Qatar islamic archaeology and heritage project

Bangsgaard, Pernille; Kristensen, Reinhardt Møbjerg; Møller, Peter Rask; Nymann, Hanne

Publication date:
2012

Document version
Publisher's PDF, also known as Version of record

Qatar Islamic Archaeology and Heritage Project

End of Season Report
Environmental Studies

2011-2012

Qatar Islamic Archaeology and Heritage Project

End of Season Report, Environmental Studies

2011-2012

The executive and staff of the Qatar Islamic Archaeology and Heritage Project acknowledge and appreciate the perceptive leadership and considerable support of:

Her Excellency Sheikha Al Mayassa Bint Hamad Bin Khalifa Al Thani

Chairperson of the QMA

His Excellency Sheikh Hassan Bin Mohammad Bin Ali Al Thani

Vice-Chairperson of the QMA

Acknowledgements

Mr. Mansoor Al Khater

Board of Trustees and Former CEO of Qatar Museums Authority

Engineer Abdullah Al Najjar

Former CEO of Qatar Museums Authority

Professor Sultan Muhesen

Director, Department of Archaeology and Heritage, Qatar Museums Authority

Mr. Faysal Al Na'imi

Head of Archaeology Section, Qatar Museums Authority

Mr. Sayf Al Na'imi

Archaeology Section, Qatar Museums Authority

Mr. Søren Frank & Mr. Steffen Sandvig Bach

Maersk Oil Qatar

Mr. Mohammed Y. Al Jaidah & Dr. Nayla Beyrouthi

Ministry of Environment, Qatar

Professor Friedhelm Krupp

Director, Qatar Natural History Museum

Mr. Khalid Hassan Al Jaber

Head of Natural History, Qatar Museums Authority

The QIAH 2011-2012 Team Members, Environment:

Pernille Bangsgaard, Jakob Walløe Hansen, Anne Majgaard Jensen, Aslak Jørgensen, Jos Kielgast, Reinhardt Møbjerg Kristensen, Jeppe Møhl, Peter Rask Møller, Phillipe Provencal, Ken Puliafico.

Contributing Authors: Pernille Bangsgaard, Jakob Walløe Hansen, Anne Majgaard Jensen, Aslak Jørgensen, Jos Kielgast, Reinhardt Møbjerg Kristensen, Nadja Møbjerg, Jeppe Møhl, Peter Rask Møller, Dennis K. Persson, Ken Puliafico, Gitte Petersen, Phillipe Provencal, Ole Seberg.

Editors: Pernille Bangsgaard, Reinhardt Møbjerg Kristensen, Peter Rask Møller & Hanne Nymann

Cover: Alexis Pantos

First Revised Edition

University of Copenhagen and Qatar Museum Authority 2012

CONTENTS

1. BIOLOGICAL SURVEY OF THE AL ZUBARAH, FIELD WORK SEASON 2012

Pernille Bangsgaard, Reinhardt Møbjerg Kristensen & Peter Rask Møller. (The Natural History Museum of Denmark, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark)

1.1 INTRODUCTION

Al Zubarah Archaeological Site is a rare intact example of a pearl fishing and trading town from the 18th-19th centuries. Moreover, the area around the site in NW Qatar has seen little modern urban development and as such showcases the flora and fauna typical of the Arabian Gulf desert and semi-desert ecoregion. As part of the on-going efforts to inscribe Al Zubarah Archaeological Site on the UNESCO World Heritage List, research into the natural environment was initiated in 2011.

In March 2012 three weeks of field work was carried out by a team of researchers from the Natural History Museum in Copenhagen, in cooperation with the QMA and the Qatar Ministry of Environment. The aim was to investigate the natural environment around the archaeological site and surrounding areas as well as explore the potential for future research project.

This report presents the findings from the field work, summarizing the results and highlighting the potential for further research in a number of areas based on the natural environment of NW Qatar and the country as a whole.

1.2 THE MARINE ENVIRONMENT

Several marine expeditions have worked in the Arabian Gulf. Most famous is the Danish Arabian Voyage to the Arabian Peninsula in 1761-67, which included zoologist Peter Forsskål, whose descriptions of many marine plants, invertebrates and fishes were published posthumously in 1775 (Niebuhr 1775). The book contains the first descriptions of the marine environment and the marine fauna of the Arabian Seas.

In the following two hundred and fifty years, many scientific expeditions have worked in the Arabian Gulf including the Danish fishery investigations of 1937-38 (Blegvad & Løbbentin 1944) and the German oceanographic expedition with the vessel *Meteor* in 1965. A comprehensive FAO guide to the marine living resources of the southern gulf was published in 1997 (Carpenter et al. 1997). But very little scientific biological sampling has been done in the marine waters of Qatar, and no information was previously available on the biology of the Al Zubarah buffer zone. The present end of season report, therefore presents the very first data from the area. The main marine faunas investigated in 2012 were: Meiofauna (mainly Tardigrades), Ichthyofauna (fishes), Malacofauna (molluscs), Botany (sea grasses).

The buffer zone contains several habitats, including sea grass beds, sand, mud, rocks, sea weed and biogenous reefs of e.g. peal oysters (Figure 1.1). Most distinctively the sea water

around Qatar has an extremely high salinity - more than 45‰ compared with the 35‰ at the entrance of Hormuz Strait (Sheppard et al. 2010, Uchupi et al, 1999). Such hypersaline environments has previously been described from Shark Bay; Western Australia.

Closer to Qatar, several scientific teams have worked on sedimentary processes (Basson et al. 1981) and the oil company ARAMCO, operating in Eastern Saudi Arabia have investigated the marine environment and particularly the meiofauna (Hansen et al. 2006). The materials contained a very rich tardigrade fauna with a large proportion of currently undescribed species. The most surprising results were the hyper saline environments attested by the sediment samples. Therefore, the salinity as an ecological factor was a priority during the field work season at Al Zubarah. The results clearly show that the salinity varies strongly depending on the tidal rhythm. The maximum tide differentials were seen on the 11 March 2012, at about 1.2 meters. The highest salinity was measured in a small lagoon close to the Old Pier (Figure 1.2). The salinity in the sediment was 58.0 ‰ at low tide – at high tide the salinity was 48.5 ‰. The temperature at the sea in the buffer zone was only 16°C, but in the sediment at low tides the temperature (11 March) was easily rising to 22°C.

The buffer zone appears to be in a healthy environmental shape and only few signs of human impact were documented. No oil spills were observed in the water, in contrast to some areas on shore. A few lost gill nets were seen, as well as an unmarked fish trap. A transect of sediment samplings was set up (5 March to 11 March 2012) at the Old Pier at Al Zubarah to investigate the meiofauna and to obtain data on the high salinity tolerance of different invertebrate groups in the area. The sediment consists of very fine coral sand with a lot of sulphur bacteria (strong smell of sulphur). At the end of the Old Pier a dense grass bed of sea grasses of the species *Halophila stipulacea* and *Halodule uninervis* exists. The buffer zone fish fauna was investigated from 6-23 March 2012, by multi-mesh gill-net (one night), baited traps (3 nights), and snorkelling with camera and spear gun (3 nights, 2 days) and scuba diving (3 day dives).

1.3 FINDINGS WITHIN THE BUFFER ZONE

Meiofauna

In the sediment of the sea grasses a rich tardigrade fauna was found. Furthermore, lot of barnacles, polychaetes and molluscs were collected in the tidal zone (Kristensen et al. 2012, Chapter 3). Together with sediment and sea grass samples the tardigrade fauna was investigated. Finally the tardigrade fauna related to the invertebrates was sorted by fresh water shocking. Four new species of tardigrades were found at Al Zubarah. Two new species (*Pseudostygarctus* nov. sp. and *Echiniscoides* nov. sp.1) of tardigrades were found in the tubes of the polychaete *Pomatoleios kraussii* and two new species of tardigrades (*Echiniscoides* nov. sp. 2 and 3) were found in the bysus threads of the mytilid mussel *Brachidontes variabilis*.

Fish

A total of ca. 48 identified fish species belonging to 33 families were observed, photographed and/or caught within the buffer zone (Møller et al. 2012, Chapter 6). The most effective method was night snorkelling and most species were observed near Ras Ushayriq.

The most diverse families were seabreams (Sparidae) with 5 species, followed by stingrays (Dasyatidae), Blennies (Blennidae) and emperors (Lethrinidae) all with 3 species. Two species of stingray (*Himantura gerrardi* and *Himantura uarnak* are considered Vulnerable (VU), a shark *Chiloscyllium arabicum* and a labrid *Halichoeres leptotaenia* are considered Near threatened (NT), a butterflyfish *Chaetodon nigropunctatus* and an angelfish *Pomacanthus maculosus* are placed in the Least Concern (LC) category, whereas another stingray *Pastinachus sephen*, a flathead *Platycephalus indicus* and a grouper *Epinephelus tauvina* are currently Data Deficient (DD).

Molluscs

In total 40 species of molluscs were reported from within the UNESCO Buffer Zone (Jørgensen 2012, Chapter 4): Gastropoda 31, Cephalopoda (1), Scaphopoda (1), Bivalvia (7), Polyplacopora (1) The registration of four genera of ellobiid snails previously not reported from Qatar is the single most important finding in the 2012 field work.

Other taxa

A dense population of the blue swimming crab (*Portunus pelagicus*, Figure 1.3) was observed on the sandy shores at high tide and several were caught in our traps. The Common Bottlenose Dolphin (*Tursiops truncatus*) was seen at several occasions, hunting in the zone, close to Al Zubarah. A single Indian humpback dolphin *Sousa plumbea* was also observed in the buffer zone. Sea turtles, a single young Hawksbill (*Eretmochelys imbricate*) was observed in the water, but not on shore, except for one large dead Green turtle (*Chelonia mydas*) at Al Jumail village and several of the same species at Al Zubarah Beach. Dugongs or sea cows (*Dugong dugon*) were not seen alive, however, dead dugongs were found and the skulls (Figure 1.4) were prepared for the museum in Doha. The Greater Flamingo (*Phoenicopterus roseus*) was observed close to The Old Pier, Al Zubarah in nearly every day in flock up till 30 individuals. This bird is an abundant winter visitor in Qatar.

1.4 THE TERRESTRIAL ENVIRONMENT

The main habitat types in the area are the sabkha and the stony desert. There is a well vegetated transition between the two, but patches of shrub and grass vegetation are also scattered around other parts of the area, although it is generally sparsely vegetated. Moreover there are a few natural stony ridges and several places with scattered piles of recent or historical building debris. The archaeological site itself makes up an important habitat for many species. A preliminary terrestrial survey of the Buffer Zone was conducted in 2010 (Kielgast & Hansen 2010).

Herpetology

A herpetological survey was conducted in the Al Zubarah archaeological site and buffer zone during 5^{th}-23^{rd} of March 2012. Activities were targeted at supplying a checklist as complete as possible for the local reptile fauna of the area. Due to the limited size of the buffer zone and the relatively long time frame of the survey it was possible to investigate all areas at a fine spatial scale with at least one visit during day and night. The survey activities were thereafter targeted at the most promising localities of the respective habitat types in the area.

A total of 17 reptile species belonging to eight different families were recorded during the survey in March 2012 (Kielgast 2012, Chapter 8). All species are widespread in the region and their occurrence in the buffer zone of Al Zubarah archaeological site is neither surprising nor unique.

Entomology

The entomological survey found about 170 species of terrestrial arthropods (Puliafico and Jensen 2012, Chapter 5). The most species were insects; however, species of scorpions (*Androctonus crassicauda*) and wind scorpions (Solifugids) were recorded. The beetle fauna was a dominating element, and several darling beetles (Tenebrionids) were observed running on the hot sands during daylight hours at Al Zubarah. Several night-active moths (Lepidoptera) were observed at the end of the season. The timing was probably due to the night temperature, which were too cold for all kind of flying insects in March 2012.

1.5 OTHER AREAS VISITED (CORAL HEADS, DÜVEL ROCK, MANGROVE)

Coral Heads

The maritime location (26°02.447'N and 50°53.254'E) east of the Al Zubarah Buffer Zone were visited by speedboat on the 12th of March 2012. The area is a very large low water coral reef. Unfortunately most of the corals are dead today, and very few fish were seen. A part of the reef is not submerged at low tide. Here many resting Socotra Cormorant (*Phalacrocorax nigrogularis*) were observed. Between the dead corals a dense population of sea grass was present. Samples of coral sand were taken from 2-4 m depths by SCUBA-diving and from 6 to 10 m depths with a mini van Veen grab. The salinity was relatively low 45‰ in the water and 48‰ in the sediment. A dead coral bloc was taken back to Al Zubarah and crushed. Lots of boring mussels and crustaceans were found inside the dead coral. The tardigrade fauna was rich. The sediment samples are not sorted out yet; however, the samples contain at least five species of tardigrades and a species of kinorhynchs (Mud dragon).

Düvel Rock

The maritime location known as Düvel Rock (26°16.717'N and 50°58.754'E) northeast of Al Zubarah was visited by speedboat on the 12th of March 2012. The area is a true coral reef with a Blue Lagoon in the middle. The corals were alive, but were largely overgrown by algae. The crew members told us that in the old days ships would visit the locality because of the upwelling fresh water, similar to the fresh water springs around Bahrain. We could not locate the wells in the lagoon; however, the salinity was low in the sea water (45 ‰) and only 44‰ in the sediment from the lagoon. The current was extremely strong at the edge of the reef and very weak in the "Blue lagoon". The sediment in the lagoon was very fine and smelled strongly of sulphur. A small sea turtle, the Hawksbill (*Eretmochelys imbricate*) was caught by the divers. The turtle was entirely covered by large barnacles (Figure 1.5). These are currently being investigated for tardigrades and for molecular studies.

The small mangrove at Al Jumail

The area near Al Jumail village (26°05.717'N and 50°09.401'E) was visited on the 5th of March 2012. The salinity was extremely high (58‰) at low tide. The mangrove has a muddy sediment, but also a lot of stones. The stones were nearly covered with barnacles. Furthermore a dead Green turtle with barnacles was found at this locality. The barnacles from both localities are still being investigated for tardigrades.

1.6 CONCLUSIONS AND RECOMMENDATIONS

The recommendations for the preservation of the natural environment of the buffer zone are to continue the marine biological research in the buffer zone with investigations of Molluscs, Fishes, Polychaetes and Crustaceans in more seasons in order to get a more complete overview of the fauna. Furthermore, a full investigation of The Canal of Al Zubarah is very relevant (Figure 1.6). This fantastic man-made canal has a very high salinity (>60 ‰). Lots of crustacean (crab) made holes are seen in the walls and perhaps it is also functioning as a nursery area for juvenile mullets (Mugilidae) The carbonated sediment dug out from the canal still exists as very large mounds close to it. This sediment consists of sub fossil marine snails (Figure 1.6). The marine meiofauna in the canal was not investigated in 2012; however, this investigation has first priority in 2013. The full investigations of the terrestrial mammals and birds in the Al Zubarah Archaeological Site are also recommended.

References

Basson, P.W., Burchard, J.E., Hardy, J. T., & Price, R. G. 1981. *Biotopes of the Western Arabian Gulf, Marine Life and Environments of Saudi Arabia.* ARAMCO, Second Edition. Shenval "80", Harlow, Great Britain. 284 pp.

Blegvad, H. & Løppenthin, B. 1944. Fishes of the Iranian Gulf. Einar Munksgaard.

Carpenter, K.E., Krupp, F., Jones, D.A. & Zajons, U. 1997. The living marine resources of Kuwait, Eastern Saudi Arabia, Bahrain, Qatar & the United Arab Emirates. Rome : FAO.

Glennie, K.W. 1998. The desert of southeast Arabia: A product of Quaternary climate change. In Alsharhan, A.S., Glennie, K.W., Whittle, G.L., Kendall, C. St.G., (Eds.) Quaternary Deserts and Climatic Change. (pp. 279-291). A. A. Balkema, Rotterdam.

Niebuhr, C. (Ed.) 1775. Descriptiones Animalium. Haunia.

Sheppard, C., Al-Husiani, M., Al-Jamali, F., Al-Yamani, F., Baldwin, R., Bishop, J., Benzoni, F., Dutrieux, E., Dulvy, N. K., Durvasula, S. R. V., Jones, D. A., Loughland, R., Medio, D., Nithyanandan, M., Pilling, G. M., Polikarpov, I., Price, A. R. G., Purkis, S., Riegl, B., Saburova, M., Namin, K. S., Taylor, O., Wilson, S., Zadinal, K. (2010). The Gulf: A young sea in decline. Marine Pollution Bulletin 60: 13-38.

Uchupi, E., S.A. Swift & D.A. Ross. 1999. Late Quaternary stratigraphy, palaeoclimate and neotectonism of the Persian (Arabian) Gulf region. Marine Geology, 160, 1–23.

Walmsley, A., Barnes, H., & Macumber, P. 2010. Al-Zubārah and its hinterland, north Qatar: excavations and survey, spring 2009. *Proceedings of the Seminar for Arabian Studies* 40: p.55–68.

Figures

Figure 1.1: Pearl oysters at Ras Ushayriq

Figure 1.2: Old Pier and the coral beach, 11 March, 2012. Al Zubarah.

Figure 1.3: The blue swimming crab (*Portunus pelagicus*).

Figure 1.4: Skulls from Green turtle (*Chelonia mydas*) and skull from dugong (*Dygon dugon*) found on the beach.

Figure 1.5: Düvel Rock. Collecting barnacles on the cement piles and on the Hawksbill, 12 March, 2012, North of Qatar.

Figure 1.6: The Canal of Al Zubarah and the carbonate sediment dug out from it.

2. THE SEAGRASSES OF AL ZUBARAH

Gitte Petersen and Ole Seberg (Natural History Museum of Denmark, gittep@snm.ku.dk and oles@snm.ku.dk)

2.1 INTRODUCTION

Worldwide only some 60 species of flowering plants, collectively named the seagrasses, have reinvaded the marine environment, occuring along the coastline, on reef tops and in estuaries. They all belong to the same order of monocotyledons, the *Alismatales*, a group which also including many well-known fresh water plants. The seagrasses belong to five different families, which do not form a monophyletic group. Thus, the ability to tolerate the harsh salinity of the ocean has evolved more than once.

Seagrasses usually form beds of vegetation in coastal, shallow watered areas, where they have an immense ecological importance. They provide the habitat and breeding ground for fish and shellfish and serve as feeding grounds for marine mammals and turtles. Thus, in the Arabian Gulf the presence of seagrasses is essential to the populations of green sea turtles (*Chelonia mydas*) and to the endangered dugong (*Dugong dugon*). Seagrasses are also important for stabilizing the ocean bottom, which would otherwise be vulnerable to intense wave action from currents and storms. Additionally, seagrasses trap the finer sediments and thereby filter the water increasing its clarity and filters nutrients that are washed out to sea and might otherwise be a treat to sensitive habitats such as coral reefs.

2.2 SEAGRASSES OF THE ARABIAN GULF

Compared to the Arabian Sea, the seagrass communities of the Gulf are species poor – probably due to high salinity of the waters within the Gulf area. But a very high temperature variation (from 10°C to 39°C) may be another limiting factor for some species. Oil-related pollution has so far not been recorded as having negative effects on seagrass populations in the Gulf. Thus, dredging and land reclamation seem the major threat to seagrasses in the Gulf.

In the Arabian Gulf, the seagrass communities are composed of three species: *Halophila ovalis*, *Halophila stipulacea* (both Hydrocharitaceae), and *Halodule uninervis* (Cymodoceaceae). The two former, *Halophila ovalis* and *Halodule uninervis*, are both rather common and widely distributed along the coastline from East Africa to the Pacific. *Halophila stipulacea* on the other hand has a more restricted distribution along the coast line of East Africa, the Arabian Peninsula, the eastern Mediterranean, and isolated occurrence along the coast of Southeast India.

2.3 AL ZUBARAH

Along the coast of Al Zubarah all three species have been recorded and collected, though species delimitation in *Halophila* is uncertain. The collected material include DNA samples, which are useful both for studies of phylogenetic relationships of the seagrasses and other Alismatales and for the purpose of DNA barcoding seagrasses worldwide. The latter will enable rapid identification of all seagrass species even for non-specialists.

Figure 2.1: *Halophila stipulacea* (with broad leaves) mixed with *Halodule uninervis* (with narrow leaves). Near Ras Ushayriq, immediately south of Al Zubarah

Figure 2.2: *Halodule uninervis*. Near Ras Ushayriq, immediately south of Al Zubarah

3. THE MARINE TARDIGRADES AT AL ZUBARAH

Reinhardt Møbjerg Kristensen[1], Dennis K. Persson[1,2], Nadja Møbjerg[2] & Aslak Jørgensen[3]. ([1]Invertebrate Department, The Natural History Museum of Denmark, University of Copenhagen, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark, rmkristensen@snm.ku.dk, dpersson@snm.ku.dk. [2]Department of Biology, August Krogh Centre, University of Copenhagen, Universitetsparken 13, DK-2100 Copenhagen Ø, Denmark, nmobjerg@bio.ku.dk. *[3]Laboratory of Molecular Systematics, The Natural History Museum of Denmark, University of Copenhagen, Sølvgade 83, DK-1307 Copenhagen K, Denmark, aslak@snm.ku.dk).*

3.1 INTRODUCTION

The microscopic water bears (Tardigrada) have a global distribution with terrestrial and limnic species primarily inhabiting mosses and lichens, whereas marine species inhabit various sediments. Only about 1100 tardigrade species have been described (Guidetti & Bertolani 2005, Degma et al. 2010); however, it is expected that many more yet undescribed species exist. These small animals are well-known for their ability to survive large fluctuations in abiotic environmental conditions (Møbjerg et al. 2011). As a response to environmental stress some tardigrades enter cryptobiosis; a state in which metabolism is reversibly switched off. Some of these tardigrades found within the marine genus *Echiniscoides*, live on barnacles, mussels and polychaete tubes in the intertidal zone throughout the world. *Echiniscoides* could be among the toughest animals on this planet; however, detailed information on their tolerance to environmental extremes is lacking. The four species of *Echiniscoides* in Al Zubarah represent the highest diversity reported from any locality (Kristensen & Hallas 1980, Hallas & Kristensen 1982, Miller & Kristensen 1999). The high diversity may reflect that this investigation comprised three different substrates in Al Zubarah, whereas most other published investigations of *Echiniscoides* usually have focused solely on barnacles.

