserve the habitats around Khawr Kalba, and further emphasises the conservation importance of this site for the biodiversity of the UAE.

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The RAF Wellington crash at Dhadnah

by Peter Hellyer and Laurence Garey

In ***Tribulus 14.1,*** in our paper on World War Two plane crashes in the Emirates (1), reference was made to the crash of an RAF Wellington bomber at Dhadnah, on the coastline of Fujairah. In that paper, it was noted that

"The precise identity of this aircraft remains a mystery. No record other than that cited above (from the Archives of the British Residency in the Gulf) [2], has yet been traced, although it seems likely that this Wellington was one of the later, more powerful versions (e.g. the Mark X) that were widely used by the RAF Coastal Command in the Middle East in the War."

As a result of enquiries made through the British Embassy in Abu Dhabi, further information has now been obtained from Sue Dickinson, of the Air Historical Branch of the Royal Air Force in Britain. Relevant extracts from an e-mail are as follows (3):

"Our records show that the aircraft in question was Wellington Bomber Mark 1C serial number HX748. The aircraft was on the strength of the Aircraft Delivery Unit, No. 4 Ferry Control Unit, Middle East Command. On 13 February 1943, Wellington HX748 landed at the Staging Post, RAF Sharjah. The aircraft was refuelled and inspected. At 0900hrs (local time) on 14 February 1943, the aircraft took off and, after circling the aerodrome to gain height, set course over the mountains at 6,500 feet.

Approximately 30 minutes later, when over the sea, the pilot noticed a small trickle of oil on the reduction gear casing of the Port Engine. This coupled with a visibility of only 2 miles made him decide to return to Sharjah. After about 7 minutes of the return journey, the Port Propeller flew off the engine. The pilot immediately cut the switches of this engine and, losing height was forced to land on a rocky strip of coast, with the result that the aircraft was badly damaged and the navigator killed.

On the evening of 16 February a message was received that the missing aircraft had been located at Saih Dhadnah (25 degrees 33 minutes North 56 degrees 22 minutes East). This place was inaccessible by land or air and the Naval Authorities were asked to arrange for the rescue of the crew.

On the morning of 17 February, an aircraft from No. 244 Squadron took off to view the scene of the crash and drop supplies. This aircraft reported that the Wellington was badly damaged but four members of the crew were apparently uninjured.

On 22 February three members of the crew were landed at Sharjah, the fourth survivor, the passenger, remaining on board the Naval Vessel HMS Capetown in order to continue his journey to Karachi.

The crew and passenger were as follows: Sgt. G. Chadwick (pilot); Sgt. W.H. Donnelly (navigator); Sgt. G.A. Wharton (wireless operator); Sgt. W.J. Brown (wireless operator); Lt.-Col. De Watteville (passenger).

Sergeant Donnelly was killed when the aircraft force-landed and he was buried by the crew near the aircraft. Sadly, however, despite extensive searches, it was not possible to locate the grave and subsequently Sgt Donnelly is commemorated on panel 270 of the Alamein Memorial."

The RAF records make no reference to the pilfering of the aircraft by local residents, mentioned in the Bahrain Residency records cited in the original paper.

Commander Colin Haley, of Britain's Royal Navy, who co-ordinated the archive research in Britain, has advised (in litt., [3]) that further information may be available in records relating to the World War Two operations of the Sharjah RAF base, although these have not yet been examined.

Following receipt of this new information, one of the authors (LG) has checked the details of the crashed plane. It was built at the Vickers' factory in Weybridge, south west of London, in early 1942 and was delivered to the RAF in mid-1942. It was probably being delivered to an operational squadron when it crashed.

The plane sent to search for the crashed bomber was from the RAF's 244 Squadron, then based at Sharjah, with detachments at Masirah and Ra's al-Hadd, in Oman. It operated Bristol Blenheim V aircraft, (originally called the Bisley.

According to Colin Richardson, these were "truly dreadful aircraft" and "the loss rate was so high that a total of fifty Bisleys were issued to the squadron in sixteen months" (4). Several crashed in Oman, while one, at least, appears to have landed "wheels-up" at Sharjah, judging by a photograph in Richardson's book (5).

244 Squadron was re-equipped with Wellingtons in 1944, and the remaining Blenheim Vs were then transferred to a base at Heliopolis, just outside Cairo.

These further details have been passed to the Government of Fujairah, and efforts will now be made to identify the precise location of the crash site, (in an area now covered partly by farms) and, if possible, of the grave of Sergeant Donnelly, who remains, at present, the only-known British and Commonwealth World War Two fatality buried in the United Arab Emirates.

The authors would welcome any further information on this or on other plane crashes in the Emirates, whether military or civilian, for the period up to the establishment of the UAE in 1971.

Acknowledgements

We are grateful to Sue Dickinson and her colleagues for undertaking the research and to Commander Colin Haley, RN, of the Policy and Diplomatic Relations Directorate of Britain's Ministry of Defence, for co-ordinating the work and for supplying additional information about the RAF Sharjah archives. Alison Hall, of the British Embassy in Abu Dhabi, kindly made the relevant contacts for us.

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NOTES and PUBLICATIONS

New Culture and Heritage Agency for Abu Dhabi

On 14th October 2005, President HH Sheikh Khalifa bin Zayed Al Nahyan, acting as Ruler of Abu Dhabi, issued a law to establish the Abu Dhabi Culture and Heritage Authority. The following summary outlines the responsibilities of the new Authority.

According to the terms of the Law, the Authority: "will oversee intellectual and artistic activities in the Emirate of Abu Dhabi and will also be responsible for maintaining, protecting, managing and promoting the cultural heritage of the Emirate through the following means:

- the evolving of cultural policies, plans and programmes and ensuring that such policies are implemented.
- undertaking projects designed to develop, promote and protect the cultural heritage of the Emirate and to make appropriate recommendations to the relevant authorities.
- organising and developing activities dealing with the heritage of the country as well as organising conferences, cultural shows, plastic arts exhibitions and other activities related to the activities of the National Library.
- organising study programmes and seminars and other intellectual, scientific and professional meetings in addition to the publication of research and studies in the field of culture and heritage.
- conserving historical, archaeological and heritage sites and buildings and preparing an inventory of cultural property and artefacts.
- carrying out of archaeological excavations, conserving archaeological artefacts and relics and issuing licences for excavations.
- supervising the work and activities of archaeological excavation teams and establishing a department to manage, develop and supervise museums and other buildings where cultural artefacts are housed.
- recommending laws and regulations to protect, promote and preserve cultural heritage.
- providing support for training and educational activities.
- developing human and cultural resources in the fields of documentation, management, archiving and preservation of cultural heritage.
- outlining general plans for the activities of museums, in addition to planning for exhibitions on heritage.
- checking for violations of and damage to the cultural heritage and antiquities of the emirate and taking the necessary legal action in association with the relevant authorities.
- providing support and assistance to bodies working in the field of the preservation, management and promotion of cultural heritage.
- exercising control over heritage and cultural property, whether public or private
- managing the National Library in such a way as to enrich and promote intellectual, artistic and scientific activities in Abu Dhabi through the provision of references, journals and periodicals in Arabic and other languages in various fields of knowledge.
- recording national history through the collection of documents, the registering of the heritage of the emirate and through the publication of works in this field.

The Authority will be governed by a Board of Directors, consisting of a Chairman, a Deputy Chairman and seven or more other members, whose powers will be specified in a decision to be taken by the Abu Dhabi Executive Council.

The new Authority will absorb the Cultural Foundation, the Department of Antiquities and Tourism in Abu Dhabi's Eastern Region, the Cultural Heritage section of the Abu Dhabi Tourism Authority and the Abu Dhabi Islands Archaeological Survey, ADIAS.

The Culture and Heritage Authority will also take over responsibility for the implementation of the new Cultural Heritage Management Strategy for the Emirate of Abu Dhabi. This been drawn up by a team of UNESCO consultanrs working with the Tourism Authority, and was formally launched at a conference in Abu Dhabi in early December 2005. (Sources: Emirates News Agency; WAM, and ADIAS)

New law establishes EAD to replace ERWDA

The Environmental Research and Wildlife Development Agency, ERWDA, of Abu Dhabi, was re-named and re-structured in July 2005, becoming the Environment Agency - Abu Dhabi, EAD, under the terms of a law issued on 10th July by UAE President HH Sheikh Khalifa bin Zayed Al Nahyan in his capacity as Ruler of Abu Dhabi. The following summary is taken from an EAD press release.