Detailed information is also lacking regarding the biodiversity of marine tardigrades. Currently only app. 150 species of marine tardigrades have been described (Degma et al. 2010; Guidetti & Bertolani; Hansen 2011). However, many species and genera new to science await description in various museum collections particularly at the Natural History Museum of Denmark (SNM). The major reasons for this lack in detailed information on biodiversity are that the marine tardigrades are small, relatively rare, difficult to extract from sediment samples and they require expert knowledge to identify to species (Jørgensen et al. 2010).

The ARAMCO Northern Area Intertidal Sampling Program in 1982 included 22 sediment samples collected in the Arabian Gulf of Saudi Arabia. These samples revealed a rich tardigrade fauna. In total, 12 species of heterotardigrades were found from four intertidal sediment localities containing three new interstitial species of Arthrotardigrada. The three new species comprise two species of *Megastygarctides* (Hansen & Kristensen 2006) and one species of *Pseudostygarctus* (Hansen et al. in press).

Our preliminary investigations at Al Zubarah have revealed four species of tardigrades new to science. However, every identified species from Qatar will be a new record from the

country and add to the growing knowledge of the biodiversity of Qatar. Once the biodiversity of the marine tardigrade fauna has been determined it will be possible to make comparisons to the fauna of Saudi Arabia (Hansen & Kristensen 2006, Hansen et al. in press), the Mediterranean Sea (Accogli et al. 2011, D'Addabbo Gallo et al. 1987,2000, 2001, Grimaldi de Zio et al. 1998), and the Faroe Bank, North Atlantic Ocean (Hansen et al. 2001). Only a few localities have been thoroughly investigated with regard to the biodiversity of marine tardigrades. Of these the faunae of the Mediterranean Sea and the Faroe Bank (North Atlantic Ocean) are the best known. Hence a thorough investigation of the marine tardigrade fauna of Qatar will greatly increase the current knowledge regarding marine tardigrade faunae. The new investigation in Qatar should focus on the following 3 questions:

How many marine tardigrade species live in Qatar?

Description of the marine tardigrade species new to science from Qatar.

Is the marine tardigrade fauna of Qatar similar to faunae known from other places in the world, especially Saudi Arabia?

3.2 Material and Methods

A transect of sediment samplings was set up at the Old Pier at Al Zubarah (Figure 3.1) and samples were collected at Coral Head and Düvel Rock using a mini van Veen grab handled by SCUBA divers. The sediment samples were freshwater shocked at the camp in Al Zubarah and plankton nets (30-60 µm) were used to collect the animals from the samples. Large clumps of annelid tubes (figure 3.3), byssi of mussels (Figure 3.2) and several species of barnacles were collected and sun-dried in coffee-filters. Later on, these samples were freshwater shocked to extract the marine tardigrades from the samples. Good stereo- and compound microscopes were needed for sorting of the sediment samples and identification/description of species. Finally, two species of *Echiniscoides* were critical point dried, transferred to aluminum stubs, coated with palladium and examined using a JEOL JSM-6335-F scanning electron microscope.

A trained and skillful scientific illustrator is still needed for preparing illustrations of the marine tardigrade species new to science.

3.3 Results

Currently 11 species of marine Heterotardigrada have been sorted out of the samples from Qatar. These species are:

1). *Pseudostygarctus* nov. sp. (Old Pier, Polychaete tubes of *Pomatoleios kraussii*)

2). *Batillipes similis* (Old Pier, coral sand mixed with sea grasses from 2 meter water depth)

3). *Batillipes pennaki* (Old Pier, coral sand, low tide)

4). *Halechiniscus* nov. sp. (Coral Head)

5). *Wingstrandarctus* sp. (Coral Head)

6). *Florarctus* sp. 1. (Old Pier, 2 meter water depth)

7). *Florarctus* sp. 2. (Düvel Rock, 1 meter water depth)

8). *Echiniscoides sigismundi* cfr. (Barnacles, Ras Ushayriq, high tide)

9). *Echiniscoides* nov. sp. 1 (Old Pier, Polychaete tubes of *Pomatoleios kraussii*)

10). *Echiniscoides* nov. sp. 2 (Beach Rock of Al Zubarah, from the mussel *Brachidontes variabilis*, Mytilidae)

11). *Echiniscoides* nov. sp. 3 (Beach Rock of Al Zubarah, from the mussel *Brachidontes variabilis*, Mytilidae).

3.3.1 **Taxonomic account**

Order: Arthrotardigrada

Diagnosis: With a median cirrus located on the head.

Family Stygarctidae Schulz, 1951

Genus *Pseudostygarctus* McKirdy, Schmidt & McGinty-Bayly, 1976

Diagnosis: Marine tardigrades always with plates. Stygarctidae with dorsal cuticle thickened to form semicircular head plate, three body plates and two intersegmental plates. A caudal plate devoid the spike-like processes. Cephalic appendages complete; however, the secondary clavae modified as semi-globular structures; cirrus E attached to the body by means of a "ball and socket"-type articulation. Each leg terminated by two or three claws. The seminal receptacles with internal cuticular bars and external cuticular pockets containing spermatozoa.

Type species: *Pseudostygarctus triungulatus* McKirdy, Schmidt & McGinty-Bayly, 1976 from Galapagos Islands.

Pseudostygarctus nov. sp. from Al Zubarah, Qatar.

Diagnosis: A medium sized *Pseudostygarctus* with two beautiful crown-shaped intersegmental plates. The lateral processes of the three segmental plates only with weakly developed sheets. A single clover-shaped ventral plate between the head and the first trunk segment. The four pairs of strongly telescopic legs with three claws on each tarsus. The bucco-pharyngeal apparatus with very long stylets, the placoides in the pharyngeal bulb with so-called internal stylet supports. True stylet supports are lacking.

Type material: Holotype, an adult female and 3 paratypes (all females) collected inside the polychaete tubes (*Pomatoleios kraussii*), the 11.of March, 2012 at the Old Pier, Al Zubarah, Qatar (25°58.347' N and 51°01.121' E). The polychaete tubes were strongly adhered to the stones of the pier at high tide level. Temperature: 18.3° C. Salinity: 55‰.

Description: The holotypic female (Figures 3.4A and 3.4B) is 165.2 µm long from the anterior margin of the head to the base of the caudal plate. The dorsal cuticle forms seven plates: the semi-circular head plate, three body plates each with a pair of flexible spine-like appendages, the caudal plate with the cirrus E, and the two crown-shaped intersegmental plates (Figure 3.4A). The head plate is semi-circular and with four deep indentions, dividing the head into five lobes. A complete set of well-developed cephalic sense organs is present on the head. Primary clava and lateral cirrus are inserted separately. The primary clava is club-shaped, and the secondary clava is semi-globular and inserted ventrally. All the cephalic cirri consist of well-developed cirrophore, a long scapus and shorter flagellum. The cirrus E on the caudal plate is inserted at a small lateral process and has the so-called "ball and socket" articulation – only found in *Pseudostygarctus*. The sense organ on the fourth leg is a pedunculate papilla without spine. No sense organs are present on the first three pairs of legs. There are three claws on each leg and each claw has a very tiny spur. All three claws originate from small pedestals insetting on the tarsus.

The ventral mouth cone consists of a basal part and three telescopic segments. The sclerified/carbonated structures of the bucco-phangyngeal apparatus are for the first time observed in the genus *Pseudostygarctus.* The stylets are very long (49 µm) with small furcae. The buccal canal (47 µm) is carbonated all the way down to the placoids in the pharyngeal bulb. The placoids in the bulb have a very large anterior extension – called the internal stylet support. These three structures terminate in a ball-shaped structure, where the furcae of the two stylets may articulate. The true stylet supports are lacking. The small pharyngeal bulb (11 µm) is nearly filled up with three placoids and from the bulb a short oesophagus leads to the white diverticulated mid-gut.

The reproductive system of the holotype consists of a single ovary with one very large and several small oocytes. The gonopore system consists of six rosette cells and very complex seminal receptacles. The ventral spheroid vesicles with looped ducts open close to the rosette-formed gonopore. Two internal bars are present at the openings of the seminal receptacles, and two external cuticlar pockets with spermatozoa overlap the female gonopore. The anus is sub-terminal and is closed by a three-lobed cuticular system.

Remarks: Based on these morphological data, the new species of *Pseudostygarctus* from Qatar is very closely related to the type species of the genus *Pseudostygarctus triungulatus* from the Galapagos Islands (McKirdy et al. 1976), and not to the new species *Pseudostygarctus galloae* currently under publication from sandy sediments in Saudi Arabia (Hansen et al. in press). The only other stygarctid from polychate tubes is *Mesostygarctus spiralis* from Sidney, Australia; however, this may be due to the fact that this habitat has not been investigated for tardigrades before.

Family Batillipedidae Ramazzotti, 1962

Type genus: *Batillipes* Richters, 1909

Diagnosis: Marine tardigrades without dorsal or ventral plates. Legs with 6 toes of equal or differing lengths. Each toe expanding distally into a sucking or adhesive round or shovel-shape disk. Claws are never present. Sense organs on all legs. Cirrus E always present. Complete set of cephalic sensory organs; however, the secondary clavae may be indistinct or only slightly dome-shaped. Cuticular seminal receptacles always lacking.

Type species: *Batillipes mirus* Richters, 1909

Two species of *Batillipes* were found at the Old Pier, Al Zubarah; *Batillipes pennaki* Marcus, 1946 tidal in coral sand and *Batillipes similis* Schulz, 1955 subtidal in coral with roots of sea grass.

Family Halechiniscidae Ramazzotti, 1962

Type genus: *Halechiniscus* Richters, 1908

Diagnosis: Marine tardigrades without dorsal plates. Telescopic legs with 4 toes in adults, 2 toes in larvae. Claws simple without spurs. Sense organs on all legs. Two cuticular seminal receptacles always present.

Only one specimen of *Halechiniscus* was found at Coral Head in the coral sand. The specimen may be a new species.

Genus: *Florarctus* Delamare-Deboutteville & Renaud-Mornant, 1965

Diagnosis: Marine tardigrades with large wing-shaped rostral, lateral and caudal expansions (alae) with procuticular support (caestus). In adults the two external toes are shorter than the two internal ones. The external toe has a hook-shaped cuticular structure (peduncle) inside the base, and the claw ending with an articulate portion (avicularia). The two cuticular seminal receptacles have an S-shaped duct.

Two species of *Florarctus* were found in the Qatar-investigation. One subtidal at Old Pier and another at Düvel Rock. None of the species have been classified.

Genus: *Wingstrandarctus* Kristensen, 1984

Diagnosis: Marine tardigrades with wing-shaped expansions without procuticular support. Symbiotic bacteria in cephalic vesicles. The avicularia on the external claws only a small notch.

A species (one specimen) similar to *Wingstrandarctus intermedius* (Renaud-Mornant, 1967) was found in coral sand at Coral Head.

Order: Echiniscoidea

Diagnosis: Without a median cirrus on the head.

Family: Echiniscoididae Kristensen & Hallas, 1980

Type genus: *Echiniscoides* Plate, 1889

Diagnosis: Trunk without dorsal plates. Legs without toes and not telescopic. Claws from 5 to 13 on each leg. Most species are found intertidal on algae, barnacles or other marine invertebrates. A few species are found in subtidal sediments.

Four species of *Echiniscoides* were found inside the buffer zone. Three of them are new to science. One of the species look very similar to the nominate *Echiniscoides sigismundi sigismundi.* All four species were found on invertebrates.

Echiniscoides sigismundi sigimundi cfr. Found on barnacles, Ras Ushayriq, Qatar at high tide (Figure 3.5A). Dorsal cuticle smooth. 7-9 claws on each leg.

Echiniscoides nov. sp. 1. Found inside polychaete tubes of *Pomatoleios kraussii* at Old Pier, Al Zubarah, Qatar. High tide. Dorsal cuticle with a fine dorsal sculpture. 7-10 claws on each leg.

Echiniscoides nov. sp. 2. Beach Rock (Q4) of Al Zubarah, Qatar. From the mussel *Brachidontes variabilis*, (Mytilidae) (Figure 3.2A). Dorsal cuticle with mammalate dorsal sculpture. 7-8 claws on each leg.

Echiniscoides nov. sp. 3. Beach Rock of Al Zubarah, Qatar from the mussel *Brachidontes variabilis*, (Mytilidae) (Figures 3.5B and 3.6B-3.6D). High tide. Strongly sculptured dorsal cuticle with small plate-like areas. Head very aberrant with large secondary clavae (looks like a toad). Surprisng this species has some similarities with *Echiniscoides horningi* from Macquarie Island, Subantarctica (Miller & Kristensen1999)

3.4 FINDINGS WITHIN THE BUFFER ZONE

The preliminary "taxonomic account" presented above shows a rich intertidal tardigrade fauna with many heterotardigrade species; several species new to science. This zoogeographical finding is surprising, as the Arabian Gulf is very young – not more than 15,000 years old (Glennie 1998; Sheppard et al. 2010; Uchupi et al. 1999). Some of the species identifications are still tentative as only a single specimen was found. Furthermore, the use of DNA sequences could help clarify the identification of some specimens of *Echiniscoides* that differ slightly from closely related species, i.e. are they genetically different (another species) or are they genetically identical (same species with another phenotype).

3.5 CONCLUSIONS AND RECOMMENDATIONS

Several aspects of the tardigrade fauna at Al Zubarah deserve further investigation and this report is only preliminary. Especially the sediment samples are still not sorted out and these samples might reveal further new species if thoroughly investigated. A number of identifications (e.g. four species of *Echiniscoides*) should be validated by the use of molecular methods to investigate if the morphological variation is reflected in the DNA (Kristensen & Hallas 1980, Hallas & Kristensen 1982, Faurby et al. 2011, 2012). The relationship between various *Echiniscoides* species could be investigated through

phylogenetic analysis of the fast evolving gene cytochrome c oxidase subunit I (COI). This gene has been suggested as a universal DNA barcode for numerous groups of animals and has recently been used to illustrate a very large genetic differentiation within *Echiniscoides* (Faurby et al. 2012).

Furthermore the mangrove habitats within the UNESCO Buffer Zone should be more thoroughly investigated for the class Eutardigrada. Eutardigrades may be found on the trunk of the trees. Not a single eutardigrade was found in the current investigation.

References

Accogli, G., Gallo, M., D'addabbo, R. & Hansen, J. G. 2011. Diversity and ecology of the marine tardigrades along the Apulian Coast. *Journal of Zoological Systematic Research* 49(Suppl. 1): p.53–57.

Degma, P., Bertolani, R. & Guidetti, R. 2010. Actual checklist of Tardigrada species (2009-2012, Ver. 21: 30-06-2012).

Faurby, S., Jørgensen, A., Kristensen, R. M. & Funch, P. 2011. Phylogeography of North Atlantic intertidal tardigrades: refugia, cryptic speciation and the history of the Mid-Atlantic Islands. *Journal of Biogeography* 38(8): p.1613–1624.

Faurby, S., Jørgensen, A., Kristensen, R. M. & Funch, P. 2012. Distribution and speciation in marine intertidal tardigrades: testing the roles of climatic and geographical isolation. *Journal of Biogeography* 39(9): p.1596–1607.

Gallo D'Addabbo M., Morone De Lucia M. R. & Grimaldi de Zio, S. 1987. Heterotardigrada of the Amendolara Shoal, high Ionian Sea. In: Bertolani R (ed.), Biology of Tardigrades. Selected Symposia and Monographs UZI I Mucchi, Modena, Italy, pp 103–110.

Gallo D'Addabbo, M., S. de Zio Grimaldi & R. D'Addabbo, R. 2000. *Pseudostygarctus apuliae* (Tardigrada, Heterotardigrada): a new species from the lower Adriatic Sea. *Italian Journal of Zoology* 67: p.125–128.

Gallo D'Addabbo, M., S. de Zio Grimaldi & Sandulli, R. 2001. Heterotardigrada of two submarine caves in S. Domino Island (Tremiti Islands) in the Mediterranean Sea. *Zoologischer Anzeiger* 240: p.361–369.

Glennie, K.W. 1998. The desert of southeast Arabia: A product of Quaternary climate change. In Alsharhan, A.S., Glennie, K.W., Whittle, G.L., Kendall, C. St.G., (Eds.) Quaternary Deserts and Climatic Change. (pp. 279-291). A. A. Balkema, Rotterdam.

Grimaldi de Zio, S., M. D'Addabbo Gallo & Morone De Lucia, M. R. 1998. A new Stygarctidae from South Tyrrhenian Sea (Tardigrada, Heterotardigrada). *Cahiers de Biologie Marine* 39: p.85–91.

Guidetti, R. & Bertolani, R. 2005. Tardigrade taxonomy: an updated checklist of the taxa and a list of characters for their identification. *Zootaxa* 845: p.1–46.

Hallas, T. E. & Kristensen, R. M. 1982. Two new species of the tidal genus *Echiniscoides* from Rhode Island, U.S.A. (Echiniscoididae, Heterotardigrada). *Proc. Third Intern. Symp. Tardigrada*, Aug. 3-6, Johnson City, Tennessee, U.S.A., ETSU Press: 179–192.

Hansen, J. G., Jørgensen A. & Kristensen R. M. 2001. Preliminary studies of the tardigrade fauna of the Faroe Bank. Zool Anz 240: p.385–393I.

Hansen, J. G. & Kristensen, R. M. 2006. The ”hyena female” of tardigrades and descriptions of two new species of *Megastygarctides* (Arthrotardigrada: Stygarctidae) from Saudi Arabia. *Hydrobiologia* 558: p.81–101.

Hansen J. G. 2011. The phylogeny of Arthrotardigrada. Unpublished PhD thesis, University of Copenhagen.

Hansen, J.G., Kristensen, R.M. & Jørgensen, A. in press. The armoured marine tardigrades (Arthrotardigrada, Tardigrada). *Scientia Danica, Series B, Biologica, Vol. ?* The Royal Danish Academy of Sciences and Letters.

Hiruta, S. 1985. A new species of marine interstitial Tardigrada of the genus *Stygarctus* Schulz from Hokkaido, Japan. *Special Publication of the Mukaishima Marine Biological Station* 245: p.127–129.

Jørgensen, A., Faurby, S., Hansen, J.G., Møbjerg, N. & Kristensen, R.M. 2010. Molecular phylogeny of Arthrotardigrada (Tardigrada). *Molecular Phylogenetics and Evolution* 54: p.1006–1015.

Kristensen, R. M. & Hallas, T. E. 1980. The tidal genus *Echiniscoides* and its variability with erection of Echiniscoididae fam.n. (Tardigrada). *Zoologica Scripta* 9: p.113–127.

McKirdy, D., Schmidt, P. & McGinty-Bayly, M. 1976. Interstitielle fauna von Galapagos XVI. Tardigrada. Mikrofauna des Meeresbodens 58: 410-449.

Miller, W. R. & Kristensen, R. M. 1999. Tardigrades of the Australian Antarctic: A new species of the marine genus Echiniscoides from Macquarie Island, Subantarctica. In H. Greven (ed.), Proceedings of the seventh international symposium on the Tardigrada, August 1997, Düsseldorf, Germany. *Zoologischer Anzeiger* 238: p.289–294.

Møbjerg, N., Halberg, K. A., Jørgensen, A., Persson, D., Bjørn, M., Ramløv, H. & Kristensen, R. M. 2011. Survival in extreme environments – on the current knowledge of adaptations in tardigrades. *Acta Physiologica* 202(3): p.409–420.

Sheppard, C., Al-Husiani, M., Al-Jamali, F., Al-Yamani, F., Baldwin, R., Bishop, J., Benzoni, F., Dutrieux, E., Dulvy, N. K., Durvasula, S. R. V., Jones, D. A., Loughland, R., Medio, D., Nithyanandan, M., Pilling, G. M., Polikarpov, I., Price, A. R. G., Purkis, S., Riegl, B., Saburova, M., Namin, K. S., Taylor, O., Wilson, S., Zadinal, K. 2010. The Gulf: A young sea in decline. *Marine Pollution Bulletin* 60: p.13–38.

Uchupi, E., S.A. Swift & Ross, D. A. 1999. Late Quaternary stratigraphy, palaeoclimate and neotectonism of the Persian (Arabian) Gulf region. *Marine Geology* 160: p.1–23.

Figures

Figure 3.1: The "Old Pier" at Al Zubarah, Qatar provides easy access to the different substrates in the tidal zone, in particular the coral sand with many species of tardigrades.

Figure 3.2: A) *Brachidontes variabilis*, Mytilidae from Al Zubarah, Qatar. B) Close-up of the byssi threads, a good place to find tardigrades.