Law No. 16 for 2005 provides that EAD will remain an independent entity with full capacity and financial and administrative independence. It will be chaired by the Crown Prince of Abu Dhabi and will remain the responsible authority for environmental and wildlife issues in the Emirate of Abu Dhabi. The law stipulates that all Government departments and agencies are required to coordinate and cooperate with the Agency on issues related to researches, studies and programs that concern the environment and wildlife.

The law further states that the Minister of Justice can, in collaboration with the Chairman or Deputy Chairman of the Agency's Board of Directors, appoint some Agency staff members to assume the capacity of a judicial enforcement officer. The officer is authorised to inspect sites and projects to ensure they comply with federal and local laws and regulations. Any breach of law would be referred to the relevant judicial authorities for prosecution.

Moreover, Agency inspection officers are authorised to stop the development of any project or activity, or ban the use of any equipment or materials found to be hazardous to the health and safety of humans and/or our environment.

The law further states that the Agency's approval is required at all times prior to the issuing of regulations, policies and decrees that are related to environmental and wildlife affairs. Any violators will be held responsible and accountable for their actions and may face imprisonment and/or strict fines of not less than AED 5,000, as well as confiscation of their hazardous equipment or material. Furthermore, the relevant court may order the violator to remedy the damage done to the environment within a relative timeframe to be set by the Agency; upon which any failure to do so would resort in the Agency to act upon the court's order at the violator's expense.

The new law also stipulates that the Agency's mission will include working towards achieving sustainable development through its environmental work and promotion of environmental awareness.

According to the law, the Agency's objectives will be:

1- To conduct studies, scientific research and comprehensive surveys of the environment and wildlife in order to prepare strategies and priorities.

2- To assess water and land resources in order to propose the most appropriate means of use of these resources.

3- To evaluate the treatment of household sewage water projects and other industrial liquid wastes on the environment and wildlife, and recommend the establishment of projects to treat and control these liquid wastes.

4- To evaluate the effect of oil wastes on the environment and wildlife, and offer suggestion and solutions for resolving the

related problems.
5- To assess the impact of industrial gases and household air pollutants on the environment and wildlife, recommend solutions for air pollution problems and recommend projects to clear and control gas emissions, in coordination with the authorities concerned.
6- To evaluate the success of existing projects and the operation of recycling programmes for household and solid wastes, to asses their impact on the environment and wildlife and to introduce new ideas to improve these projects or to establish new ones.
7- To recommend the establishment of projects to treat, control and eliminate toxic medical wastes.
8- To evaluate the effect of chemicals used in agriculture on the environment and wildlife, to classify material according to their harmful effect and to propose projects to control their use in the Emirate of Abu Dhabi.
9- To evaluate the effect of existing and future industrial and economic projects and investments in the Emirate of Abu Dhabi, in coordination with the Federal Environment Agency (FEA) and other concerned bodies. Moreover, to prescribe studies that should be conducted and the required precautions which should be taken, and to forward recommendations and solutions for the environmental problems related to these subjects to the Executive Council.
10- To assess the impact of population growth and infrastructure projects of town planning on the environment and wildlife.
11- To recommend projects to treat or eliminate negative effects of industrial and economic schemes on the environment and wildlife.
12- To prepare plans required to introduce and develop a balanced environmental strategy, and implement it on the industrial, agricultural and economic projects within the Emirate of Abu Dhabi. The said plans will be submitted to the Executive Council for approval.
13- To evaluate the impact of hunting and fishing n wildlife in the Emirate of Abu Dhabi, and to recommend solutions to prevent the extinction of wildlife, and recommend management plans, and to establish protected zones for wildlife.
14- To evaluate the effect of recreation and leisure on the environment and wildlife, to introduce proposals and solutions regarding any unfavourable impact and to recommend projects to organize these activities.
15- To establish and run parks and protected areas, and implement rules and regulations to protect these areas.
16- To establish and run specialized centres for the breeding and development of endangered species of wildlife.
17- To establish veterinary centres to take care of wildlife species and rehabilitate them to live in their natural habitat.
18- To establish specialized centres to carry out studies and scientific research related to the environment and wildlife, and to develop techniques to collect information about the natural constituents of the environment and wildlife.
19- To coordinate and cooperate with government bodies, scientific establishments, and research centres within the Emirate of Abu Dhabi and abroad.
20- To recruit and train qualified national staff capable of planning and implementing strategies to protect the environment and wildlife.
21- To provide the public and private sector with information related to the environment and wildlife.
22- To enhance public awareness on the importance of protecting and restoring the environment and wildlife, and to familiarise the general public with the Agency and its objectives throughout the educational and cultural programmes.