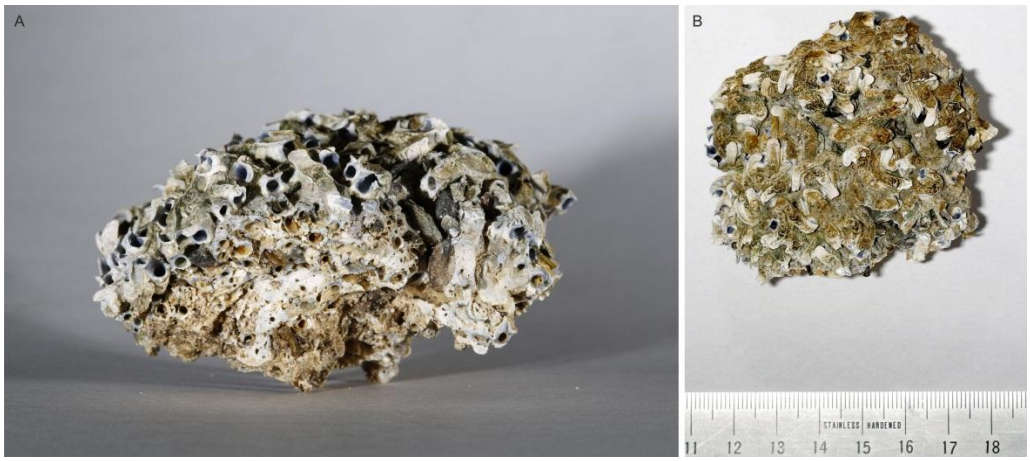


Figure 3.3: A) Polychaete tubes of *Pomatoleios kraussii* from Old Pier, Al Zubarah, Qatar. B) The average size of these habitat-structures. Several species of tardigrades were found in the polychaete tubes at a salinity of 50‰. This is also the type locality of the new species of *Pseudostygarctus*.

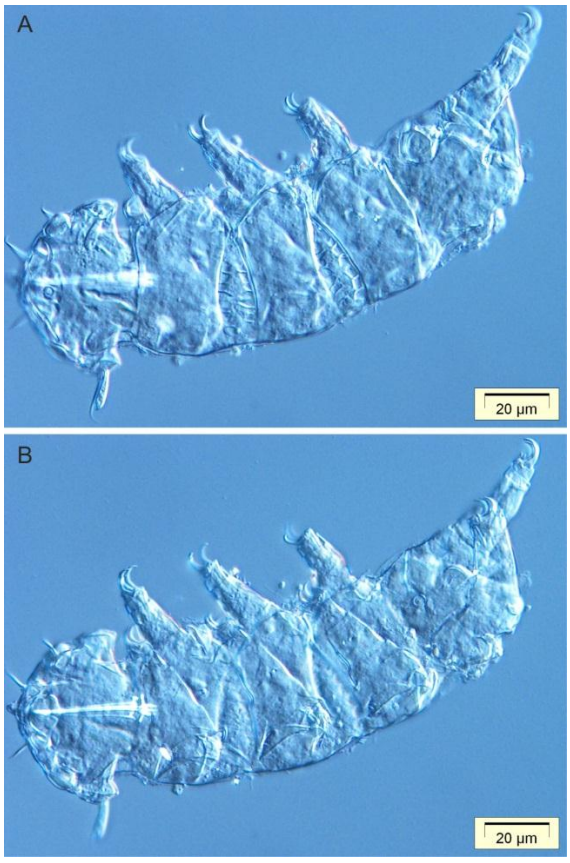


Figure 3.4: A new species of *Pseudostygarctus* with three claws. The species was found inside the polychaete tubes of *Pomatoleios kraussii*. A) Notice the two crown-shaped intersegmental plates. B) Notice the shape of the stylets and placoides.

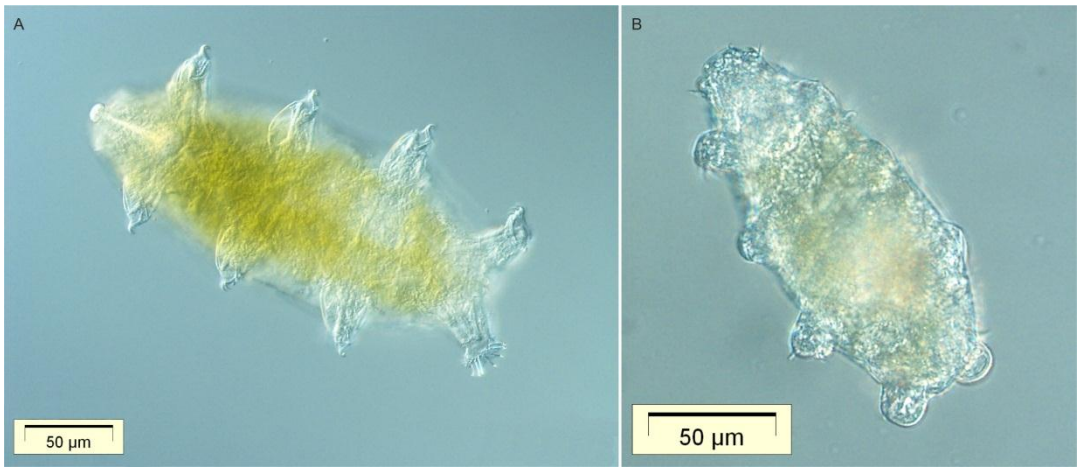


Figure 3.5: Light microscopy of two tardigrade species from Qatar. A) This could possibly be a subspecies of *Echiniscoides sigismundi*. B) *Echiniscoides* nov. sp. 3 from mussels.

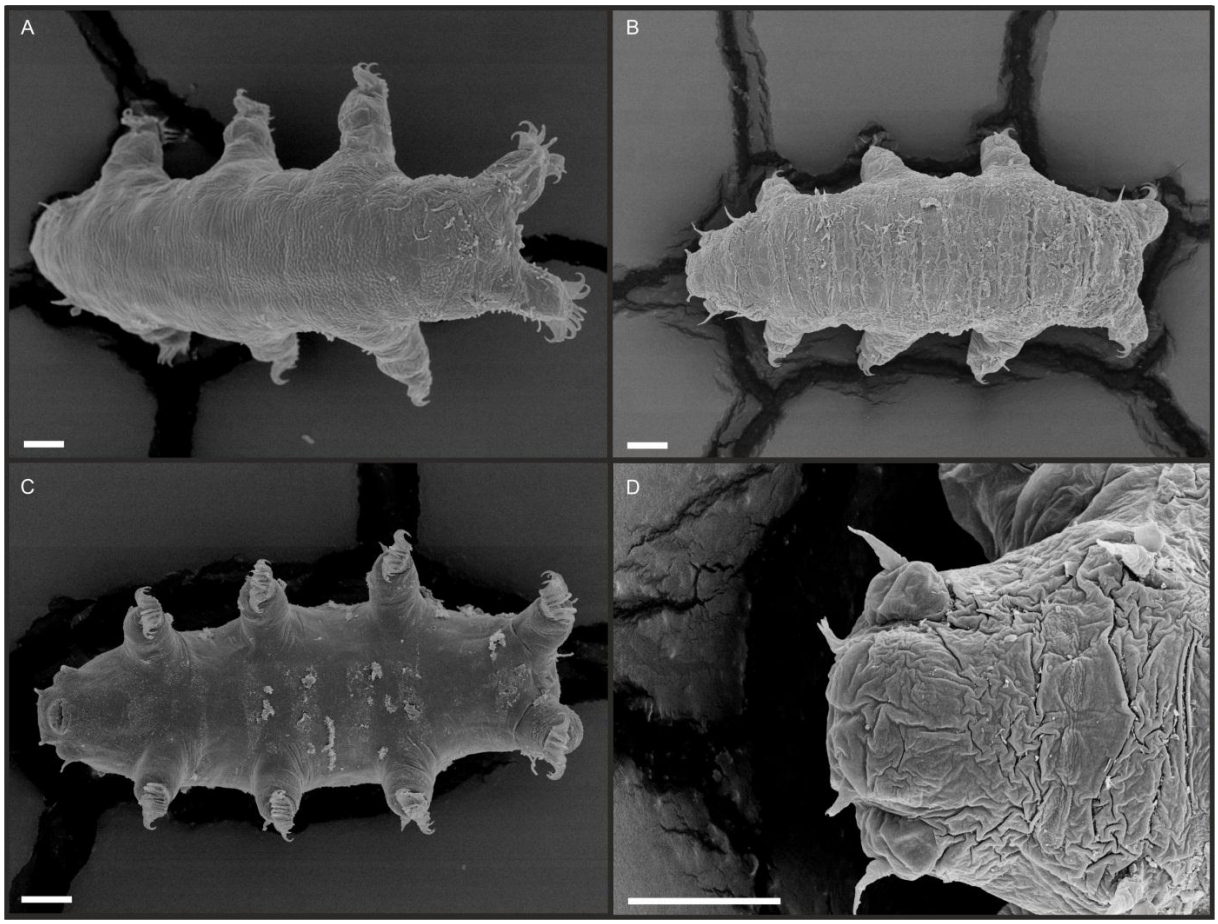


Figure 3.6: A) The dorsal cuticle of the *Echiniscoides* nov. sp. 2. B) The dorsal cuticle of the *Echiniscoides* nov. sp. 3, notice the cuticle differences between A and B. C) Ventral cuticle and claws of *Echiniscoides* nov. sp. 3, notice the shape of the head. D) Close-up of the head of *Echiniscoides* nov. sp. 3. Scale bars = 10 µm.

4. THE RECENT MARINE MOLLUCS AT AL ZUBARAH

Aslak Jørgensen (The Natural History Museum of Denmark, Sølvgade 83, DK-1307 Copenhagen K, Denmark, aslak@snm.ku.dk).

4.1 INTRODUCTION

The molluscs are an important marine faunal component within the Al Zubarah buffer zone both with regard to the current marine biodiversity and the socioeconomic impact of the pearl fishing trade on Al Zubarah. Many of the mollusc classes are present within the buffer zone with representatives of Gastropoda (snails), Bivalvia (bivalves), Cephalopoda (squids), Polyplacophora (chitons) and Scaphopoda (tusk shells). Of these the fisheries of *Pinctada* (pearl oyster) and *Sepia* (squid) have an economic impact on the Arabian Gulf communities.

Several studies have focused on the Qatari marine molluscan fauna resulting in the reported occurrence of 129 species of gastropods, 2 cephalopods, 5 scaphopods, 144 bivalves and 6 polyplacophorans (Al-Ansi & Al-Khayat, 1999; Al-Khayat, 1997; Al-Khayat, 2007; Al-Khayat, 2008; Al-Khayat & Al-Ansi (2008), Al-Khayat & Al-Khayat, 2000; Al-Khayat & Jones, 1999; Mohammed & Al-Khayat, 1994). Furthermore, five species of recently introduced terrestrial gastropods have been reported (Al-Khayat, 2010).

4.2 FINDINGS WITHIN THE BUFFER ZONE

The preliminary species list presented below show a rich intertidal fauna with many gastropod species and a relatively poor bivalve fauna due to the lack of extensive soft bottom (mud) habitats within the buffer zone. Many of the species identifications are tentative as a good reference collection illustrating the conchological variation is still not established. Furthermore, the use of DNA sequences could help clarify the identification of some specimens that differs slightly from closely related species, i.e. are they genetically different (another species) or are the genetically identical (same species with another phenotype).

Species list

Gastropoda
Vetigastropoda
Chilodontidae
Euchelus asper

Fissurellidae
Diodora sp.

Phasianellidae
Phasianella solida

Trochidae
Osilinus kotschyi
Priotrochus obscurus
Osilinus kotschyi/Priotrochus obscurus-like but with fine, more subtle nodules.
Trochus cf. *scabrosus* (three teeth in aperture).
Trochus sp. (very triangular appearance; 1 cm; *T. erithreus* or *T. radiatus*?).

Turbinidae
Lunella coronata

Mesogastropoda
Cerithiidae
Cerithium caeruleum
Cerithium rueppelli
Clypeomorus bifasciatus persicus

Littorinidae
Echinolittorina arabica
Nodilittorina cf. *millegrana* ("very" large 10+ mm)
Littorina sp. (smooth shells)
Peasiella isseli

Planaxidae
Planaxis sulcatus

Potamididae
Cerithidea cingulata
Potamides conicus

Neogastropoda
Columbellidae
Mitrella blanda

Muricidae
Thais savignyi
Thais cf. *tissoti*

Nassariidae
Nassarius fissilabris
Nassarius cf. *stolatus*

Nudibranchia
Chromodorididae
Goniobranchus obsoletus

Panpulmonata
Siphonariidae
Siphonaria belcheri

Ellobiidae
Allochroa bronnii
Laemodonta monilifera
Laemodonta rapax
Melampus sp.
Pedipes sp.

Cephalopoda
Sepiidae
Sepia sp.
Remarks: The specimens closely resemble *S. pharaonis*; however *S. pharaonis* has a split anterior spine on the internal shell according to Bosch *et al.*, (1995) and the collected specimens have an internal shell with a single unsplit anterior spine. Anderson *et al.*, (2007) suggest that "*S. pharaonis*" is a cryptic species complex consisting of at least five species within its geographical range.

Scaphopoda
Laevidentaliidae
Only dead shells of *Laevidentalium longitrosum*.

Bivalvia
Arcidae
Barbatia setigera

Chamidae
Chama sp.

Glycymerididae
Glycymeris pectunculus

Mytilidae
Brachidontes variabilis
Mytilidae sp. on Pier (perhaps *Brachidontes variabilis* with frayed shell edges).

Malleidae
Malvufundus sp. (juvenile specimens).

Pinnidae
Pinna muricata (or *Pinna bicolor*)

Pteriidae
Pinctada radiata

Polyplacophora
Chitonidae
Chiton sp.

4.3 CONCLUSIONS AND RECOMMENDATIONS

Several aspects of the molluscan fauna at Al Zubarah deserve further investigation. Especially the nudibranchs, ellobiids and the polyplacophorans might reveal further species if thoroughly sampled. A number of identifications should be validated by the use of molecular methods to investigate if the morphological variation is reflected in the DNA. Furthermore, the mangrove habitats within the UNESCO Buffer Zone should be more thoroughly investigated as minute species of assiminid gastropods have been reported from mangroves in the United Arab Emirates (Feulner & Hornby, 2006). Finally, a more thorough sampling effort in the few and small subtidal mud habitats present within the buffer zone and more extensive digging into the tidal mud flats will most likely increase the currently recorded number of bivalves.

The findings of the 2012 field work have been summarized in the table below.

Molluscan class	**Number of families**	**Number of species**
Gastropoda	15	31
Cephalopoda	1	1
Scaphopoda	1	1 (only dead shells)
Bivalvia	7	7
Polyplacopora	1	1
Total	25	40

References

Al-Ansi, M.A., & Al-Khayat, J.A. 1999. A preliminary study of coral reef and its associated biota in the Qatari waters, Arabian Gulf. *Qatar University Science Bulletin* 19: p.294–311.

Al-Khayat, J.A. 1997. The marine mollusc of the Qatari waters, Arabian Gulf. *Qatar University Science Bulletin* 17: p.479–491.

Al-Khayat, J.A. 2007. Macrofauna abundance in seagrass of Qatari Water, Arabian Gulf. *Egyptian Journal of Aquatic Research* 33: p.257–276.

Al-Khayat, J.A. 2008. Molluscs of the State of Qatar. Qatar Biodiversity Newsletter 2: p.1–5.

Al-Khayat, J.A. 2010. First record of five terrestrial snails in the State of Qatar. *Turkish Journal of Zoology* 34: p.539–545.

Al-Khayat, J.A., & Al-Ansi, M.A. 2008. Ecological features of oyster beds distribution in Qatari waters, Arabian Gulf. *Asian Journal of Scientific Research* p.1–18. ISSN 1992-1454.

Al-Khayat, J.A., & Al-Khayat, F.A. 2000. Study of macrobenthic invertebrates in the Qatari waters, Arabian Gulf. *Bulletin of the National Institute of Oceanography and Fisheries* 26: p.125–148.

Al-Khayat, J.A., & Jones, D.A. 1999. A comparison of the macrofauna of natural and replanted mangroves in Qatar. *Estuarine, Coastal and Shelf Science* 49: p.55–63.

Anderson, F.E., Valinassab, T., Ho, C.-W., Mohamed, K.S. & Asokan, P.K. 2007. Phylogeography of the Pharaoh Cuttle *Sepia pharaonis* based on partial mitochondrial 16S sequence data. Reviews in Fish Biology and Fisheries 17: p.345–352.

Bosch, D.T., Dance, S.P., Moolenbeek, R.G., & Oliver, P.G. 1995. Seashells of Eastern Arabia, Motivate Publishing, 296 pp.

Feulner, G.R., & Hornby, R.J. 2006. Intertidal molluscs in UAE lagoons. Tribulus 16: p.17–23.

Mohammed, S.Z., & Al-Khayat, J.A. 1994. A preliminary checklist of benthic mollusca on the Qatari coasts, Arabian Gulf. *Qatar University Science Bulletin* 14: p.201–206.

Figures

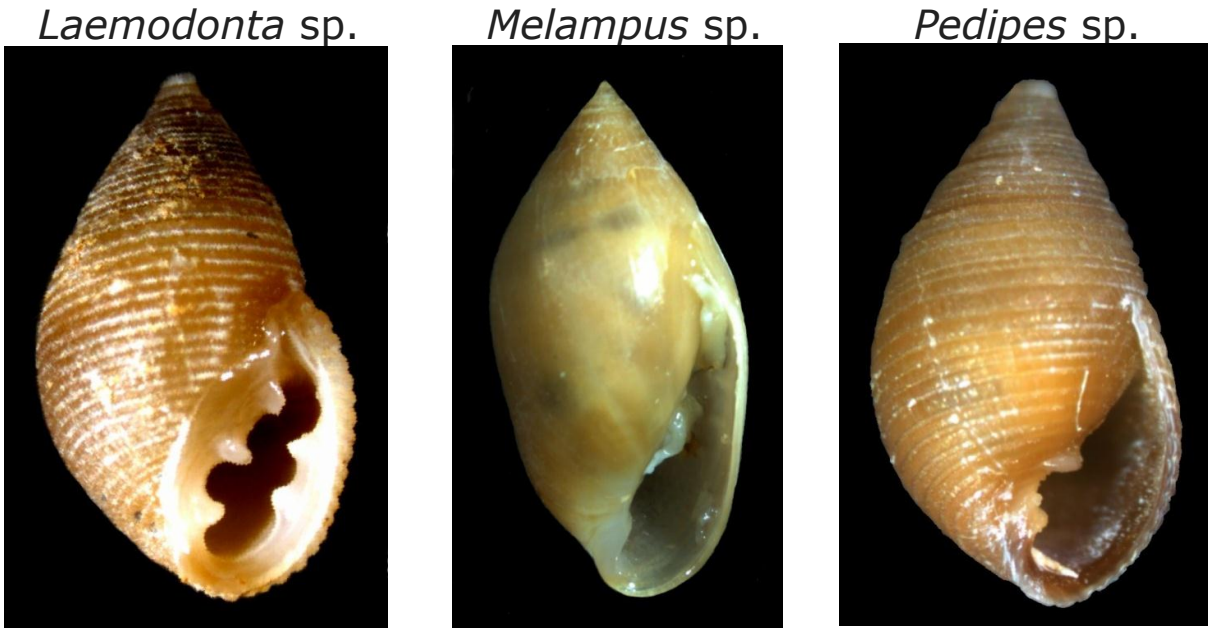


Figure 4.1: Some ellobiid gastropods from the Old Pier at Al Zubarah. The shells are app. 10 mm in height. The ellobiids are a common, albeit often hidden, component of mangrove fauna. The specimens from Al Zubarah were collected by hand picking from rock crevices and washed up sea weed at the Old Pier. They represent new faunal records for the Qatari animal inventory.

5. ENTOMOLOGY

Kenneth P. Puliafico (Entomology Department, Zoological Museum, The Natural History Museum of Denmark, puliafico@gmail.com) Anne Majgaard Jensen (University of Copenhagen. anne-majgaard@hotmail.com).

5.1. INTRODUCTION

Qatar's native terrestrial environment is characterized by desert and semi-desert ecological zones, yet even under these harsh conditions there is a rich diversity of arthropod species to be found. Arthropods; invertebrate animals with legs and an exoskeleton; are the most abundant and diverse animals in terrestrial habitats and make up over 80% of all animals known throughout the world. The native land-living arthropods of Al Zubarah are well adapted to the hot, dry conditions of the Qatari Desert and have several behavioural and physiological adaptations to tolerate extreme temperatures and to prevent water loss. Some of these adaptations also mean that these creatures are not easy to find during the daylight hours when most visitors come to Al Zubarah. Our survey used a variety of different trapping and hunting techniques to find these animals when they are most active, so that we can give a better assessment of the true diversity of this fascinating region.

It has been estimated that over 500 species of the phylum Arthropoda occur in Qatar and the vast majority of these are insects. To date only a preliminary check list of Qatar's insects has been published (Table 1, Abdu & Shaumar 1985). An extensive review of the literature indicated that there are very few scientific publications covering the arthropod fauna of this region (>20 papers mentioning Qatar), and many of these journal articles are primarily ecological studies that focus on a subset of Qatar's insects (e.g. Abushama 1999). As a result the taxonomic literature specific to Qatar are extremely limited and usually only covers a specific group at the family level (e.g. Soldati 2009). Furthermore, most of these taxonomic treatments do not include species identification keys (e.g. Háva & Pierre 2008, Keith & Bordat 2011). This lack of basic taxonomic information for the majority of arthropod groups occurring within the region has made it particularly difficult to put exact names on the animals we collected. Despite these obstacles we found several new taxa in the designated area that have not been previously recorded for the nation of Qatar (Table 5.1).

5.2 METHODS

The area within the Al Zubarah Archaeological Site exclusion and buffer zones can be divided into several local habitat types, including beachfront, sabkha (salt flats), and rocky desert. Our sampling focused mainly on the native habitats outside of those heavily influenced by activities relating to the preservation and restoration of the Fort and old city of Al Zubarah (archaeological sites and the modern camp). In the surrounding natural habitat plant features that are significant for animal life such as the presence of acacia trees (*Acacia ehrenbergiana* and *A. tortillis*), shrubs (e.g. *Alhagi maurorum*, and *Limonium axillare*) and grasslands were a particular focus for collecting. Therefore we recognized the following five natural habitats to direct our sampling: beach, lower sabkha, upper sabkha, acacia trees, and grassy depressions in the rocky desert.