A new Board for EAD was formed by Emiri Decree no. 23 for 2005. The Honorary Chairman is Sheikh Mohammed bin Zayed Al Nahyan, Crown Prince of Abu Dhabi and Deputy Supreme Commander of the Armed Forces, with Sheikh Hamdan bin Zayed, UAE Deputy Prime Minister and Minister of State for Foreign Affairs as Chairman and Sheikh Mansour, UAE Minister of Presidential Affairs, as Deputy Chairman. Mohammed Al Bowardi, Secretary-General of the Abu Dhabi Executive Council, remains as Managing Director. (Source: EAD)

UAE Qualifies for Category 1 Status for its ClTES legislation

The secretariat of the Geneva-based Convention of International Trade in Endangered Species (CITES) has given the UAE category 1 status in its National Legislation Project to implement ClTES regulations. Others in the same category include several EU member countries, Japan, Australia, Canada, Switzerland, Spain, and Singapore.

The UAE was given this status because of its work on introducing and implementing Federal Law No. 11 for the year 2002 on regulating and controlling international trade in endangered species of wild fauna and flora. This law deemed it illegal to import, export and re-export or offer for sale any animals, plants or derivatives that have not been obtained in accordance with ClTES requirements and formed the legal infrastructure to implement and enforce ClTES regulations in the UAE.

Relevant UAE authorities include the Federal Environment Agency (FEA), the Ministry of Agriculture and Fisheries (the ClTES Management Authority for the Northern Emirates), and the Environment Agency, Abu Dhabi, EAD (the ClTES Scientific Authority) on local ClTES implementation.

Following the issue of this law in 2002, Ministerial Council Decision No. 22 of the year 2003 was issued by the Minister of Justice, Islamic Affairs and Endowments, giving 16 officials from the UAE ClTES Authorities judicial powers. Since 2003, these officials have been responsible for confiscating a number of items and species covered under CITES, primarily caviar, birds of prey and houbara.

Dh 35,000 worth of caviar was confiscated from an Abu Dhabi supermarket in June 2005.

The passing of Federal Law No. 11 for 2002 followed the imposition by ClTES in 2001 of a ban on trade with the UAE because of evidence that it was being used in the illegal caviar trade. (Source: EAD)

EAD drawing up hunting by-laws

Following the issue earlier in 2005 of Law No. 22 for 2005 on the control of hunting in the Emirate of Abu Dhabi, the Environment Agency - Abu Dhabi, EAD, is preparing by-laws to regulate hunting. A press release issued on 16th October 2005 indicated that the by-laws will identify specific areas and seasons for hunting as well as indicate those species of mammals, birds and reptiles which cannot be hunted. No hunting can take place without permission from EAD.

The by-laws will also detail the steps required when requesting, renewing or cancelling a hunting licence as well as all the set fees, rules and conditions, which include age restrictions. Hunters will be required to carry a separate permit for their hunting equipment. Those hunting with falcons will be required to carry their falcon's passports, which are issued by EAD, the ClTES Scientific Authority in the UAE. Those hunting by methods will be required to carry a Hunting Record Card. (Source: EAD)

Conserving Ra's al-Khaimah's natural habitats and wildlife

Ra's al-Khaimah's Environmental Protection and Industrial Development Commission (EPIDC) has recently

recruited a British environmental expert, Robert Llewellyn-Smith, to establish its new Wildlife and Protected Areas Division. Llewellyn-Smith (a former contributor to Tribulus), has fifteen years of experience in wildlife conservation and protected area management, gained mainly in Middle East/Arabian Peninsula, Africa and Europe.

Before he joined EPIDC, Robert worked for the Earthwatch Institute (Europe), an international environmental organisation based in Oxford, UK, where he built up and managed its African Programme. Prior to that, he worked in the UAE from 1999 to 2001 for the Sharjah-based conservation charity, the Arabian Leopard Trust, during which period he carried out various surveys of Ra's al Khaimah's natural habitats in collaboration with the EPIDC, presenting various plans and recommendations for conservation of key habitats and wildlife.