For three weeks in the spring of 2012 (5. – 24. March) we collected terrestrial arthropods within the exclusion and buffer zones of the Al Zubarah Archaeological Site. Using a number of different collecting methods (pitfall traps, yellow pan traps, light traps, and hand collecting) we captured a wide variety of insects and other arthropods within the five local habitat types. Specimens were preserved in propylene glycol or ethanol until their return to the Zoological Museum, University of Copenhagen, Denmark. Specimens were sorted to family and assigned to a morpho-species based on their external morphological characters. Taxonomic experts for particular groups have been contacted for further identification of species whenever possible. A preliminary list of the species and morpho-species identified thus far are shown in the tables below (Tables 5.2, 5.3, and 5.4).

In addition to the general species survey of the entire arthropod fauna we also used standardized sampling protocols to compare the habitats for their diversity and abundance of four major taxonomic groups. Beetles, spiders, ants, bees and wasps (Coleoptera, Arachnida, Formicidae and Hymenoptera, respectively) are commonly used as indicator species in broader ecological studies throughout the world. Three independent trapping sites were placed in each habitat type. Five plastic cups (95mm diameter x 120 mm depth) were placed approximately 5 meters apart, buried so that they were level with the ground and filled with propylene glycol. After 5 days the traps were emptied, specimens were rinsed using ethanol and sorted for identification. For each of these taxonomic groups we counted the number of individuals captured within a series of pitfall traps. To display the results so that comparisons can be made between taxa the count for each habitat type was divided by the total number of specimens collected and presented as a percentage using weighted averages.

The use of standardized pitfall trapping allowed us to compare the five habitat types identified within the Al Zubarah exclusion and buffer zones. Although each animal type had a unique distribution within these habitats we can see an overall pattern which suggests that places with more stable environments tend to have greater arthropod abundance (Figure 5.1). The beach and lower Sabkha, which tend to be extremely unstable environments had the lowest trap catch while the areas with less disturbance had greater abundance and diversity (not shown). Also important was the presence of vegetation resources such as shrubs in the upper sabkha, grasses and herbs within the moist depressions of the rocky desert, or the acacia trees. Plants provide food for herbivores, nectar resources, prey items, increased humidity, shade and shelter. Interestingly the Acacia tree species appear to have lower levels of both spiders and winged Hymenoptera (bees and wasps), but this is most likely because these animals have moved off of the ground and are utilizing the flowers, leaves and branches of the tree. In contrast, the high abundance of ground nesting ants near the trees is probably due to the presence of aphids and other Hemipterans that produce honeydew to feed the ants in exchange for protection from predators. The unique ecological interactions that occur because of these plant resources make the preservation of these habitats essential for maintaining a diverse fauna in the harsh desert landscape.

5.3 Conclusions and Recommendations

These results are a first step to better understanding Qatari fauna, but we are only beginning to get a picture of the complete terrestrial Arthropod community for Qatar. This study should still be considered very preliminary since some major taxonomic groups including Diptera, Hymenoptera, Lepidoptera, Orthoptera and Hemiptera have not been fully examined from

our samples. Several of these taxonomic groups required identification by experts who have not had time to return their results. Therefore we expect the species list to greatly increase as more accurate names are added.

The current study also should be viewed as a snap-shot of the entire community rather than a comprehensive picture of all the insects, spiders and other arthropods that inhabit the Al Zubarah area. Our collecting trip occurred in March before the end of winter temperatures. Since all of the Arthropoda are ectothermic ("cold blooded") most of these animals were not particularly active during this time of year, therefore trap catches were much smaller than what could be expected in other seasons. Warmer temperatures later in the year also allow the new generation of insects to complete their development and emerge as adults. Several species known from the other areas in the eastern Arabian Peninsula have only been collected during the summer and autumn. One study of the insects in Doha showed that there are two peaks of insect abundance, one in April-May and a second much larger peak in September-October (Abushama, 2006). Therefore we recommend later spring and autumn collecting trips be initiated as soon as possible to take advantage of these peaks of insect activity.

Every insect collection has some level of bias, and this study is no exception. Due to the failure of some equipment arriving from an overseas supplier we were not able utilize all the trapping methods originally planned for. As a result many of the collecting methods deployed tended to favor ground dwelling animals such as beetles, ants, spiders, and scorpions. The fact that we did collect so many bees and wasps (Hymenoptera) and flies (Diptera) in the pitfall traps is an indication of the scarcity of vegetative cover and the attractiveness of the white cups used to make these traps. Future workers should utilize the UV light traps, Malaise traps, flight intercept traps and other equipment that will open the door to collecting a wider variety of day and night flying insect species.

Our final recommendation is to encourage the preservation of the habitats that support Qatar's unique plant and animal life. Studies such as our standardized pitfall sampling should be conducted to quantify the species richness and assess the quality of these habitats. Our results suggest that areas that support the deserts sparse plants also encourage wildlife diversity. Features like the shrub covered upper sabkha, acacia trees and the moist grassy depressions of the desert that have traditionally provided fodder for domestic animals also provide important resources for the wild animals of Qatar. Beyond the arthropod community surveyed in our study we also observed the spiny-tailed lizard or dhub (*Uromastyx aegyptia*), several rodents, and a variety of birds utilizing these habitats. The placement of future buildings should avoid disruption of vegetated habitats as much as possible. That would leave room for interpretive pathways which might take advantage of these unique parts of the ecosystem, especially the transition zone between the sabkha and the slightly higher elevations where the rocky desert plants thrive.

References

R.M. Abdu and N.F. Shaumar, 1985. A preliminary list of the insect fauna of Qatar. Qatar *University Science Bulletin.* 5: 215-232.

F.T. Abushama, 1999. Dominance value and community production of desert Arthropoda in Qatar. *Qatar University Science Journal*. 18: 137-153.

F.T. Abushama, 2006. Night and early morning flying insects in a residence backyard in Doha City, Qatar. *Qatar University Science Journal.* 26: 83-90

List of Lepidoptera of Qatar. Wikipedia, accessed 8/24/2012 at 11:32, http://en.wikipedia.org/wiki/List_of_Lepidoptera_of_Qatar

Carabidae Checklist of the Qatar. Carabidae of the World, accessed 8/25/2012 at 14:57, http://carabidae.pro/carabidae/pcid_83.html

J. Háva and E. Pierre, 2008. Contribution to the Family Dermestidae (Coleoptera) from Qatar. *Journal of the Entomological Research Society.* 10(2): 37-41.

D. Keith and P. Bordat, 2011. Sur la faune des Scarabaeoidea du Qatar (Coleoptera). *Nouvelle revue d'entomologie (N.S.)*. 27 (2): 183-189.

L. Soldati, 2009. *Darkling Beetles (Coleoptera: Tenebrionidae) of Qatar*. Natura optima dux Foundation, Warszawa (Poland). pp. 101.

Tables

Table 5.1. Summary of the terrestrial Arthropoda species known from Qatar.

	Class	All Orders	Insecta Orders*	Family	Genera	Species	Date	References
Qatar Checklist	1	15	(15)	63	154	170	1985	1.
Literature review	4	20	(15)	86	208	262	25 Sep. 2012	1., 2., 4., 5. and others
Al Zubarah Morpho-species	5	30	(16)	82	80	171	25 Sep. 2012	current study
New taxonomic records†	1	12	(3)	27	23	3	25 Sep. 2012	current study

*Columns present totals for all Arthropods except for "Insecta Orders" which are a subset of Arthropod Orders.
†Taxa found in this survey not previously reported from the literature for Qatar.

Table 5.2. Minor Arthropod Classes collected from proposed UNESCO Exclusion and Buffer Zone, Al Zubarah, Qatar, in March 2012.

Class	Order	Family	Genus	Species	Author	Date	Morpho-species	New record	References
Malacostraca	Amphipoda			sp.			1	O	
	Isopoda	Oniscidia	*Porcellio*	*evansi*	Omer-Cooper	1923	1?		2.
Chilopoda	Geophilomorpha	Geophilidae		sp.			1	O/F	
	Scalopendramorpha	Scolopendridae	*Scolopendra*	*mirabilis*	Porat	1876	1		2.
Entognatha	Entomobryomorpha			sp.			1	C/O	
	Poduromorpha			sp.			1	C/O	
	Symphypleona			sp.			1	C/O	

The numbers of Morpho-species are distinct specimens types thought to represent undetermined species; a "?" indicates uncertainty at the lowest taxonomic level indicated. New records are indicated for Qatar for taxonomic Class (C), Order (O), and Family (F). Notice that none of these taxa have been previously reported from Al Zubarah.

Table 5.3. Arachnids (Arthropoda: Arachnida) collected from proposed UNESCO Exclusion and Buffer Zone, Al Zubarah Archaeological Site, Qatar, in March 2012.

Class	Order	Family	Genus	Species	Author	Date	Morpho-species	New record	References
Arachnida	Ixodida	Ixodidae		sp.			2		
	Trombidiformes			sp.			1	O	
	Oribatida			sp.			1	O	
	Araneaea	Araneidae		sp.			1	F	
		Clubionidae		sp.			1?	F	
		Gnaphosidae		sp.			1		
		Linyphiidae	*Prinerigone*	cf *vagans*	(Audouin)	1826	1	F/G/S	
		Lycosidae	*Lycosa*	sp.			1 (Fig. 5.2)		2.
		Oonopidae		sp.			1	F	
		Oxyopidae		sp.			1?	F	
		Philodromidae	*Phillodromus*	sp.			2		2.
		Pholcidae	Artema	sp.			1	F/G	
		Salticidae		sp.			1	F	
		Scytodidae		sp.			1	F	
		Sicariidae	*Loxosceles*	sp.			1	F/G	
		Sparasidae		sp.			1	F	
		Tetragnathidae		sp.			1?	F	
		Theridiidae	*Enoplagnatha*	sp.			1	F/G	
		Theridiidae	*Latrodectus*	sp.			1	F/G	
		Zodariidae		sp.			1	F	
	Pseudoscorpiones	Withiidae		sp.			1?	O/F	
	Scorpiones	Buthidae	*Androctonus*	*crassicauda*	(Olivier)	1807	1? (Fig 5.3)		2.
	Scorpiones			sp.			2		
	Solifugae	Daesiidae		sp.			1	O/F	
		Rhagodidae		sp.			1	O/F	

The numbers of Morpho-species are distinct specimens types thought to represent undetermined species; a "?" indicates uncertainty at the lowest taxonomic level indicated. New records are indicated for Qatar for taxonomic Order (O), Family (F), Genus (G) and Species (S). Notice that none of these taxa have been previously reported from Al Zubarah.

Table 5.4. Insects (Arthropoda: Insecta) collected from proposed UNESCO Exclusion and Buffer Zone, Al Zubarah, Qatar, in March 2012.

Order	Family	Subfamily	Genus	Species	Author	Lit. Al Zubarah	Morpho-species	New record	References
Coleoptera	Anobiidae		*Ptilinus*	sp.			1	G	
	Anobiidae			sp.			1		
	Anthicidae		*Anthicus*	sp.			1?	F/G	
	Anthicidae			sp.			4	F	
	Carabidae	Anthiinae	*Anthia*	*duodecimguttata*	Bonelli	x			1., 2., 5.
	Carabidae	Carabinae	*Calosoma*	sp.			1		
	Carabidae	Cicindelinae	*Megacephala*	*euphratica*	(Latreilla & Dejean)		1	G	
	Carabidae	Cicindelinae	*Nebria*	sp.			1	G	
	Carabidae	Trechinae	*Bembidion*	sp.			3?	G	
	Carabidae			sp.			7		
	Cerambycidae		*Apomecyna*	*lameerei*	Pic	x			1.
	Chrysomelidae	Bruchinae		sp.			1	F/SF	
	Chrysomelidae			sp.			1	F	
	Cleridae		*Necrobia*	sp.			2		
	Coccinellidae		*Coccinella*	*undecimpunctata*	Linnaeus	x	1?		1.
	Coccinellidae			sp.			2		
	Cryptophagidae		*Cryptophagus*	sp.			1	F/G	
	Curculionidae		*Tychius*	sp.			1	G	
	Curculionidae			sp.			5		
	Dermestidae	Dermestinae	*Dermestes*	sp.			1		
	Dermestidae			sp.			5		
	Elateridae			sp.			1		
	Endomychidae		*Holoparamecus*	sp.			1	F/G	
	Histeridae		*Saprinus*	sp.			1	F/G	
	Histeridae			sp.			4	F	
	Latridiidae		*Migneauxia*	sp.			1	F/G	
	Ptiliidae		*Acrostrichis*	sp.			1	F/G	
	Ptiliidae		*Actidium*	sp.			1	F/G	
	Scarabaeidae	Aphodiidae	*Aphodius*	sp.			1	G	
	Scarabaeidae	Dynastinae	*Pentodon*	*bispinosus*	Kuster		1?		1.
	Scarabaeidae			sp.			3		
	Staphylinidae	Aleocharinae	*Aleochara*	sp.			1		

	Staphylinidae	Aleocharinae		sp.			1		
Order	**Family**	**Subfamily**	**Genus**	**Species**	**Author**	**Lit. Al Zubarah**	**Morpho-species**	**New record**	**References**
Coleoptera	Staphylinidae	Oxytelinae	*Bledius*	sp.			3	SF/G	
	Staphylinidae	Staphylininae		sp.			3	SF	
	Tenebrionidae		*Adesmia*	sp.		x	1 (Fig. 5.4)		1.
	Tenebrionidae		*Akis*	sp.			1		
	Tenebrionidae		*Blaps*	*mortisaga*	Linnaeus		1? (Fig 5.5)		2.
	Tenebrionidae		*Erodius*	sp.			2		2.
	Tenebrionidae		*Gonocephalum*	sp.			4		
	Tenebrionidae		*Mesostina*	sp.			3		
	Tenebrionidae		*Micipsa*	sp.			3?		1.
	Tenebrionidae		*Pimelia*	sp.			1?		
	Tenebrionidae		*Trachyderma*	sp.			1		
	Tenebrionidae		*Trachyderma*	*hispida*	(Forsskal)		1?		2.
	Tenebrionidae		*Zophosis*	sp.			1		1., 2.
	Tenebrionidae			sp.			10		
Dermaptera	Labiduridae		*Labidura*	*confusa*	Capra	x			1.
Dictyoptera	Blattidae		*Blattella*	*germanica*	Linnaeus	x			1.
	Blattidae			sp.			2		
	Mantidae		*Blepharopsis*	*mendica*	(Fabricius)	x			1.
	Mantidae			sp.			1		
Diptera	Bombyliidae			sp.			1		
	Calliphoridae			sp.			1		
	Culicidae			sp.			1		
	Muscidae		*Musca*	*domestica*	Linnaeus		1?		1.
	Sarcophagidae		*Blaesoxipha*	*setose*	(Salem)		1	G/S	
	Sarcophagidae		*Sarcophaga*	sp.			1		
	Sarcophagidae		*Wohlfahrtia*	sp.			1		
	Syrphidae			sp.			1		
	Tachinidae			sp.			1		
Embioptera				sp.		x	1		1.

Order	Family	Subfamily	Genus	Species	Author	Lit. Al Zubarah	Morpho-species	New record	References
Hemiptera	Aphididae			sp.			1	F	
	Coccoidea			sp.			1		
	Cydnidae		*Cydnus*	*hispidulus*	Klug	x			1.
	Cydnidae		*Cydnus*	*macrophthalmus*	E. Wagner	x			1.
	Cydnidae			sp.			1		
	Lygaedae			sp.			1		
	Pentatomidae			sp.			1		
	Pyrrhocoreidae		*Scantius*	*aegyptius*	(Linnaeus)		1?		1.
	Reduviidae		*Reduvius*	sp.			1		
	Rhopalidae		*Agraphopus*	*lethierryi*	Stål		1?		1.
Hymenoptera	Apidae			sp.			1 (Fig. 5.6)		
	Dryinidae			sp.			1	F	
	Formicidae		*Camponotus*	*maculatus*	Emery	x			1.
	Formicidae	Formicinae		sp.			1		
	Formicidae	Myrmicinae	*Cardiocondyla*	sp.			1	G	
	Formicidae	Myrmicinae	*Crematogaster*	sp.			1	G	
	Formicidae	Myrmicinae	*Monomorium*	sp.			1		2.
	Formicidae	Myrmicinae		sp.			2		
	Formicidae	Ponerinae	*Ponera*	*sennaarensis*	(Mayr)		1	G/S	
	Formicidae	Formicinae	*Cataglyphis*	*niger*	(Linnaeus)		1?		2.
	Sphecidae		*Liris*	*haemorrhoidalis*	Fabricius	x			1.
Isoptera	Hodotermitidae		*Anacanthotermes*	*ochraceus*	(Burmeister)		1?		1., 2.
	Rhinotermitidae		*Psammotermes*	*hybostoma*	Desneux		1?		1., 2.
Lepidoptera	Acrtiidae		*Utetheisa*	*pulchella*	(Linnaeus)		1? (Fig. 5.7)		1., 4.
	Crambidae		*Herpetogramma*	*licarsisalis*	(Walker)	x			1., 4.
	Noctuidae		*Clytie*	*haifae*	(Habich)	x			1., 4.
	Noctuidae		*Trichoplusia*	*ni*	(Hubner)	x			1., 4.
	Papilionidae		*Papilio*	*demoleus*	Linnaeus	x			1., 4.
	Pieridae		*Madais*	*fausta*	Oliver	x			1., 4.
	Sphingidae		*Hippotion*	*celerio*	(Linnaeus)	x			1., 4.

Order	Family	Subfamily	Genus	Species	Author	Lit. Al Zubarah	Morpho-species	New record	References
Neuroptera	Chrysopidae			sp.			1		
	Coniopterygidae			sp.			1	F	
	Myrmeleontidae		*Morter*	*hyalinus*	Oliver	x			1.
	Myrmeleontidae			sp.			1		
Odonata	Aeshnidae		*Anax*	*parthenope*	Selys		1?		1.
Orthoptera	Acrididae		*Anacridium*	*aegyptium*	Linnaeus	x			1.
	Acrididae		*Cyclopternacris*	*etbaica*	Ramme	x			1.
	Acrididae		*Locusta*	*migratoria*	(Linnaeus)		1?		1., 2.
	Gryllidae		*Oecanthus*	sp.		x			1.
	Gryllidae		*Acheta*	*domesticus*	Linnaeus		1?		1., 2.
	Gryllotalpidae		*Gryllotalpa*	*gryllotalpa*	Linnaeus	x			1.
	Tettigonidae		*Homorocryphus*	*nitidulus*	Scopoli	x			1.
Psocoptera				sp.			1	O	
Siphonaptera				sp.			1	O	
Thysanoptera	Thripidae			sp.			1	O	
Thysanura	Lepismatidae		*Thermobia*	*domestica*	(Packard)		1?		1.

"Lit. Al Zubarah" column shows if the species has been previously recorded for the locality in the literature. The numbers indicated in the Morpho-species are distinct specimens types thought to represent undetermined species; a "?" shows uncertainty at the lowest taxonomic level indicated. New records are indicated for Qatar for taxonomic Order (O), Family (F), Subfamily (SF), Genus (G) and Species (S).

Figures

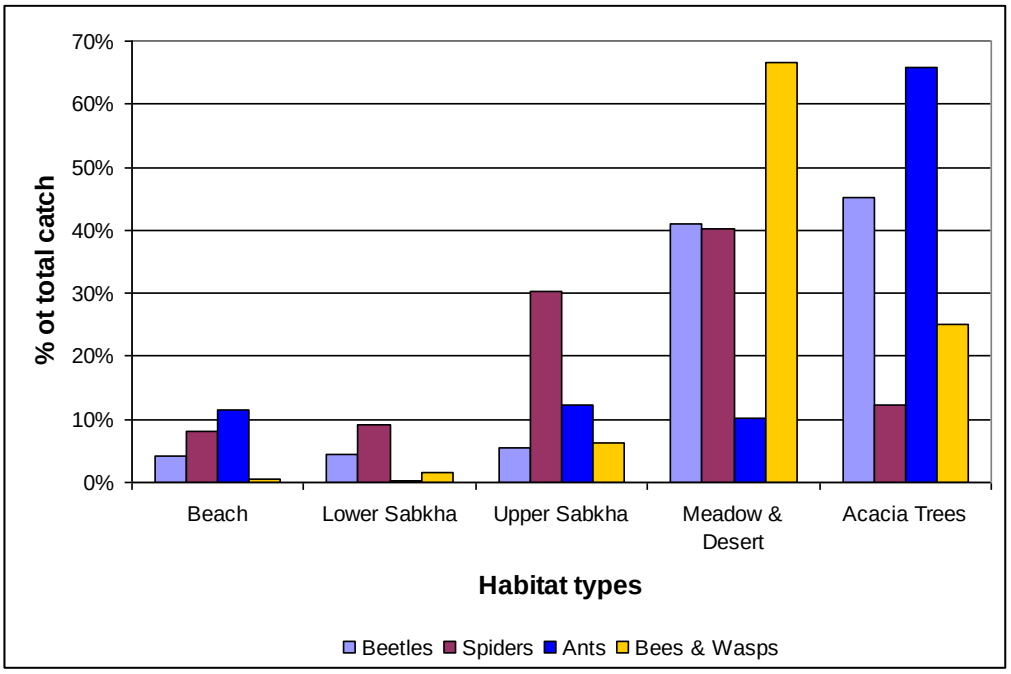


Figure 5.1: Terrestrial arthropod collections made in each habitat type using standardized pitfall sampling. Percentages are calculated from average values of each habitat type divided by a weighted average of the total catch.

Figure 5.2: A large wolf spider (Lycosidae). These spiders are solitary hunters that usually come out at night to feed on other arachnids and small animals. Although they can give a poisonous bite when continuously harassed, they prefer running away from people. (photo by J. Kielgast).

Figure 5.3: Arabian fat-tailed scorpion, *Androctonus crassicauda* (Olivier 1807), is one of the most lethal scorpion species in the world. This mildly aggressive species can grow up to 10 cm long and is the largest of the three species we found in Qatar. (photo by K.P. Puliafico).