Ra's al-Khaimah's EPIDC was established in 1999 to tackle environmental impacts caused by local cement and quarry industries. EPIDC is the competent authority within the emirate of Ra's al Khaimah entrusted with the implementation of the requirements of the Federal Law No. (24) of 1999 for the Protection and Development of the Environment. With the approval of Ra's al-Khaimah Crown Prince and Deputy Ruler Sheikh Saud bin Saqr al Qassimi, EPIDC is now widening its remit to cover wildlife and natural habitat conservation.

(Robert Llewellyn-Smith)

Publications

Books

Review

Reef Fishes - UAE and Gulf of Oman. Field, R.F. (2005). Motivate Publishing, Dubai. ISBN 1-86063-161-4. 144 pages. 303 colour plates. 21cm x 15.2cm. Spiral bound. Price 55 UAE Dirhams.

Richard Field built his first underwater camera housing when living in Port Sudan in 1964, where he spent much of his free time diving along the Sudanese Red Sea coast. After living in various Far East locations he spent some time in Jeddahon the Saudi Arabian Red Sea coast. It was during his stay there that he and his wife Mary published the book "Reef Fishes of the Red Sea". Richard is a retired Chartered Engineer now resident in Qurm in the Sultanate of Oman. This new book "Reef Fishes - UAE and Gulf of Oman" is a labour of love which represents many hours of diving and photography in the waters of the region. The majority of the pictures taken in this book were taken by the author (or in some cases, by his immediate family) in the Gulf of Oman, Red Sea or Arabian Sea. A conscious effort was made to ensure that the photographs selected truly represent species that are seen in the Gulf of Oman or Arabian Gulf. This is particularly important when using Red Sea examples since species can exhibit different colour forms according to the particular regions they inhabit.

The book, designed as "a reference book for divers and snorkellers", is beautifully illustrated by more than three hundred underwater shots of reef fishes. Its handy size and spiral-bound format make it easy to handle and practical for field use. It will undoubtedly become a popular handbook for the diving fraternity in Arabia as well as others with a general interest in marine life of the region.

The introductory pages to the book outline the oceanographic background to the study region. There is a brief mention of the Daymaniyat Island National Nature Reserve in Oman and the proposed reserves at Barr al-Hikman-Masirah Island, Musandam (Khawr Quway-Jazirat Um al-Ghanam) and Dhofar (Raaha) in Oman, as well as the Al Yasat area in the UAE. It is a pity that no mention is made of the 5561 sq km Marawah Marine Protected Area in Abu Dhabi emirate in the UAE. This is the largest marine protected area in the entire region, which was designated in 2001 and is managed by the Environment Agency - Abu Dhabi. The author makes an important point when he says that "… Marine Reserves have no value as simply a shaded area on a map" (p.9). Marine protected areas can only be successful if there is monitoring, patrolling and enforcement to effectively manage them.

A useful feature of the book is a checklist of species within the three main distribution areas, namely the Arabian Gulf, Gulf of Oman and Arabian Sea. The checklist, in combination with the index, are extremely useful for quickly looking up details on particular species. It is a shame however that no effort was made to include local Arabic names for the fishes. Local names could have been added in Arabic, as well as English transliterations of their names. The author states that "...Arabic names are not included, since no standard list of names is available" (p14). However, lists of Arabic names have been publicly circulated by the Ministries of Agriculture and Fisheries in both the UAE and Oman. Many Arabic names are also available in the FAO 1997 publication (K.E. Carpenter, F. Krupp, D.A. Jones and U. Zajonz - 1997 - The Living Marine Resources of Kuwait, Eastern Saudi Arabia, Bahrain, Qatar, and the United Arab Emirates. FAO Species Identification Field Guide for Fishery Purposes. FAO, Rome), as well as on the internet via Fishbase (www.fishbase.org).

As all biologists know, there is no such thing as a perfect checklist of species. Name changes and frequent taxonomic revisions complicate things. A further complication is the fact that comparatively little detailed research has been undertaken on Arabian fisheries. It is stated in the book that the checklist provided is compiled from "trusted authors" plus the author's own observations. It is a pity that these sources are not listed since those interested in reading further would have appreciated details of some of the key references. A minor gripe, yet one that is very important for fish taxonomists, is the way the checklist has been prepared. The convention in taxonomy is that authors who first describe a species have their surnames as well as the year it was named following the genus and species name. If there has been subsequent revision of the genus and/or species name then the new authors' names and year are placed in brackets, e.g. Epinephelus coioides (Hamilton, 1822). In the checklist given in this book all brackets have been removed! This is probably an editorial oversight by someone not familiar with taxonomy.