Figure 5.4: A pitted darkling beetle in the genus *Adesmia* is one of the few beetles commonly seen during daylight hours at Al Zubarah. These long-legged beetles are well adapted to running on the hot sands of the desert. Their angular shape and hard exoskeletons help to protect them from daytime predators like birds. (photo by K.P. Puliafico).

Figure 5.5: *Blaps cf. mortisaga* Linnaeus, 1758, is the largest beetle species (over 4 cm) collected in the Al Zubarah Archaeological Site during our study. Like most of the beetles found here, it is most active at night. Despite its large size this species only feeds on plant material (photo by J. Kielgast).

Figure 5.6: A bee pollinating flowers near the grassy depressions found in the rocky desert near Al Zubarah Fort. Possibly a member of the family Apidae, pollinators like this are most active during the day because they search out the flowers by sight (photo by K.P. Puliafico).

Figure 5.7: Other pollinators such as these moths (*Utetheisa* sp.) are active at night. This pair is preparing to lay eggs for the next generation (photo by J. Kielgast).

6. FISHES

Peter Rask Møller[1], Philippe Provencál[1], Jos Kielgast[2] (Vertebrate department[1] and Center of GeoGenetics[2], Natural History Museum of Denmark, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark, Email: pdrmoller@snm.ku.dk*).*

6.1 INTRODUCTION

The Arabian Gulf including the waters of Qatar is characterized by shallow depths, high salinity and dramatic seasonal temperature changes (Sheppard et al. 1992). Due to recent glacial extinctions, the fish fauna is relatively young and comparatively species poor for a tropical sea, but characterized by high productivity and abundance. This extreme marine setting makes the Gulf interesting for conventional marine biodiversity research, but even more so as a study ground for the development of novel bio-monitoring approaches. For the present study we tested the use of night snorkeling as a tool for fish biodiversity surveys. Additionally environmental DNA (eDNA) was sampled, in filtered seawater for future biodiversity projects (see Thomsen et al. 2011, 2012).

Danish investigations of the marine fauna of Arabian seas goes back to the famous Arabian *Voyage* 1761-67, where Peter Forsskål collected and described more than 150 common fish species. The type specimens of 60 species are still stored at the Natural History Museum of Denmark, available for modern studies (see http://www.zmuc.dk/VerWeb/Peter_ Forsskaal/Peter_Forsskaal.html). A very significant contribution to the knowledge about the fish fauna of the Arabian Gulf was the survey (1937-38) and publication (1944) of H. Blegvad and B. Løppenthin. In fact there was no comprehensive scientific study of the ichthyofauna of the region until this Danish systematic survey. Despite of many more recent studies in the region (e.g. Randall 1995, Carpenter et al. 1997, Al-Baharra 1986), the fish fauna in the waters of Qatar is still not well known. Available literature does not represent complete check-lists (e.g. Sivasubramaniam 1982) and no detailed information exists on the fish fauna of the Al Zubarah buffer zone.

The purpose of the present study is to provide an overview of the local fish fauna in the Al Zubarah buffer zone. With only 3 weeks of field work all we can expect is a snapshot of the fauna and more seasons is needed before we can expect a full species list. We hope, however, that this small contribution will be relevant for the future management of the zone and that it will represent at new beginning and continuation of the fine Danish tradition for exploration in the Arabian Seas

6.2 METHODS

The buffer zone was investigated from the 6 March to 23March 2012, by multi-mesh gill-net (one night), baited traps (3 nights), and snorkelling with camera (Cannon D7) and spear gun (3 nights, 2 days) and scuba diving (3 day divers). Gil-netting was abandoned due to problems with floating seaweed. The baited traps were not successful and caught swimming crabs only.

6.3 FINDINGS WITHIN THE BUFFER ZONE

A total of ca. 48 identified fish species in 33 families were observed, photographed and/or caught within the buffer zone. A total of 33 species were collected for museum collections and tissue was sampled for DNA sequencing. A total of 35 species were UV-photographed. Most species were observed along the Ras Ushayriq area, where 38 species were found. At the old pier 13 species were recorded, followed by 7 at the outer zone and 1 in the canal, respectively. The most diverse families were seabreams (*Sparidae*) with 5 species, followed by stingrays (*Dasyatidae*), Blennies (*Blennidae*) and emperors (*Lethrinidae*) all with 3 species.

6.4 SPECIES LIST

Species recorded inside the Buffer zone. Families listed according to Nelson (2006). Abundance symbols: - absent, + 0-5 specimens, ++ 6-50 specimens, +++ >50 specimens observed.

			Localities					
Species		IUCN	Old Pier	Ras Ushayriq	Outer zone	Canal	UV photo	Collected
Hemiscylliidae								
Chiloscyllium arabicum Gubanov, 1980	Arabian carpetshark	NT	-	+	-	-	+	-
Dasyatidae								
Himantura gerrardi (Gray, 1851)*	Sharpnose stingray	VU	-	+	-	-	-	+
Himantura uarnak (Gmelin, 1789)	Honeycomb stingray	VU	-	+	-	-	+	+
Pastinachus sephen (Forsskål, 1775)*	Cowtail stingray	DD	+	-	-	-	+	+
Chanidae								
Chanos chanos (Forsskål, 1775)*	Milkfish	NE	-	+	-	-	-	+
Plotosidae								
Plotosus lineatus (Thunberg, 1787)*	Striped eel catfish	NE	-	+	-	-	+	+
Batrachoididae								
Allenbatrachus grunniens (Linnaeus, 1758)*	Grunting toadfish	NE	-	+	-	-	+	+
Mugilidae								
Moolgarda seheli (Forsskål, 1775)*	Bluespot mullet	NE	-	+++	-	-	+	-
Mugilidae sp. (juv)			-	-	-	+	-	+
Atherinidae								
Atherinomorus lacunosus (Forster, 1810)*	Hardyhead silverside	NE	+	+++	-	-	+	+
Hemiramphidae								
Hemiramphus far (Forsskål, 1775)*	Black-barred halfbeak	NE	-	++	-	-	+	+
Belonidae								
Ablennes hians (Valenciennes, 1846)*	Flat needlefish	NE	+	++	-	-	-	+
Tylosurus crocodilus (Péron & Lesueur, 1821)*	Hound needlefish	NE	-	++	-	-	-	+
Platycephalidae								
Platycephalus indicus (Linnaeus, 1758)*	Bartail flathead	DD	-	++	-	-	+	+
Serranidae								
Epinephelus tauvina (Forsskål, 1775)*	Greasy grouper	DD	-	++	-	-	+	+
Pseudochromidae								
Pseudochromis percicus Murray, 1887*	Bluespotted dottyback	NE	-	-	+	-	+	-
Teraponidae								
Terapon puta (Cuvier and Valenciennes, 1829)*	Smallscaled terapon	NE	++	-	-	-	+	-

Apogonidae								
Apogonichthyoides nigripinnis (Cuvier, 1828)*	Bullseye	NE	+	+++	-	-	+	+
Carangidae								
Carangoides bajad (Forsskål, 1775)	Orangespotted trevally	NE	-	+	-	-	+	+
Gnathanodon speciosus (Forsskål, 1775)*	Golden trevally	NE	-	+	-	-	-	-
Lutjanidae								
Lutjanus argentimaculatus (Forsskål, 1775)	Mangrove red snapper	NE	-	+	-	-	-	+
Lutjanus fulviflamma (Forsskål, 1775)	Dory snapper	NE	+++	+++	-	-	+	+
Gerreidae								
Gerres oyena (Forsskål, 1775)*	Common silver-biddy	NE	+++	+++	-	-	+	+
Haemulidae								
Plectorhinchus sordidus (Klunzinger, 1870)*	Sordid rubberlip	NE	-	++	-	-	+	+
Nemipteridae								
Scolopsis ghanam (Forsskål, 1775)	Arabian monocle bream	NE	-	+	+	-	+	-
Scolopsis taeniata (Cuvier, 1830)	Black-streaked monocle bream	NE	-	+	-	-	+	-
Lethrinidae								
Lethrinus lentjan (Lacepède, 1802)	Pink ear emperor	NE	-	++	-	-	+	+
Lethrinus microdon (Valenciennes, 1830)	Smalltooth emperor	NE	-	++	-	-	-	+
Lethrinus nebulosus (Forsskål, 1775)	Spangled emperor	NE	-	++	-	-	-	+
Sparidae								
Acanthopagrus bifasciatus (Forsskål, 1775)	Twobar seabream	NE	+	++	-	-	+	+
Diplodus sargus kotschyi (Steindachner, 1876)	One spot seabream	NE	-	++	-	-	+	+
Rhabdosargus haffara (Forsskål, 1775)	Haffara seabream	NE	-	++	-	-	+	+
Rhabdosargus sarba (Forsskål, 1775)	Goldlined seabream	NE	+	-	-	-	+	-
Sparidentex hasta (Valenciennes, 1830)	Sobaity seabream	NE	-	+	-	-	+	+
Mullidae								
Upeneus tragula Richardson, 1846*	Freckled goatfish	NE	+	+	+	-	+	+
Monodactylidae								
Monodactylus argenteus (Linnaeus, 1758)*	Silver moony	NE	-	++	-	-	-	+
Chaetodontidae								
Chaetodon nigropunctatus Sauvage, 1880*	Black-spotted butterflyfish	LC	-	+	-	-	-	-
Pomacanthidae								
Pomacanthus maculosus (Forsskål, 1775)	Yellowbar angelfish	LC	-	+	-	-	+	+
Labridae								
Halichoeres leptotaenia Randall & Earle, 1994*	A labrid	NT	-	-	+	-	+	-
Blennidae								
Ecsenius pulcher (Murray, 1887)*	A combtooth blennie	NE	-	+	-	-	-	-
Istiblennius lineatus (Valenciennes, 1836)*	Lined rockskipper	NE	+	-	-	-	+	-
Petroscirtes ancylodon Rüppell, 1835*	Arabian fangblenny	NE	-	-	+	-	+	-
Gobiidae								
Istigobius ornatus (Rüppell, 1830)*	Ornate goby	NE	-	+	-	-	+	-
Cryptocentrus lutheri (Klausewitz, 1960)*	Luther's shrimpgoby	NE	-	-	+	-	+	-
Gobidae sp.			-	+	-	-	+	-
Siganidae								
Siganus canaliculatus (Park, 1779)*	White-spotted spinefoot	NE	+	+++	-	-	+	+
Acanthuridae								
Acanthurus sohal (Forsskål, 1775)*	Sohal surgeonfish	NE	-	+	-	-	-	+
Sphyraenidae								
Sphyraena obtusata Cuvier, 1829*	Obtuse barracuda	NE	-	++	-	-	+	+
Soleidae								
Solea stanalandi Randall & McCarthy, 1989*	Stanaland's sole	NE	+	-	-	-	-	+
Monacanthidae								
Paramonacanthus oblongus (Temminck & Schlegel, 1850)*	Hair-finned filefish	NE	-	-	+	-	+	-

Hemiscylliidae (Bamboo sharks)

A single specimen of *Chiloscyllium arabicum* was photographed at night near Ra`s ´Ushayriq.

Dasyatidae (Whiptail stingrays)

Three species were collected from the zone. Most abundant seems to be *Pastinachus sephen* often observed at daytime around the Old Pier. *Himantura gerrardi* has not previously been reported from Qatari waters. The collected specimens are currently being studied by Peter Last, CSIRO, Hobart.

Chanidae

Chanos chanos was collected from the Ras Ushayriq area, where it appeared to be common.

Plotosidae (Eeltail catfishes)

A few specimens of *Plotosus lineatus* was found on rocky bottoms at Ras Ushayriq.

Batrachoididae (Toadfishes)

A few specimens of *Allenbatrachus grunniens* was found at night time on rocky bottoms at Ras Ushayriq.

Mugilidae (Mullets)

Huge schools of mullets were seen at night time in shallow water near Ras Ushayriq. Based on the dark spot in the pectoral basis they were identified as *Moolgarda seheli*, but more species might be present. A juvenile specimen (12 mm) was collected in the old water canal by the entomology team (Anne and Ken).

Mullidae (Goatfishes)

A single species, *Upeneus tragula*, was observed both day and night in low densities in the zone. The taxonomy of the genus is currently being investigated by Franz Uiblein, IMR, Bergen. Schools of another species, *Parupeneus margaritatus* Randall & Guézé, 1984 were photographed at Düvel Rock.

Atherinidae (Old world silversides)

At least one species, *Atherinomorus lacunosus*, was very common in the zone. They were observed near the surface at night.

Hemiramphidae (Halfbeaks)

A single species *Hemiramphus far* was common near Ras Ushayriq.

Belonidae (Needlefishes)

At least two species seen and collected at night time near Ras Ushayriq.

Platycephalidae (Flatheads)

A single species *Platycephalus indicus* was common on sandy bottoms near Ras Ushayriq.

Serranidae (Sea basses)

A single species, *Epinephelus tauvina*, was common near Ras Ushayriq. Some of the archeologists had also seen it from the Old Pier. It was found in rocky crevices, but they were also observed digging holes in the sand in very shallow waters, typically under rocks. This is one of the most popular and valuable species at local fish markets. Specimens up to 69 cm were collected.

Pseudochromidae (Dottybacks)

A few specimens of *Pseudochromis percicus* was photographed at daytime during diving in the outer zone.

Teraponidae (Terapons)

A small school of *Terapon puta* was photographed in the sea weed near the "Old Pier".

Apogonidae (Cardinal fishes)

At least one species, *Apogonichthyoides nigripinnis*, was very common in the zone. A bright red specimen seen in a cave at Ras Ushayriq is likely to represent another species.

Carangidae (Jacks and pompanos)

Carangoides bajad was caught and UV photographed, whereas *Gnathanodon speciosus* was observed only, and needs further confirmation.

Lutjanidae (Snappers)

Two species was found in the zone. *Lutjanus fulviflamma* was very common including juvenile specimens.

Gerridae (Mojarras)

At least one species was very common on the shallow, sandy habitats. More species is likely to be present.

Haemulidae (Grunts)

A single species, *Plectorhinchus sordidus,* was common at Ras Ushayriq.

Nemipteridae (Thredfin breams)

Scolopsis ghanam and *Scolopsis taeniata* were observed and photographed in low numbers in the zone.

Lethrinidae (emperors)

Three species were caught near Ras Ushayriq. Most common was *Lethrinus lentjan*, a well know fish at local fish markets. All were recorded by night snorkelling, except for one specimen found in a trap set by locals from Ras Ushayriq.

Sparidae (Porgies)

Five species were recorded in the buffer zone. Most abundant was *Acanthopagrus bifasciatus*, whereas *Rhabdosargus sarba* was represented by a single specimen. The largest collected specimen was a *Sparidentex hasta*, 66 cm in total length.

Monodactylidae (Moonfishes)

A school of ca. 10 specimens of *Monodactylus argenteus* was observed at night time at the tip of the Ras Ushayriq area.

Chaetodontidae (Butterflyfishes)

A single species was observed at Ras Ushayriq. Furthermore, the species was collected from the pier at Al Dhabiyah and photographed at Düvel Rock.

Pomacanthidae (Angelfishes)

A single species, *Pomacanthus maculosus*, was observed at Ras Ushayriq. Two specimens were collected from a trap set by local people from Ras Ushayriq.

Labridae (Wrasses)

A few specimens of *Halichoeres leptotaenia*, was photographed in the outer zone at ca. 5 m.

Blennidae (Combtooth blennies)

Three species were observed in the buffer zone, all as single specimens. None of these were collected and further confirmation of the identification is needed. One of the species, *Petroscirtes ancylodon*, was collected outside the zone at the pier at Al Dhabiyah.

Gobiidae (Gobies)

Two species were identified on the basis of photos, whereas one additional photographed species was left unidentified. Only few specimens of gobies were observed.

Siganidae (Rabbitfishes)

A single species, *Siganus canaliculatus*, was very abundant near Ras Ushayriq. Rabbitfishes can change colour in seconds, so more species might be present. The identification of *S. canaliculatus* was based on the dark spot behind the head.

Acanthuridae (Surgeon fishes)

A single specimen of *Acanthurus sohal* was observed and collected at the tip of Ras Ushayriq. It was found in the rocky pier at night time.

Sphyraenidae (Barracudas)

One species, *Sphyraena obtusata*, was common in small groups at Ras Ushayriq.

Soleidae (Soles)

A single, juvenile specimen of *Solea stanalandi* was collected by a push net near the Old Pier.

Monacanthidae (Filefishes)

A single juvenile specimen of *Paramonacanthus oblongus* was photographed hiding in sea weed, at the outer buffer zone at about 5 meters depth

6.5 FINDINGS, OTHER LOCATIONS

Pier at Al Dhabiyah

This abandoned harbor seemed to be severely polluted by oil. During one hour night snorkeling 13 March 2012, the following species were collected: *Petroscirtes ancylodon, Chaetodon nigropunctatus, Plectorhinchus sordidus, Lutjanus argentimaculatus* and *Epinephelus tauvina*.

Coral heads

The coral there were all dead, and only two fish species were observed during day snorkeling 12 March 2012: *Acanthopagrus bifasciatus* and *Scolopsis taeniata*.

Düvel Rock

Many living corals were forming reef. Most, however, were covered by algae. Several fish species were photographed during day, snorkeling on the 12 March 2012: e.g. *Acanthopagrus bifasciatus, Scolopsis ghanam, Parupeneus margaritatus, Chaetodon nigropunctatus, Abudefduf vaigiensis* (Quoy & Gaimard, 1825), *Pseudochromis percicus, Lutjanus fulviflamma* and *Ecsenius pulcher.*

6.6 CONCLUSIONS AND RECOMMENDATIONS

A total of 48 species in 33 families were found in the buffer zone. No less than 31 of the species are not mentioned as present in Qatari waters in FishBase (Frose and Pauly 2012), a global internet facility much used by ichthyologists and managers worldwide. This large proportion is most likely caused by the fact that no study of the Qatari fish fauna has been done, and that few entries of Qatari fishes have been made into the database.

Most of the species (39) have not been evaluated for the international IUCN Red list of threatened species. Two species of stingray (*Himantura gerrardi* and *Himantura uarnak* (Figure 6.3) are considered Vulnerable (VU), a shark *Chiloscyllium arabicum* (Figure 6.2) and a labrid *Halichoeres leptotaenia* are considered Near threatened (NT), a butterflyfish *Chaetodon nigropunctatus* and an angelfish *Pomacanthus maculosus* are placed in the Least Concern (LC) category, whereas another stingray *Pastinachus sephen* (Figure 6.4), a flathead *Platycephalus indicus* (Figure 6.5) and a grouper *Epinephelus tauvina* (Figure 6.6) are currently Data Deficient (DD).

Although the current study does not have a quantitative approach, some species were clearly more common than others. Based on the observations the following 20 species can be considered common in the zone: *Ablennes hians, Acanthopagrus bifasciatus, Apogonichthyoides nigripinnis, Atherinomorus lacunosus, Diplodus sargus kotschyi, Epinephelus tauvina, Gerres oyena, Hemiramphus far, Lethrinus lentjan, Lethrinus microdon, Lethrinus nebulosus, Lutjanus fulviflamma, Monodactylus argenteus, Moolgarda seheli, Platycephalus indicus, Plectorhinchus sordidus, Rhabdosargus haffara, Siganus canaliculatus, Sphyraena obtusata, and Tylosurus crocodiles.*

Recommendations for future studies

The buffer zone contains a wide range of habitats, from sea grass, sand, mud, rocks, sea weed and biogenous reefs of peal oysters. The zone seemed to be in a healthy environmental shape; with a few signs of human impact were notes. No oil spills were observed in the water, in sharp contrast to the situation on shore, but a few lost fishing gill nets were seen, as well as an unmarked fish trap.

In order to preserve the natural environment in the zone, it is essential that fishing and collection of animals and plants are regulated. The zone should probably be a No-Take zone, so that snorkelers and divers get to see as mush of the fauna as possible. Alternatively – a small bag-limit could be introduced – so that recreational fishermen and visitors can catch a few fish or blue-crabs per day. Gill-nets, trawls and traps should not be allowed, whereas fishing rods, spear guns, and hand nets should be accepted, but with strict bag-limits.

As many as 35 % (17 of 48) of the species recorded from the zone are described by Forsskål (1758). The types of most of these species were collected in the Red Sea during the Arabian voyage (1761-67), most likely obtained from local fishermen. Future studies based partly on the collections made in the Buffer zone may focus on the small morphological (and genetic) differences that are found between Red Sea and Arabian Gulf populations.

Several fish species were heavily infected with external parasites. Some of the worst examples were seen on e.g. *Upeneus tragula*, *Platycephalus indicus*, *Rhabdosargus sarba*, *Siganus canaliculatus*, *Plectorhinchus sordidus*, *Apogonichthyoides nigripinnis*, *Gerres oyena* and *Scolopsis taeniata* were

infected by unknown fish lice (Argulidae) (Figure 6.5). The high parasite density might be caused by osmoregulatory stress as a result of the high salinity. The parasite fauna is another obvious topic for future studies in the buffer zone.

References

Al-Baharra , W.S. 1986: *Fishes of Bahrein*, Ministry of Commerce and Agriculture,

Directorate of Fisheries, Bahrein.

Blegvad, H. & Løppenthin, B. 1944. Fishes of the Iranian Gulf. Einar Munksgaard.

Carpenter, K.E., Krupp, F., Jones, D.A. & Zajons, U. 1997. The living marine resources of Kuwait, Eastern Saudi Arabia, Bahrain, Qatar & the United Arab Emirates. Rome : FAO.

Forsskål, P. 1775. Piscium. In: Niebbuhr, C. (Ed.) Descriptiones Animalium. Haunia.

Froese, R. and D. Pauly. Editors. 2012.FishBase. World Wide Web electronic publication. www.fishbase.org, version (08/2012).

Randall, J. E. 1995. Coastal Fishes of Oman. University of Hawaii Press.

Sheppard, C.R.C., Price, A.R.G. & Roberts, C.M. 1992. Marine Ecology of the Arabian Region. Academic Press, New York.

Thomsen, P. F., Kielgast, J., Iversen, L. L., Wiuf, C., Rasmussen, M., Gilbert M. T. P., Orlando, L. & Willerslev, E. 2011. Monitoring endangered freshwater biodiversity by environmental DNA. Molecular Ecology 21: 2565–2573).

Thomsen, P. F., Kielgast, J., Iversen, L. L., Møller, P.R., Rasmussen, M. & Willerslev, E. 2012. Detection of a diverse marine fish fauna using environmental DNA from seawater samples. PLoS ONE 7(8): e41732. Doi: 10.1371/journal.pone.0041732.

Sivasubramaniam, K. 1982: *Common Fishes of Qatar*, marine Science Department, Faculty of Science, University of Qatar, Doha.

Figures

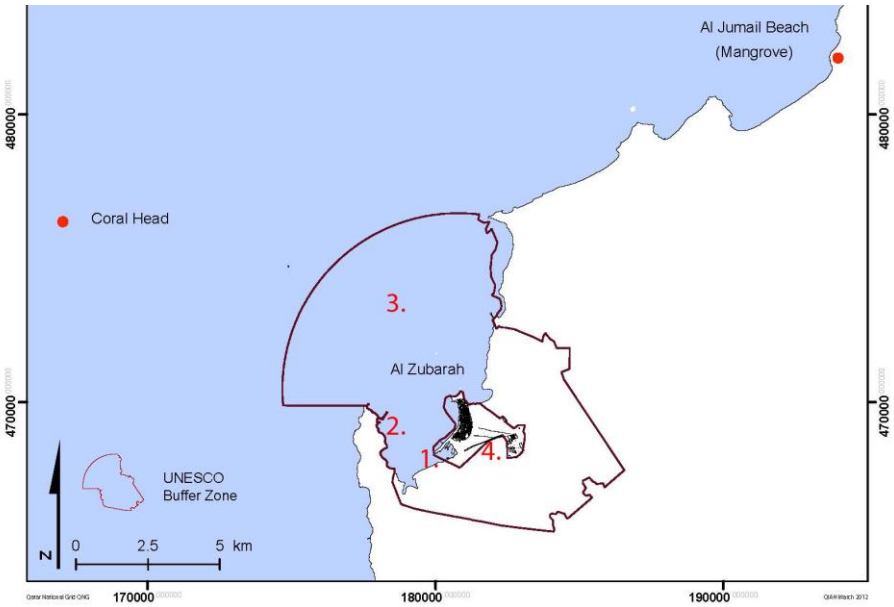


Figure 6.1: Map of collection sites. Four subareas studied: 1. “Old Pier”, 2. “Ras Ushayriq”, 3. “Outer zone” and 4. “Old Canal”.

Figure 6.2: Arabian carpetshark , *Chiloscyllium arabicum*, phographed near Ras Ushayriq, at night 12 March 2012. Photos PRM.

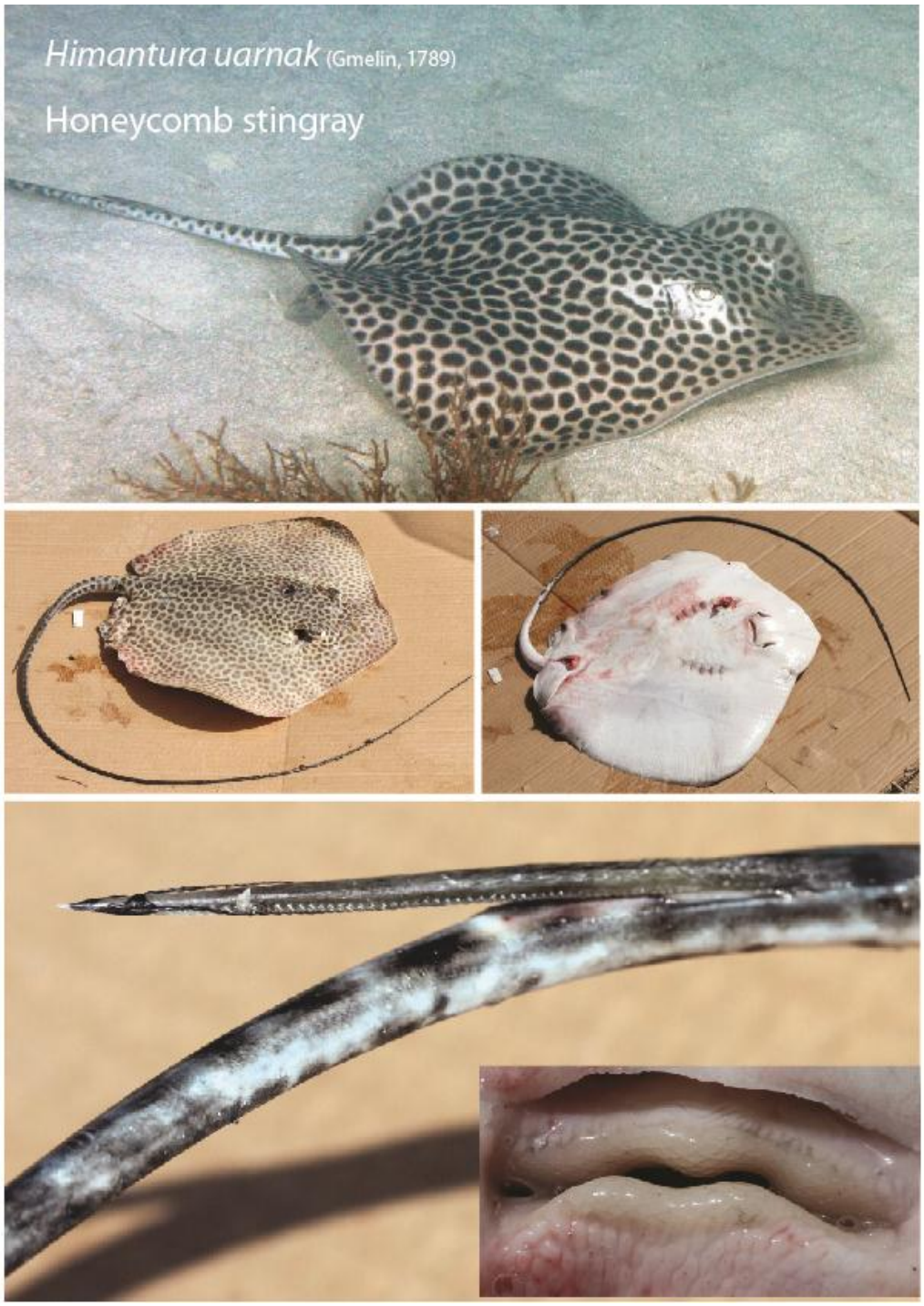


Figure 6.3: Honeycomb stingray *Himantura uarnak.* Upper photo: Specimen photographed near Ras Ushayriq, at night 12 March 2012. Lower four photos of a specimen ZMUC uncat. (10114), collected near Ras Ushayriq, at night 10 March 2012.

Figure 6.4: Cowtail stingray *Pastinachus sephen*. Upper photo of an un-collected specimen from the Old Pier, 9. March 2012. Lower five photos of ZMUC uncat. (10225) collected 9 March 2012 near the Old Pier.

Figure 6.5: Bartail flathead *Platycephalus indicus* phographed near Ras Ushayriq, at night 12 March 2012. Mid-left and lower photo shows a specimen infected with an unknown fish lice (Argulidae). Photos PRM.

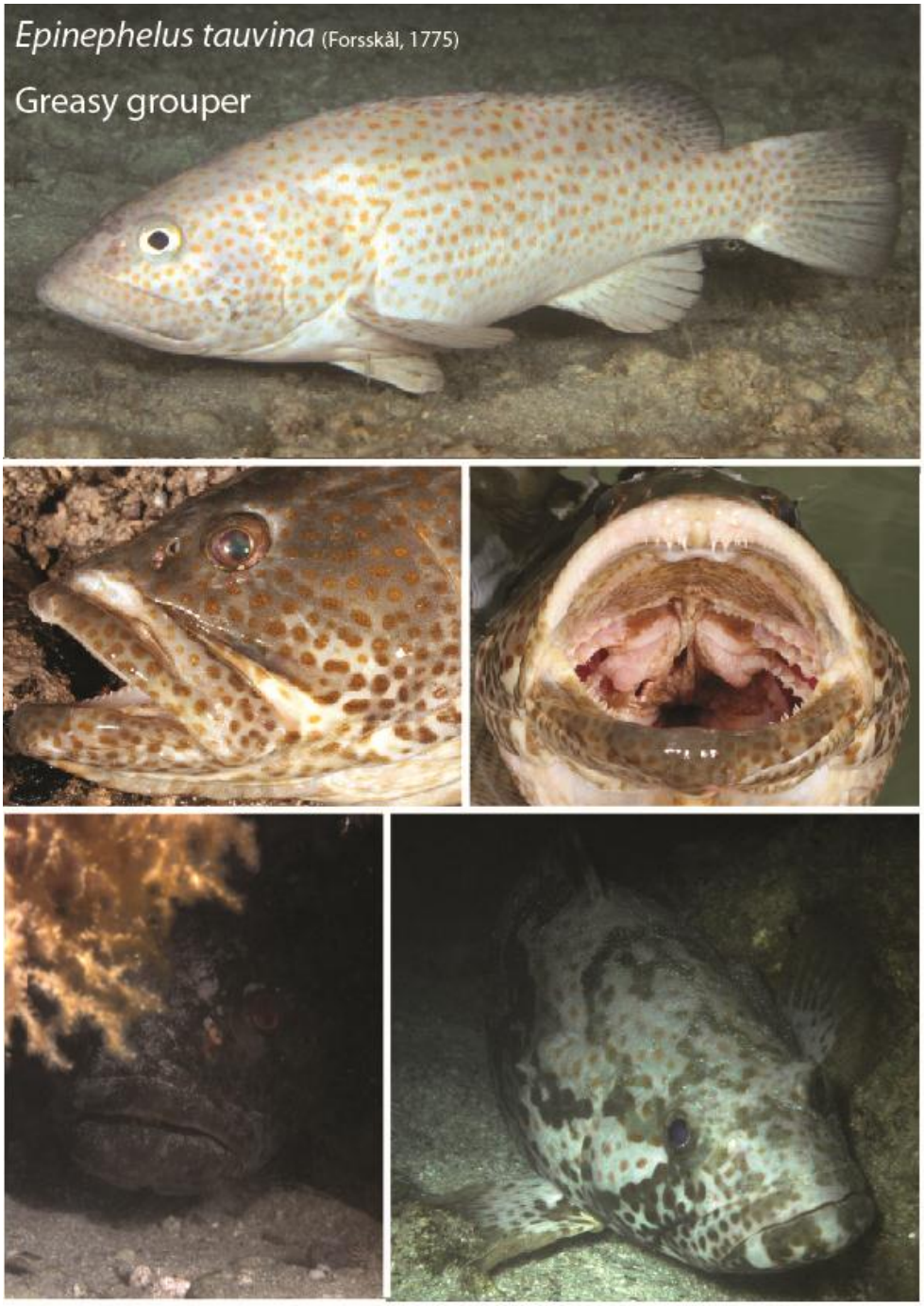


Figure 6.6: Greasy grouper, *Epinephelus tauvina* photographed and/ or collected from near Ras Ushayriq, at night 8 -12 March 2012.

7. NAMES OF FISH AND OTHER MARINE ANIMALS IN QATAR

Philippe Provençal (Vertebrate department, Natural History Museum of Denmark, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark),

7.1 INTRODUCTION

My area of study was two folds for this field season. Firstly, the goal was to gather local fish names in Qatar, in the NW region and in Doha. Secondly, the aim was to compare these names to fish names gathered from the Red Sea and the Mediterranean region as well as to names known from Classical Arabic texts.

7.2 LOCAL FISH NAMES

The study was effectuated by visits to a smaller fish shop in the town of Al Shamāl and to a larger fish market in Doha. The sellers were asked for the names of the fishes displayed. As all sellers were from the Indian subcontinent, the names provided were subsequently compared with the names provided by K. Siwasubramaniam & M.A. Ibrahim (1982) and Wajeeh S. Al-Baharna (1986) whose publications were at the Al Zubarah camp.

Below are the lists showing the scientific names of the investigated species and the corresponding local Arabic names in both Latin scientific transcriptions and in Arabic letters. The scientific names are written in italics.

Table 7.1. Names gathered from a fish shop in Al Shamāl 18 March 2012

1	*Siganus javus*	ṣāfī	صَافِي
2	*Rhabdosargus sarba*	qurqufān	قُرْقُفَان
3	*Carangoides chrysophys*	suwaydī	سُوَيْدِي
4	Coral groupers *Serranidae* spp. (common designation)	hāmūr	هَامُور
5	*Alepes mate*	jīš	جِيش
6	*Lethrinidae* (common designation)	šafirī	شَعْرِي
7	Queenfish *Scomberoides commersionanus*	laḫlā (laḥlāḥ)	لَخْلَا (لَحْلَاح)
8	Crab	qabqab	قَبْقَب
9	Cuttlefish *Sepia sp.*	ḫaṯāq	خَثَّاق

Table 7.2. Names gathered from a poster in Doha on 21 March 2012

10	Queenfish *Scomberoides commersionanus*	basār	بسار
11	Parrot fish *Scaridae* sp.	qīš (vocalisation according to the pronunciation provided at the fish market)	قيش

Table 7.3. Names gathered at the fish market in Doha on 21 March.

12	Doublebar bream *Acanthopagrus bifasciatus*	fuskar	فُسْكَر
13	*Scomberomorus commersoni*	kanʿad	كَنْعَد
14	*Gnathanodon speciosus*	rubīb	رُبِيب
15	*Mylio berda*	šuʿm	شُعْم
16	Barracuda *Sphyraena* sp.	jidd	جِدّ
17	*Arius thalassinus*	kim (Classical Arabic) čim (Qaṭar dialect)	كِم
18	*Scaridae*	qīš	قِيش
19	*Lethrinus* spp. (common designation)	šuʿrī	شُعْرِي
20	*Rhonciscus stridens*	ẖīrah	خِيرة
21	*Nemipterus* sp.	bāsī	بَاسِي
22	Trevallly *Carangidae* sp.	zubaydī	زُبَيْدِي
23	Blue Crab	kukūb	كُكُوب
24	Shark *Pleurotremata* sp.	nawr	نَوْر
25	Coral groupers *Serranidae* spp. (common designation)	hāmūr, hamūr	هَامُور ، هَمُور
26	*Platax orbicularis*	ḥammūd, hammūd	حَمُّود ، هَمُّود
27	*Euthynnus affinis (*identity not certain)	ḍabān, dabbān	ضَبَّان ، دَبَّان
28	Coral hind *Cephalopholis miniatus*	ridāmūr	رِدَامُور
29	Sole *Soleidae* sp.	mūsā	مُوسَا
30	Black tail bream *Diplodus sargus*	kirkafān	كِرْكَفَان
31	Needlefish *Tylosurus leiurus, Ablennes hians*	ʿāqūl (correct pronunciation persumably ḥākūl)	عَاقُول (حَاكُول)-
32	Pony fish *Leiognathus* sp.	zubaydī	زُبَيْدِي
33	*Rachycentron canadus*	sikkīn (correct pronunciation persumably sikin)	سِكِّين (سِكِن)-
34	Greater amberjack *Seriola dumerili*	ḥamām	حَمَام
35	mullet *Mugilidae* sp.	būrī	بُورِي
36	Red goatfish *Parupeneus* sp.	sulṭān Ibrāhīm	سُلْطَان إِبْرَاهِم
37	Halfbeack *Hemiramphidae* sp.	surūs	سُرُوس
38	Flathead *Thysanophrys* sp.	baḥr	بَحْر

7.3 MAIN CONCLUSIONS FROM THE WORK UNDERTAKEN THIS SEASON

The list of fish names from Qatar bears witness to the elaborate knowledge of the sea and sea creatures found in the coastal populations around the Arabian Peninsula. Such knowledge manifest itself in a wide vocabulary regarding all sea animals and the phenomenon was documented by the research of Peter Forsskål (1775) and earlier by the description of fishes and sea creatures in the Arabic geographical and scientific texts from the Classical period, ie. the period from the VIIIth to the XVth century AD.

The fish names gathered during the Qatar field work season show some interesting features. When the names are compared to names for the same species from the Red Sea, it is clear that not only is the notion of species the same on both shores of the Arabian Peninsula, but the notion of genera also remain the same. Thus Coral Groupers *Serranidae* spp. are designated by a common name both in the Red Sea and in the Arabic Gulf, but this designation varies with the locality. In Egypt and in other locations around the Red Sea the groupers as a group are called *kušar* while their common designation in the Qatar is *hamūr.* In Egypt the members of the gender *Lethrinus* have šaᶜūl as common designation while in Qatar they have šuᶜrı as common designation (personal observations).

This pattern illustrates that the Red Sea and Qatar represent two different linguistic entities when it comes to the lexical contents of the fish fauna, but the notion of which species belong together in families or genera remain the same across the Arabian Peninsula. More interesting is the fact, that some species, e.g. mullets, *mugilidae*, have the same name as the one used in Arabic in the Mediterranean region. In Egypt the fact that mullets are called by the same name both on the Mediterranean and on the Red Sea Coasts could be explained by the geographical proximity of the Red Sea to the Mediterranean. But the fact that mullets are called by the name būrī in both the Mediterranean region, the Red Sea and in Qatar shows an interesting continuity. Such continuity is also visible in the historical record, as this fish name is well known from Classical Arabic texts. For instance in the list of 79 fishes and aquatic animals included in the descriptions of the island of Tinnīs in Lake Manzalah in the Delta of the Nile by Yāqūt ibn ᶜAbdullāh al-Ḥamāwī (1179-1229) in his book *Muᶜjam al-Buldān* and by Zakariāʾ b. Muḥammad b. Maḥmūd al-Qazwīnī (1203-1283) in his Cosmography, *Kitāb ʿAjāʾib al-Maḫlūqāt wa Gharāʾib al-Mawjūdāt*.

A similar observation could be made on the name of the red goatfish. The Mediterranean species of red goatfish *Mullus barbatus* and *Mullus surmuletus* are called sulṭān Ibrāhīm in Egypt and the Syro-Palestinian region (Oman 1966 and personal observations), and a red species of mullet is known by this name at the fish market in Dawḥah. This name has also been recorded for the Red Sea area, but it is not very common there (cf. Provençal 1997, Oman 1992, personal observations).

7.4 FUTURE RESEARCH

This study is part of the project **The Arabic Animal-Names of Forsskål's Descriptiones Animalium** by myself and B. Skaarup, housed at the Zoological Museum in Copenhagen. The aim is to systematize the Arabic names of primarily fishes and other marine animals noted by Peter Forsskål during the expedition *The Arabian Voyage 1761-1767.* This material has not yet been adequately studied. This systematisation includes investigations in contemporary ichtiological nomenclature around the Arabic Peninsula and in the Middle East as well as studies of fish

nomenclature in Classical Arabic geographical and scientific texts. In this respect material from Qaṭar is of great interest as it provides data from a part of the Arab World, where the sea and fisheries play a crucial role from antiquity to the present day and thus gives an indispensable contribution to investigations on the importance of the sea and its resources and on the knowledge of marine life the Arabic culture in both Classical and modern context.

References

Al-Baharna, W. S. 1986. *Fishes of Bahrein*, Ministry of Commerce and Agriculture, Directorate of Fisheries, Bahrein.

Forsskål, P. 1775. *Descriptiones Animalium,* -post mortem auctoris edidit Carsten Niebuhr. Möller, Copenhagen.

Oman, G. 1966. *L'ittionimia nei Paesi Arabi del Mediterraneo.* Quaderni dell'archivio linguistico veneto. Casa editrice Leo S. Olschiki. Firenze.

Oman, G. 1992. *L'Ittionimia nei paesi arabi dei Mari Rosso, Arabico e del Golfo Persico (o Arabico),* Instituto Universitario Orientale, Napoli.

Provençal, P. 1995. *Enquête lexicographique sur les noms d'animaux en arabe /Alexicographic survey of arabic animal names*. Ph. D. afhandling ved Carsten Niebuhr Instituttet for Nærorientalske Studier, Københavns Universitet.

Provençal, P. 1997. Animal names gathered by interviews with members of the Muzın tribe in Sinai. *Acta orientalia* vol. 58 pp. 35-46.

Siwasubramaniam, K. & M.A. Ibrahim 1982. *Common Fishes of Qatar,* Marine Science Department, Faculty of Science, University of Qatar, Doha.

Figures

Figure 7.1: A specimen of *Gerres acinaces* gathered during the field work 2012. Specimen and photo: P. Provençal.

8. REPTILES

Jos Kielgast (Natural History Museum of Denmark, Universitetsparken 15, 2100 Copenhagen, Denmark. joskielgast@snm.ku.dk).