As someone who has worked on fishes predominantly within the Arabian Gulf region I noticed one or two biases in the book towards the representation of Gulf of Oman and Arabian Sea fishes. Some of these are as follows: (1) the most common grouper represented in UAE Arabian Gulf waters is the brown-spotted grouper, Epinephelus coioides. This is not described in the book and there is no picture of this species, although it does appear in the checklist. (2) some other examples of common fishes occurring in the Arabian Gulf and Gulf of Oman which are omitted from the main text and are not illustrated include marine catfish (Ariidae), flatheads (e.g. Platycephalus indicus), sea bream (e.g. Acanthopagrus latus and Argyrops spinifer) and the longtail tuna, kawakawa (Thunnus tonggol). This is not surprising considering the bulk of the material was gathered for the book in Omani waters. Users of this book based in the Arabian Gulf should therefore be cautious in using this book to identify some species which only appear as a mention in the checklist but which are not described or illustrated in the main text.

This book was published with the support and encouragement of Nakheel, the Dubai developers responsible for the Palm Island projects, who boldly advertise

their ongoing projects on pages 21 and 39. Nakheel have recently been subject to criticism over their handling of recent coastal development in Dubai and its impact on the marine environment.They should be commended here, however, for supporting the publication of important information on the marine fauna of the region. The book should go some way to engendering respect and awareness of the variety of reef fishes in the region. The author should be commended for producing such an excellent book. Let us hope that future editions will include updates as new research reveals the presence of further species recorded in the region. It is important, however, that such publications are translated into Arabic as well as English so that the information can be disseminated far and wide to local communities.

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The Emirates - A Natural History, Hellyer, P. & Aspinall, S. [eds.] (2005). Trident Press, UK.ISBN 1-905486-2-2. 580 colour photographs, 428 pp.

To be reviewed in the next issue. This book, the first detailed study of the UAE's flora and fauna (both terrestrial and marine), also includes an overview of geology and palaeontology, and contains a 20,000 word bibliography and species check lists. UAE price: Dh 400.

Emirates Heritage Vol. **1** *- Proceedings of the 1st Annual Symposium on Recent Palaeontological and Archaeological Discoveries in the Emirates, Al Ain. Hellyer, P. and Ziolkowski, M. [eds.].2005. Zayed Centre for Heritage and History, Al Ain. ISBN 9948-06-130-6. 139 pages.*

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Velde, C., The Residence of Falayah (88-100).
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Articles & Papers

Archaeology

Arabian Archaeology & Epigraphy Vol. 16.1 (May 2005)

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Gaultier, M., Guy, H., Munoz, O., Tosi, M. and Usai, D. Settlement structures and cemetery at Wadi Shab-GAS1, Sultanate of Oman: Report on the 2002 and 2003 field seasons (1-20).
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Arabian Archaeology & Epigraphy Vol. **16.2** *(November* **2005)**

Magee, P., Barber, D., Sobur, M. and Jasim, S., Sourcing Iron Age softstone artefacts in southeastern Arabia: results from a programme of analysis using Inductively Coupled Plasma-Mass Spectrometry/Optical Emission Spectrometry (ICP-MS/OES) (129-143).
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Ziolkowski, M.C. and al-Sharqi, A.S., Bayt Sheikh Suhail bin Hamdan al-Sharqi, al-Fara', Fujairah, United Arab Emirates: An ethnoarchaeological study (1) (183-255).

Paleorient Vol. **31.1** *(2005)*
Past Exploitations of Aquatic Ecosystems in South-West Asia: Environmental Approaches. Edited by Jean Desse and Nathalie Desse-Berset.
This volume includes the following articles of regional interest:

Beech, M.J. and Glover, E., The Environment and Economy of an Ubaid-related Settlement on Dalma Island, United Arab Emirates.
Berger, J.-F., Cleuziou, S. and Davtian, G., Evolution paleogeographique du Ja'alan (Oman) a l'Holocène moyen : impact sur l'evolution des paléomilieux littoraux et les strategies d'adaptation des communautes humaines.
Martin, C., Strategies et statut de la collecte des mollusques marins sur les sites côtiers d'Oman du Néolithique a l'âge du Bronze : apport des sites de Suwayh 1, Ra's al-Khabbah1 et Ra's al-Jinz 2.
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