8.1. INTRODUCTION

Reptiles are among the most conspicuous terrestrial animals in the arid landscapes of the Arabian Peninsula and account for a substantial part of its vertebrate biodiversity. However, there are substantial knowledge gaps in our understanding of the herpetofauna in the region and Qatar features among comparatively poorly studied areas. Although reptiles have been covered in recent national check-lists (Mohammed 1988; El-Sherif and Al-Thani 2000) very little scientific work has been published on this sector of Qatar's biodiversity. The country comprises characteristic habitats of the Persian Gulf desert and semi-desert terrestrial ecoregion (Olson et al. 2001) and is hence expected to harbour a fauna similar to the xeric lowlands of Western Saudi Arabia and The United Arab Emirates. Currently a total of 29 species have been recorded in Qatar (El-Sherif and Al-Thani 2000). In comparison WWF lists 53 species to occur in the ecoregion and adjacent marine areas (WWF 2006). This is some indication that the herpetological diversity in the country may potentially be underestimated. The reference work for the entire Gulf region (Leviton et al. 1992) provide an overview of all occurring species and subspecies including a total of 150 taxa from South Eastern most Iraq, Iran, Kuwait, Western Saudi Arabia, Bahrain, Qatar and the United Arab Emirates. Obviously this large area covers a number of habitats and zoogeographic zones which are not present in Qatar. However, the neighbouring and more thoroughly investigated United Arab Emirates has 72 nominal species which have been covered in a number of accessible popular and scientific publications (Baha el Din 1996; Hornby 1996, Jongbloed 2000; Gardner 2005, 2008; Baldwin et al. 2008; Soorae et al. 2010; Uetz et al. 2012). Such a substantial discrepancy in the known diversity of these two neighbouring states should spur curiosity to the exploration of Qatar. Intriguingly the most notable contribution to the knowledge on the herpetofauna of Qatar comes from Saudi Arabia in the form of the book series "Fauna of Saudi Arabia" which provide the most important broad herpetofaunistic references for the region (e.g. Arnold 1986; Gasperetti 1988, 1993; Schätti et al. 1994) as well as comprehensive treatment of specific groups (e.g. Arnold 1980, 1994; Hillenius 1984).

8.2 FINDINGS WITHIN THE BUFFER ZONE

Methods

A herpetological survey was conducted in the Al Zubarah archaeological site and buffer zone during 5 March to 23 March 2012. Activities were targeted at supplying a checklist as complete as possible for the local reptile fauna of the area. In arid landscapes the trade-offs between quantitative and qualitative survey methods are noticeable due to the low abundance animals and patchy nature of suitable micro habitat - in particular shelter from sun and predators. These features make quantitative survey approaches very inefficient and opportunistic transect walks much more feasible with regards to both number of records and taxonomic coverage. For similar reasons collection was

opportunistic by visual encounter and hand catching rather than installing time consuming contraptions such as pitfalls and drift fences. During the survey the entire area of the archaeological site and buffer zone was systematically surveyed by transect walks both during day and night. Due to the limited size of the buffer zone and the relatively long time frame of the survey it was possible to systematically investigate all areas at fine spatial scale with at least one visit during day and night. The survey activities were thereafter targeted at the most promising localities of the respective habitat types in the area. Day transect walk surveys in desert areas are normally focussed at mornings and late afternoons due to the basking and foraging behaviour of diurnal species. However, cold weather especially during the beginning of the survey made it more productive to focus on the hottest hours of the day. In spite of this unconventional strategy many findings of diurnal species were made, while the species were clearly inactive, by turning stones, vegetation and debris they hide under during night and hibernation. Nocturnal surveys were carried out from 19:00-05:00. The main habitat types in the area are sabkha and stony desert. There is a well vegetated transition between the two, but also patches of shrub and grass vegetation scattered around other parts of the area although it is generally sparsely vegetated. Moreover, there are a few natural stony ridges and several places with scattered piles of recent or historical building debris. The archaeological site itself makes up such important habitat for many species. Shelter in all forms, be it natural or man-made, is a decisive micro habitat feature to most of the species in the area. The localities with the highest abundance and diversity of reptiles in the buffer zone area also include two graveyards.

Reptiles recorded:

The Al Zubarah area hosts a relatively rich herpetofauna of lizards, amphisbaenids, snakes and sea turtles including at least 18 reptile species belonging to eight different families. Lizards are by far the most abundant and diverse group in the area with geckoes representing the most specious family.

Lizards

The gulf short-fingered gecko (*Pseudoceramodactylus khobarensis*) (Figure 8.1A) is perhaps the most widespread species in the area occurring both in the sabkha and the stony desert hinterland. It was found even in quite bare habitat of sparsely vegetated gravel plain, but more abundantly on moist soils. It is particular numerous around the area of the camel racetrack in the east of the buffer zone. The former congeneric slevin's sand gecko (*Stenodactylus slevini*) (Figure 8.1B) also occur in the area, but it was only found where there were scattered large rocks or other shelter. The arabian rough-tailed gecko (*Cyrtopodion scabrum*) (Figure 8.1D) and baluch ground gecko (*Bunopus tuberculatus*) (Figure 8.1C) were very numerous in the same sheltered areas and especially around the stony ridges in the northern sector of the buffer zone and among the archaeological building debris. The latter is the more common of the two. The diurnal dwarf rock gecko (*Pristurus rupestris*) (Figure 8.1E) can be found in decent numbers on the permanent buildings of the archaeological site camp and scattered around the buffer zone were large rocks and permanent piles of historical or recent building debris occur. Only a single specimen of persian leaf-toed gecko (*Hemidactylus persicus*) (Figure 8.1F) was recorded in an old well north of the camp.

The most prominent reptile species in the area is the large diurnal spiny-tailed lizard (*Uromastyx aegyptia microlepis*) (Figure 8.2A). This primarily herbivorous animal grows up to 80 cm in length and can be observed in vegetated areas sunbathing next to its burrows. During the survey only four

specimens were recorded inside the buffer zone. However, two of these were found very close to camp on the particularly hot last day of the survey while the third one was found hiding under debris during broad daylight. Many burrows were recorded scattered around the area during the survey and the finding of a juvenile documents that reproduction occur in the area. These findings all indicate that the temperature during the survey period was too low for the species to be active and that the density was hence most likely under estimated. Only one other agamid lizards, the yellow-spotted agama (*Trapelus flavimaculatus*) (Figure 8.2B), was observed a single time at the graveyard south of the camp, while short-nosed lizards (*Mesalina brevirostris*) (Figure 8.2C) were present at moderate density scattered throughout all habitats in the area - from the shore to the hinterlands.

The peculiar fossorial amphisbaenid zarudnyi's worm lizard (*Diplometopon zarudnyi*) (Figure 8.3E) was recorded with a single specimen under debris in an un-restored sector of the Al Zubarah archaeological site.

Snakes

A single specimen of each of the regions harmless rear-fanged colubrids, shokari sand snake (*Psammophis shokarii*) (Figure 8.3A) and hooded malpolon (*Malpolon moilensis*) (Figure 8.3D), were recorded at the old peer and along the road from camp to Al Shamal, respectively. The terrestrial fauna also include a single venomous species, the sand viper (*Cerastes gasperetti*) (Figure 8.3B). It was not recorded during the survey, but has been documented from the archaeological site where it is occasionally found during restoration activities.

A number of sea snakes potentially occur in the marine area of the buffer zone (Gasperetti 1988, Baldwin & Gardner 2005) including the blue-banded sea snake (*Hydrophis cyanocinctus*), shaw's sea snake (*Lapemis curtus*), yellow-bellied sea snake (*Pelamis platurus*), beaked sea snake (*Enhydrina schistosa*), common small headed sea snake (*Microcephalophis gracilis*), Arabian Gulf sea snake (*Hydrophis lapemoides*), and the ornate sea snake (*Hydrophis ornatus*). Only the latter two have been documented at Al Zubarah by collected dead specimens or photographs (e.g. *Hydrophis ornatus* Figure 8.3C), but none were observed during the actual survey.

Turtles

In terms of species conservation the presence of marine turtles in the waters off Al Zubarah is the most important component of the herpetofauna. Dead specimens of the endangered green turtle (*Chelonia mydas*) and the critically endangered hawksbill turtle (*Eretmochelys imbricata*) (Figure 8.4) are recurrently found washed up on the shore in the buffer zone, indicating that these species occur in the area on a regular basis. A single live adult green turtle and a sub-adult hawksbill turtle were observed by snorkelling during the survey. Skeletal remains of a leatherback turtle (*Dermochelys coriacea*) have also been recorded on the shore, but this species most likely only occur vagrantly in the area. The marine section of the buffer zone may hence constitute a foraging ground for sea turtles, but the shores are not known to be used as nesting sites.

8.2.1 species list

Reptile species recorded within the Al Zubarah archaeological site buffer zone. Species which were not recorded during the survey, but documented by photos or specimens collected during the archaeological excavations are marked with *

Agamidae
Spiny-tailed lizard (*Uromastyx aegyptia microlepis*)
Yellow-spotted agama (*Trapelus flavimaculatus*)

Lacertidae
Short-nosed lizard (*Mesalina brevirostris*)

Gekkonidae
Slevin's sand gecko (*Stenodactylus slevini*)
Gulf short-fingered gecko (*Pseudoceramodactylus khobarensis*)
Persian leaf-toed gecko (*Hemidactylus persicus*)
Rough-tailed gecko (*Cyrtopodion scabrum*)
Baluch ground gecko (*Bunopus tuberculatus*)
Dwarf rock gecko (*Pristurus rupestris*)

Trogonophidae
Zarudnyi's worm lizard (*Diplometopon zarudnyi*)

Viperidae
Arabian horned viper (*Cerastes gasperetti*)*

Colubridae
Shokari sand snake (*Psammophis shokarii*)
Hooded malpolon (*Malpolon moilensis*).

Hydrophiidae
Ornate sea snake (*Hydrophis ornatus*)*
Arabian Gulf sea snake (*Hydrophis lapemoides*)*

Cheloniidae
Green turtle (*Chelonia mydas*)
Hawksbill turtle (*Eretmochelys imbricata*)
Leatherback turtle (*Dermochelys coriacea*)*

8.3 CONCLUSIONS AND RECOMMENDATIONS

A total of 18 reptile species belonging to eight different families were recorded within the buffer zone of Al Zubarah archaeological site during the survey in March 2012. This equals almost two thirds of all species previously known from the entire country. However, all recorded species are widespread in the gulf region and their occurrence in the area is neither surprising nor unique. Notably the marine turtles recorded in the area are of global conservation concern. The buffer zone does not include coral reef structures or sea grass beds substantial enough for the area to be regarded as important key habitat for these species. However, they do occur and forage here and may hence constitute the most important biological feature of the area to global biodiversity conservation.

The generally cold weather conditions during the survey and consequently inactive behaviour of the reptile fauna likely caused an underestimate of species abundance and possibly even species richness. To ensure that the list of species from the area is complete would necessitate further survey activity during a later part of the spring or early fall, when animals are at their peak activity. This would certainly also be necessary to ensure a more complete spatial mapping e.g. of the occurrence of Uromastyx in the area.

A few recommendations can be made regarding the conservation of the reptile diversity recorded in the buffer zone of Al Zubarah archaeological site. All grazing by domestic animals should be avoided to protect the vegetation in the area both as important micro habitat structure and as a source of food. This is particularly important for Uromastyx, but also for other species in this reptile assemblage. Compared to surrounding areas the buffer zone of Al Zubarah archaeological site is notably rich in vegetation due to hydrology and may therefore be considered important to local reptile conservation. Conversely little has been done to document the fauna in surrounding areas so it is premature to conclude anything on a larger spatial scale. Human disturbance in the area should be kept to a minimum and in particular sheltered areas of rocks, debris and vegetation should be left as is. Any bulldozing, re-location or removal of rocks, vegetation or building debris (new or historical) will likely be harmful to the resident reptile fauna, as these landscape features provide essential micro habitat. Similarly restoration practises on buildings at the archaeological site which include filling of crevices and polishing surfaces with cement like materials make the area less suitable reptile habitat. On the other hand excavation activities that expose parts of the ruins that are currently completely covered by sand can provide new suitable habitat for some species.

References

Arnold, E. N. 1980. Reptiles of Saudi Arabia. A review of the lizard genus Stenodactylus (Reptilia: Gekkonidae). *Fauna of Saudi Arabia* 2: 368-404

Arnold, E. 1986. A key and annotated check list to the lizards and amphisbaenians of Arabia. *Fauna of Saudi Arabia* 8:385-435.

Arnold, E. N. & Gardner, A. S. 1994. A review of the middle eastern leaf-toed geckoes (Gekkonidae: Asaccus) with descriptions of two new species from Oman. *Fauna of Saudi Arabia* 14: 424-441.

Baldwin, R., & Gardner, A.S. 2005. Marine Reptiles. Pp. 242–251. *In* The Emirates: A Natural History. Hellyer, P, and S. Aspinall (Eds.). Trident Press, London, U.K

Baha El Din, S. 1996. Terrestrial Reptiles of Abu Dhabi. Pp. 124-147 In Desert Ecology of Abu Dhabi - a Review and Recent Studies. Osborne, P.E. (Ed.). Pisces Publications, Newbury, U.K.

El-Sherif, G. & Al-Thani, A. S. 2000. Record, histological and enzyme histochemical demonstration of Qatari reptiles in relation to seasonal and environment variations. Report for First Part HE/45/95 Project SARC, University of Qatar: 3.

Gardner, A.S. 2005. Terrestrial reptiles. Pp. 229–241. In The Emirates: A Natural History. Hellyer, P, and S. Aspinall (Eds.). Trident Press, London, U.K

Gardner, A.S. 2008. The Terrestrial Reptiles of the United Arab Emirates: Herpetological History, Zoogeography and Conservation. Pp. 281–307. In Terrestrial Environment of Abu Dhabi Emirate

Gasperetti, J. 1988. The snakes of Arabia. *Fauna of Saudi Arabia* 9:169–450.

Gasperetti, J., Stimson, A.F., Miller, J.D., Ross, J.P. & Gasperetti, P.R.. 1993. Turtles of Arabia. *Fauna of Saudi Arabia* 13:170–367.

Hillenius, D. & Gasperetti, J. 1984. Reptiles of Saudi Arabia: the chameleons of Saudi Arabia. *Fauna of Saudi Arabia* 6: 513-527.

Hornby, R. 1996. A checklist of the amphibians and reptiles of the UAE. *Tribulus*, 6: 9-13.

Jongbloed, M. 2000. Field Guide to the Reptiles and Amphibians of the UAE. Atlas Printing Press.

Levinton, A. E., Anderson, S. C., Adler, K. & Minton, S. A. 1992. Handbook to the Middle East Amphibians and Reptiles. Society for the Study of Amphibians and Reptiles.

Mohammed M.B.H. 1988. Survey of the reptiles of Qatar. *Proceedings of the Zoological Society A.R. Egypt*, 15: 17-26.

Olson D, Dinerstein E, Wikramanayake E, Burgess N, Powell G, et al. (2001) Terrestrial ecoregions of the world: a new map of life on earth. Bioscience 51: 933-938.

Pritpal S. Soorae, Myyas Al Quarqaz, and Andrew S. Gardner. 2010. An Overview and Checklist of the Native and Alien Herpetofauna of the United Arab Emirates. *Herpetological conservation and biology*, 5:529-536.

Schätti, B. & Gasperetti, J. 1994. A contribution to the herpetofauna of Southwest Arabia. *Fauna of Saudi Arabia* 14: 348-423.

Uetz, P. (ed.), The Reptile Database, http://www.reptile-database.org, accessed July 2012

WWF 2006. WildFinder: Online database of species distributions, ver. Jan-06. www.worldwildlife.org/WildFinder

Figures

Figure 8.1: Lizards

Figure 8.2: Lizards

Figure 8.3: Snakes

Figure 8.4: Turtle

Figure 8.5: Rocky outcrops in the buffer zone represent hotspots for reptile diversity at Al Zubarah

9. PALEONTOLOGY

Jakob Walløe Hansen (Natural History Museum of Denmark, Øster Voldgade 5-7, DK-1350 Copenhagen K, Denmark, jwhansen@snm.ku.dk).

9.1 INTRODUCTION

During three seasons from 2009 through to 2012 geomorphology and hydrology studies was carried out in the Al Zubarah Region and NW Qatar (Macumber, 2009, 2010, and 2011). Both are two important factors when studying the relationship between earlier human occupation and the natural environment. As a part of the UNESCO application in 2011, a brief survey and following assessment report on the biosphere of the Al Zubarah Region was initiated. This programme was extended in 2012 with a month of field work covering all main areas of the zoology of the area, including the paleontology.

Preliminary paleontological sampling was carried out during the 2012 season in order to shed light on this unstudied part of the natural history. This involved smaller scale sampling in and around the ruins of the old town of Al Zubarah, where sub-fossils have been used as construction material. But fossils were also collected in the entire buffer zone along the coastline, on the mud plains, in the sabkha (and paleo-sabkha), and in the old canal and its ridges, as well as in the arid stony desert area towards the Al Zubarah Fort.

An extended part of the preliminary survey, took place in the Dukhan Region, especially at Umm Bab (80 km south Al Zubarah) where a prolific Eocene formation, yielding a high quantity of fossil shark teeth, had a certain interest.

This report covers the results of the surveys and tries to provide new information on the natural history of Al Zubarah and the Dukhan Region.

9.2 FINDINGS WITHIN THE BUFFER ZONE AT AL ZUBARAH

The Al Zubarah Region stretches over a vast area, and exhibits many different habitats and rock types.

Holocene deposits dominate the sabkha and mud plain areas, around the city ruins and close to the sea. Further inland, the prevalent habitat is arid stony desert, dominated by Eocene limestone. A certain habitat, labelled paleo-sabkha, covers the vast area in between the city ruins and the project compound. This is an area with low relief and only sparse vegetation. But huge quantities of Holocene fossils are present, and of which some were collected for reference (see species list).

The excavation at Al Zubarah testifies to the use of fossiliferous limestone for construction material. These building blocks consist predominantly of smaller gastropods and are used for both floors as well as for walls. These limestone building blocks originate from the Holocene deposits in the sabkha and mud plain areas.

The Eocene limestone (Dammam Formation) yields almost no fossil evidence other than the random gastropod and bivalve. These are of considerable size though; the gastropods can easily grow to be more than 25 cm long. But they are only exposed in very few and poor outcrops. The lithology is a very hard and dolomitized limestone and it appears that the population only occasionally used this rock type for construction material.

9.2.1 Species list

The fossils listed beneath are some of the most common among the sub-fossils found in the paleo-sabkha and on the present sabkha, as well as within the old city ruins. Furthermore, the fossil assemblage, include a large amount of especially gastropods. For studies on these, see end of season report by Dr. Aslak Jørgensen.

Anodontia edentula (Linnaeus, 1758). Toothless clam, normally found buried in mudflats in the intertidal and subtidal zones.

Asaphis violascens (Forsskål, 1775). Marine bivalve found in the intertidal mudflats.

***Barbatia* sp. (*Arcoidea*)**. Ark clam, normally stuck under stones and rocks on the shore, and normally covered by periostracum (Figure 9.1).

***Hexaplex* sp.** Large marine gastropod sometimes referred to as rock snail (Figre 9.2).

***Pinnidae* sp.** Large saltwater/marine clam sometimes called pen shell. Lives anchored in sediment using a byssus (Figure 9.3)

Strombus* (*Conomurex*) *persicus. Marine gastropod belonging to the true conchs (Figure 9.4).

***Tellinoidea* sp.** Marine bivalve living fairly deep in soft sediments in shallow seas. They respire using long siphons that reach up to the surface of the sediment.

***Turbo* sp.** Marine gastropod/large sea snail with gills and an operculum (Figure 9.5)

***Veneroidea* sp.** Venus clam with short siphon and long foot (Figure 9.6).

9.3 Findings at Umm Bab, Dukhan Region, Southern Qatar

Smaller scale operations took place during the field season of 2012. Amongst other places, the Eocene formations of the Dukhan Region were examined and a number of samples were brought home to the University of Copenhagen for processing and further studies.

The preliminary results of these examinations are quite spectacular. One small sample (approx. 250 grams) contained large quantities of fossil fragments from many animal groups, primarily from marine invertebrates such as echinoderms, foraminifera, and bivalves. Shark teeth were also present in large numbers (Figures 9.7 – 9.11). Species are not listed, but pictures of the relevant fossils are presented).

The geological surface of Qatar consists mainly of Eocene deposits (Al-Saad, 2005) and may so retain important information about the latest "greenhouse climate" of the Earth, since the Late Cretaceous. During this warm period, Qatar was situated centrally in the Tethyan Sea, which stretched from North Africa to East Asia. This area separated the warmer low latitudes from the cooler European Boreal Realm, making it an important location for environmental and faunal information.

Shark teeth are an interesting source for faunistic and climatic information. They take top positions in the marine food web and due to rapid tooth replacement; their teeth are fairly common in the geological record. Furthermore, the enameloid of the teeth are very resistant to diagenesis (Kolodny & Luz, 1991; Pucéat et al., 2003) and as such, an almost perfect agent for preserving isotopic information, which can be utilized for very precise climatic information.

Shark teeth are well known from the Midra Member of the Dammam Formation and may also occur in other formations. The last published paper on this important shark fauna was published by Casier (1971) and contained only larger taxa and thereby missed the important smaller species. This year's results show that many of the smaller species are also present, and many of these are new to science.

The before mentioned sample did contain more than 25 teeth; surprisingly so it also contained many fragments of marine invertebrates. Particularly the uncommon echinoderm morphological features attracted attention (Figure 9.11). These will be determined by experts from the Natural History Museum in London in order to properly determine the paleoecological characteristics.

9.4 CONCLUSIONS AND RECOMMENDATIONS

At present the fossils from the buffer zone can be attributed to the Holocene age but not further. The geomorphology provides strong evidence for the sea level increasing and decreasing several times during the same period. But at present there is no strong difference in the fossil assemblage of the paleo-sabkha and the present sabkha, and therefore a true fossil assemblage analysis would be beneficial.

Further studies of the geology of the buffer zone (and surrounding areas) can reveal a more complex solution to the natural history of the area. However, this will only be possible if large scale sampling is initiated. Furthermore it would require on shore and probably also off shore drilling to be initiated. Such a study should reveal structures within the sediments on which Al Zubarah rests; information than could enhance our understanding of the area.

Finally, it would be interesting to investigate the geological formations of the Dukhan area in order to obtain further knowledge of the fossil assemblage of especially the Dammam Formation. Such a project could be linked with a newly initiated project at the Natural History Museum of Denmark, on the selachian faunas from the Eocene of Denmark at Trelde Næs. Thus the first initial step for comparing the fossil faunas of Qatar and Denmark could be taken and may include advanced isotopic research utilizing the latest technology within oxygen studies in phosphates.

References

Al-Saad, H. 2005. Lithostratigraphy of the Middle Eocene Dammam Formation in Qatar, Arabian Gulf: effects of sea-level fluctuations along a tidal environment. Journal of Asian Earth Sciences 25: 781-789.

Casier, E. 1971. Sur un materiel ichthyologique des Midra (and Saila) shales du Qatar (Golfe Persique). Bulletin de l'Institut Royal des Sciences Naturelles de Belgique 47 (2): 1-9.

Kolodny, Y. & Luz, B. 1991. Oxygen isotopes in phosphate of fossil fish - Devonian to recent. *In* Taylor, H.P., O'Neil, J. R. and Kaplan, I. R. eds. Stable Isotope Geochemistry: A Tribute to Samuel Epstein. University Park, Geochemical Society 3: 105-119.

Macumber, P. 2009. Preliminary Report on the Geomorphology and Hydrology of the Al Zubarah Region, Northern Qatar.

Macumber, P. 2010. Geomorphology and Geoarchaeology. In Season 2 Report (2010). University of Copenhagen.

Macumber, P. 2011. Geomorphology, Hydrology and Occupation across North-Eastern Qatar – Geomorphological and Geoarchaeological Results from the third Season of the Copenhagen University Study in Northern Qatar.

Pucéat, E., Lécuyer, C., Sheppard, S.M., Dromart, G., Reboulet, S., & Grandjean, P. 2003. Thermal evolution of Cretaceous Tethyan marine waters inferred from oxygen isotope composition of fish tooth enamels. Paleoceanography 18 (2): 1029.

Figures

Figure 9.1: *Barbatia* sp. *(Arcoidea)*. (Photo by Sten Lennart Jakobsen).

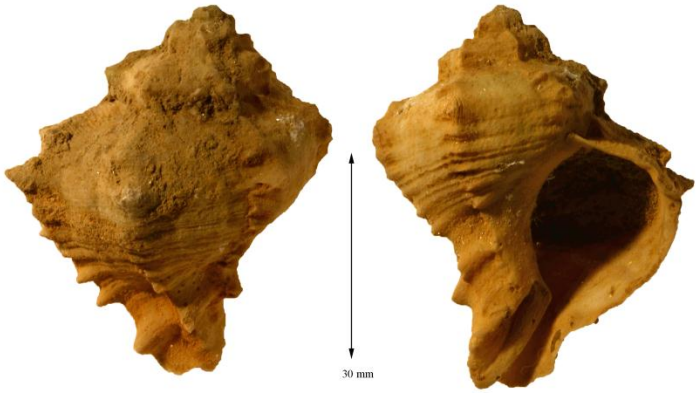


Figure 9.2: *Hexaplex sp.* (Photo by Sten Lennart Jakobsen)

Figure 9.3: *Pinnidae sp.* (Photo by Sten Lennart Jakobsen)

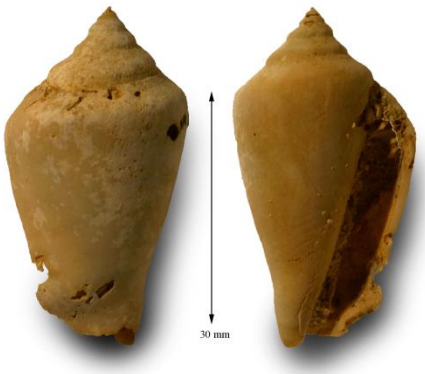


Figure 9.4: *Strombus (Conomurex) persicus*. (Photo by Sten Lennart Jakobsen)

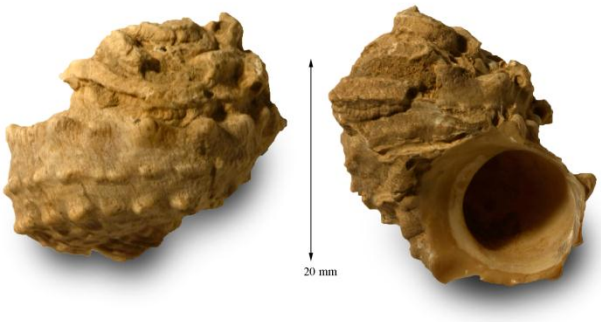
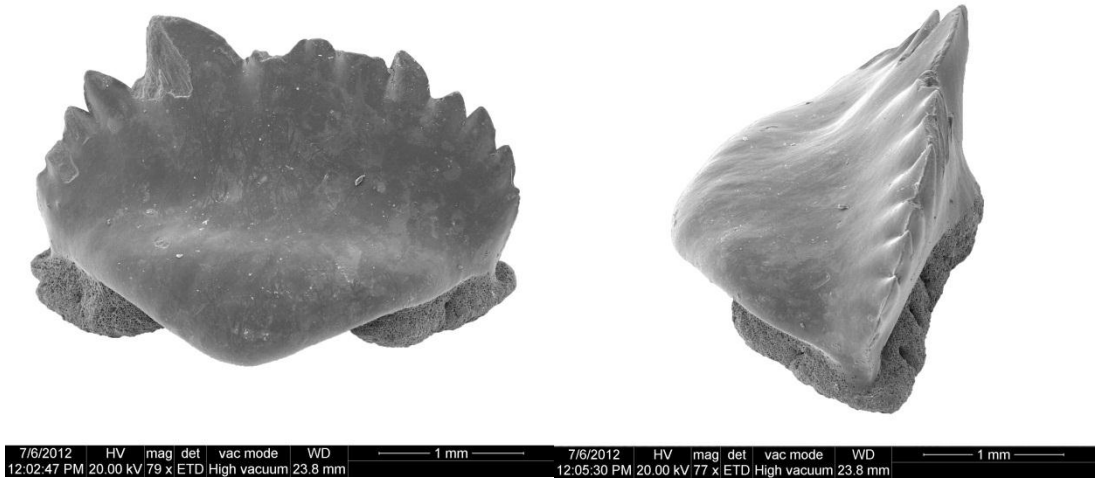


Figure 9.5: *Turbo sp.* (Photo by Sten Lennart Jakobsen)

Figure 9.6:. *Veneroidea sp.* (Photo by Sten Lennart Jakobsen)



Figures 9.7 and 9.8: Not yet described fossil shark teeth from Umm Bab, Dukhan Region. (SEM-photos by Jan Schulz Adolfssen)

Figures 9.9 and 9.10: Not yet described fossil shark teeth from Umm Bab, Dukhan Region. (SEM-photos by Jan Schulz Adolfssen)

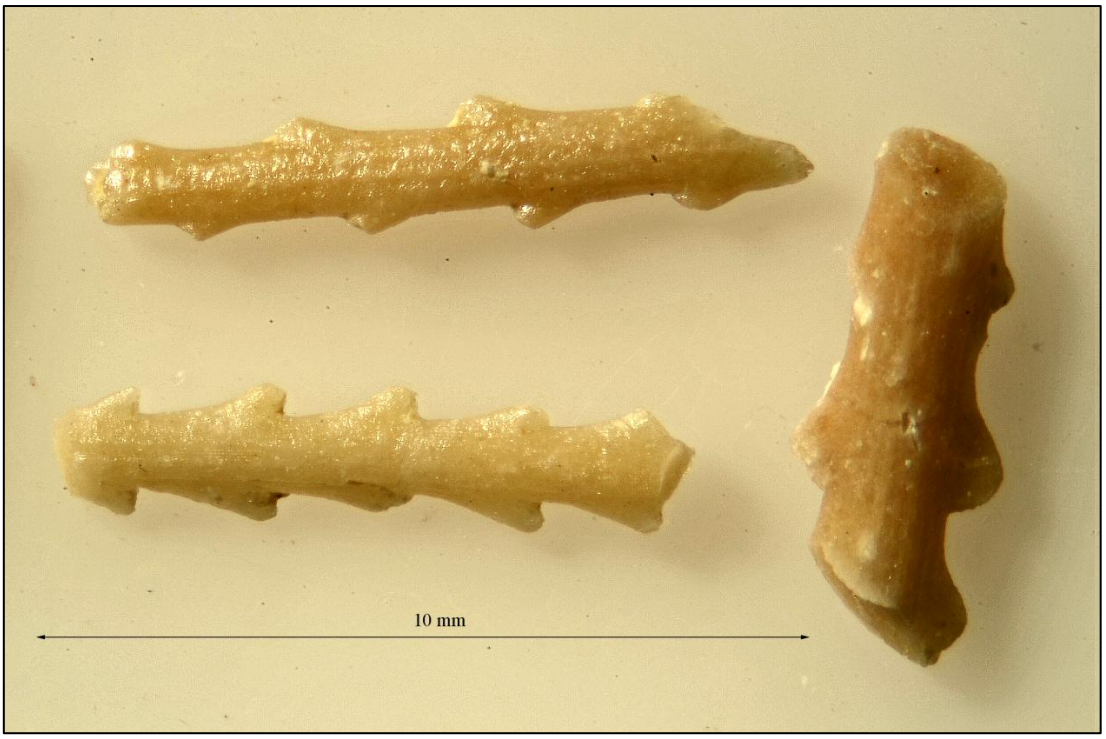


Figure 9.11: Echinoderm spines revealing special morphology features, yet to be described by experts. (Photo by Sten Lennart Jakobsen)

10. THE COMPARATIVE COLLECTION OF ANIMAL SKELETONS

Jeppe Møhl and Pernille Bangsgaard (the Natural History Museum of Denmark, Quaternary Zoology, Department of vertebrate, jeppemhl99@gmail.com and bangsgaardp@hotmail.com).

10.1 INTRODUCTION

The first biological field season of the QIAH project included the creation of a comparative collection due to the efforts of conservator Jeppe Møhl with some assistance from Pernille Bangsgaard. The aim of this collection is two-folds. Firstly, the comparative collection is a necessary tool for the Zooarchaeologists working with the excavated faunal remains from the QIAH excavations at Al Zubarah and other sites. These analyses were also initiated during the 2012 season. Due to this use the collection will be stored and used for scientific research at Al Zubarah camp in the coming years. Secondly, for the long term the comparative collection is intended to remain in Qatar as a tool for biological and zooarchaeological research. It is envisioned that the collection will become part of the planned Qatar Natural History Museum, where the collection can be maintained and remain accessible to other researchers.

During the previous archaeological field season in 2011 to 2012, it became clear that opportunities for collecting skeletons in NW Qatar was abundant, from marine animals and birds to all terrestrial mammals, wild and domesticated. The situation is probably mainly due to the dry climate, the flat landscape and sparse vegetation, thus creating optimal conditions for spotting cadavers. This combined with a large team of biologists, archaeological surveyors and archaeologists, who are constant moving within the area, create optimal conditions for retrieving multiple dead animals. For few of the domesticated species it was possible to buy a fresh animal, but in most cases a cadaver was the only option, due to cost concerns. Cadavers were also the only option for many of the wild animals, particularly those which are currently featured on the IUCN red list of threatened species, such as the green turtles, *Chelonia mydas*.

10.2 THE PROCESS OF CLEANING A SKELETON

The ideal procedure for **skeletonising** an animal is often hard to apply in the field, with less than ideal equipment. Furthermore the best starting point is a newly dead animal, which most of the found specimen in Qatar were not. But when possible the following procedure was followed:

1. *Ideally the following data was registered for all collected animals: secure species identification, measurements of body size, total body weight, in situ photograph of the animal and time and place of the find. In many instances, however, measuring and weighing the animal was not possible or useful due to the unset of putrefaction.*

2. *Skinning the animal and roughly skeletonising it, removing most meat and sinew. A wire was pushed through the spine and hand and foot bones were put in separate bags.*

3. *The roughly skeletonised animal was left to soak in plenty of water overnight to pull out any remaining blood.*

4. *The skeleton was then transferred to clean water, preferably kept at around 30 degrees. It was left for about 10 to 14 days depending on age and size of the animal. Enzymes or washing power was in some cases added at the beginning, to kick start the process. At the end of the putrefaction process all meat, tendons and sinew should have dissolved or at least be completely soft and loose.*

5. *In order to stop the process of putrefaction the skeleton was briefly boiled. Some soda or chlorine was added to the mixture to slightly bleach the bones or were subsequently left over night in cold water with 2% chlorine added. Any residue of meat, fat or soft tissues should loosen during the final boiling.*

6. *The skeleton was then rinsed in running water over a fine sieve, so none of the small bones were lost. The bones were then gently dried. In order to avoid cracking, particularly of the teeth, direct sunlight was avoided.*

The skeletal material we found in Qatar varied significantly in species and state. In most cases the animals were far from fresh, more rotting or downright mummified. Due to the cold nights we found that step 4 often did not lead to proper putrefaction even though the highest day temperature was around or above 30 degrees. Therefore step 4 was most often followed by a longer more intensive boiling with extra Chlorine added, in order to loosen the remaining tissues that could then be removed manually.

10.3 THE COLLECTION

All the cleaned skeletons were subsequently packed in boxes with tags contained information on the collection number, species, find location and date. All are currently stored in one of the containers on site, at Al Zubarah Camp. In total 40 more or less complete skeletons have so far been processed (table 10.1). These include at least 18 different species and some are therefore clearly represented multiple times, such as domesticated sheep (8 complete skeletons) and green sea turtle (3 skulls and 4 complete skeletons). The remaining species include mainly mammals, marine and terrestrial, but also birds and reptiles are represented. Additionally, work on a collection of fish skeletons have also begun, but this is not included in the current report.

A comparative collection intended purely for field identification purposes does not necessarily have to include multiple specimens from each species, although it may prove useful for sex differentiation and age distinction. But due to the intended destination in the Qatar Natural History Museum it is well worth the effort to collect as many skeletons as possible. Such a large scale collection may serve as the base for much research in the future.

10.4 OTHER WORK PROCESSES

A small part of the collection has been temporarily deposited with the school service program. These include three skulls and the lower leg of a horse (table 10.2). They are intended to be used in the coming season for the many school visits where the story of the wild life and nature of the area is included.

An experimental treatment was initiated this season with two small cadavers, a house mouse and a cape hare (table 10.3). These were skinned and emptied for intestine and then deposited in baskets of fine mesh. Due to the substantial amount of dermestid beetles that were attracted by the cadavers we decided to test if smaller animals left out in the open could be process to cleaned skeletons by the insects during the summer. The fine mesh baskets were then deposited inside an iron frame with a heavy-duty mesh for safekeeping from potential scavengers.

Due to time constraints a small number of dried-out or in some instances almost mummified animals were wrapped in plastic and packed up without further treatment. These will be processed next season when more time is available (table 10.4). Finally, three partially cleaned skeletons were buried near the camp (table 10.5) also to be processed next season.

In total this group include a further 7 species of animals, that can be added to the current comparative collection of 40 skeletons from 18 species.

10.5 CONCLUSION AND RECOMMENDATIONS

During 2012 season the creation of a comparative collection of modern skeletons was initiated. 40 more or less complete skeletons from at least 18 different species were processed during this time. They represent a substantial start to what will hopefully become a large collection of animal skeletons that may serve as the base for future zooarchaeological and biological research in Qatar. A placement with the future Qatar Natural History Museum has therefore been arranged. The results from the current season clearly show the potential for building such a collection as part of the QIAH field seasons and with fairly limited funds due to the large amount of animals that can be found in NW Qatar.

It is therefore the recommendation of this report that a least two to three seasons of field work are to include a trained conservator, who can work together with the zooarchaeologists and biologists, developing the comparative collection. Such initiative would also be useful for the future school service program and the planned visitors centre in order to prepare materials for exhibits on the modern biology of the area.

Tables

Table 10.1 Comparative Collection of animal skeletons.

No	Species	Skeletal Information
1	Dugong, *Dugong dugon*	Skull, unknown age and sex, very large specimen
2	Green Sea Turtle, *Chelonia mydas*	Skull, unknown age and sex, fusing
7	Ethiopian hedgehog, *Paraechinus aethiopicus*	Partial skeleton, unknown age and sex
8	Socotra cormorant, *Phalacrocorax nigrogularis*	Complete skeleton, unknown sex, juvenile, PIC
9	Dromedary, *Camelus dromedarus*	Near complete skeleton, unknown age and sex, PIC
10	Lesser Crested Tern, *Sterna bengalensis*	Partial skeleton – unknown age and sex
11	Sheep, *Ovis aries*	Complete skeletons, big female, adult, black and a little white coat, PIC
12	Sheep, *Ovis aries*	Almost complete skeleton, smaller female, adult, brown and white coat, PIC
13	Green Sea Turtle, *Chelonia mydas*	Complete skeleton, unfused skull, unknown sex and age, PIC
14	Cat, *Felis* sp.	Mandible, unknown age and sex
15	Spiny tailed lizard, *Uromastyx aegyptia*	Partial skeleton, most limb bones are missing, *PIC*
16	Dugong, *Dugong dugon*	Skull, unknown age and sex, adult
17	Green Sea Turtle, *Chelonia mydas*	Skull, unknown sex and age, adult, fusing
18	Dromedary, *Camelus dromedarus*	Skull, unknown age and sex,
19	Dugong, *Dugong dugon*	Partial skeleton, unknown age and sex
20	Dolphin, *Delphinidae* sp.	Partial skeleton – maxilla missing, unknown age and sex, PIC
22	Sea snake, *Hydrophis lapemoides*	Complete skeleton, unknown age and sex, PIC
23	Socotra Cormorant, *Phalacrocorax nigrogularis*	Complete skeleton, unknown age and sex, PIC
25	Green Sea Turtle, *Chelonia mydas*	Complete skeleton, juvenile, unknown sex, PIC, carapace length 24cm, width 22 cm, weight: 1120 g
26	Green Sea Turtle, *Chelonia mydas*	Complete skeleton, juvenile, unknown sex, PIC, carapace length 30cm, width 28cm, weight: 1860 g
27	Horse, *Equus caballus*	Near complete skeleton, unknown age and sex
29	Domesticated cat, *Felis catus*	Complete skeleton, adult, unkown sex, PIC
30	Chicken, *Gallus gallus domesticus*	Partial skeleton, adult and male
32	Dog, *Canis familiaris*	Complete skeleton, juvenile male of what looks like a golden retriever/German Shepard mix
33	Green Sea Turtle, *Chelonia mydas*	Skull, unknown sex and age, adult, fusing
34	Green Sea Turtle, *Chelonia mydas*	Complete skeleton, adult, unknown sex, PIC carapace length 109cm, width 93cm
36	Medium size gull, *Larus* sp.	Complete skeleton, unknown age and sex, PIC
38	Grey Heron, *Ardea cinerea*	Complete skeleton, unknown age and sex, both wings broken, PIC
39	Domesticated cat, *Felis catus*	Complete skeleton, adult, probably male
41	Sundevall´s jird, *Meriones crassus*	Complete skeleton, unknown age and sex, PIC
42	Sheep, *Ovis aries*	Partial skeleton, unknown age and sex – probable male
43	Spiny tailed lizard, *Uromastyx aegyptia*	Partial skeleton, juvenile unknown sex,
45	Sheep, *Ovis aries*	Almost complete skeleton, pullus, unkown sex
46	Sheep, *Ovis aries*	Almost complete skeleton, juvenile, unkown sex

47	Sheep, *Ovis aries*	Almost complete skeleton, pullus, unkown sex
48	Sheep, *Ovis aries*	Almost complete skeleton, juvenile, unkown sex
49	Sheep, *Ovis aries*	Almost complete skeleton, juvenile, unkown sex
50	Sundevall´s jird, *Meriones crassus*	Complete skeleton, unknown age, male
51	Brown rat, *Rattus norvegicus*	Complete skeleton, unknown age and sex
56	Dugong, *Dugong dugon*	Skull, adult, unknown sex, very large specimen

Table 10.2 Skeletons currently on loan to the school service program.

No	**Species**	**Skeletal Information**
3	Dromedary, *Camelus dromedarus*	Skull, unknown age and sex
53	Ethiopian hedgehog, *Paraechinus aethiopicus*	skull, adult, unknown sex
54	Domesticated cat, *Felis catus*	skull, adult, unknown sex
55	Horse, *Equus domesticus*	Front leg, unknown age and sex

Table 10.3 Collected specimens that are partially processed, now in experimental treatment.

No	**Species**	**Skeletal Information**
44	House mouse, *Mus musculus*	Complete skeleton, unknown age and sex.
52	Cape hare, *Lepus carpensis*	Complete skeleton, unknown age and sex.

Table 10.4 Collected animal skeletons that has not been processed

No	**Species**	**Skeletal Information**
21	Tortoise, *testudinidae* sp.	Complete skeleton, unknown age and sex
24	Large white-headed gull, *Larus* sp.	Complete skeleton, adult, unknown sex, PIC, Probably Caspian (*L. cachinnans*)
28	Dove, *Columba* sp.	Complete skeleton, pullus and unknown sex
31	Ethiopian hedgehog, *Paraechinus aethiopicus*	Complete skeleton, unknown age and sex, PIC
35	Lilith Owl, *Athene (noctua)lilith*	Complete skeleton unknown age and sex, PIC
37	Socotra Cormorant, *Phalacrocorax nigrogularis*	Complete skeleton, unknown age and sex, PIC
40	Common Redshank, *Tringa tatatus*	Complete skeleton, unknown age and sex, PIC

Table 10.5 Collected animal skeletons that has been buried

No	**Species**	**Skeletal Information**
4	Dugong, *Dugong dugon*	Partial skeleton, juvenile
5	Dolphin, *Delphinidae* sp.	Partial skeleton, unknown age and sex
6	Sheep, *Ovis aries*	Partial skeleton, unknown age and sex

Figures

Figure 10.1: Collecting and processing animals

Figure 10.2: Some of the processed animal skeletons in the comparative collection


هيئة متاحف قطر
QATAR MUSEUMS AUTHORITY


UNIVERSITY OF
COPENHAGEN


QATAR ISLAMIC ARCHAEOLOGY AND
HERITAGE PROJECT
مشروع قطر لعلم الآثار و التراث الإسلامي