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ORIGINAL PAPER

Fishing at the Late Islamic settlement in Kharā'ib al-Dasht, Failaka Island, Kuwait

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Abstract

The Kharā'ib al-Dasht settlement, located on the north-eastern coast of the island of Failaka in Kuwait, has been excavated systematically since 2013 by the Kuwaiti-Polish Archaeological Mission. The investigated area yielded remains dated to the Late Islamic period, from the late seventeenth to the nineteenth century. In the northernmost part of the site, a fish processing area was uncovered, while the remains of residential structures (houses 1 and 2), as well as a mosque, were discovered in the eastern part of the site. Concentrations of fireplaces, hearths and ovens were discovered inside the houses and courtyards of what seems to be the centre of the settlement as well as from the periphery of the site. Fishing was evidenced not only by the presence of fish bones but also by recovered fishing technologies, including the remains of stone fish traps that were discovered in the coastal waters near to the site. The excavations yielded 12,182 bones of marine fishes. Twenty eight families are represented, including six families of cartilaginous fishes. Ariidae bones were most numerous followed by Haemulidae, Sciaenidae and Carcharhinidae. The analysis of the assemblage shows that fishing could have been of great importance to the inhabitants of the settlement. Moreover, we attest different patterns in the fish assemblages between the two different parts of the village. The fish processing area can be seen as a workplace, while the daily activity took place in the village. These differences can also be used to shed light on the fishing techniques these people used.

Keywords Late Islamic period · Late Islamic settlement · Fish processing · Fishing · Fishing techniques

Introduction

Failaka Island lies in the Arabian Gulf, some 20 km off the Kuwaiti coast (Fig. 1). The results of archaeological research conducted since the 1950s indicate that the island was settled from at least the third millennium BC until the Late Islamic period (Bibby 1969, pp. 195–212; Højlund and Abu-Laban 2016; Grassili and Di Miceli 2018). Early twentieth century texts state that the primary occupations of Failaka's inhabitants were fishing and, to a lesser extent, farming. Although the presence of freshwater sources is mentioned in some textual evidence (Persian Gulf Gazetteer 1904, p. 56; Lorimer 1908, p. 513), including sixteenth century Portuguese maps that label Failaka as Ilha de Aguada, meaning 'island of the water well' (Slot 1991, p. 59), recent discoveries by the Kuwaiti-Georgian Archaeological Mission indicate that by the Late Islamic period, the island's inhabitants also collected rainwater (Chkhvimiani et al. 2021).

Kharā'ib al-Dasht (20°27′47.45″N, 48°18′59.22″E) was a large Late Islamic settlement, the remains of which stretch approximately 600 m along Failaka's north-eastern coast (Fig. 1). The site was first registered during a survey in 1976 and dated to the Late Islamic period (AD 1650–1870) (Patitucci and Uggeri 1984, p. PL. XXXV:a; Mierzejewska 2021). Regular archaeological investigations at the site have been conducted since 2013 by the Kuwaiti-Polish

This paper is dedicated to the memory of Marta Mierzejewska.

This article is part of the Topical Collection on *Fishing Over the Millennia*

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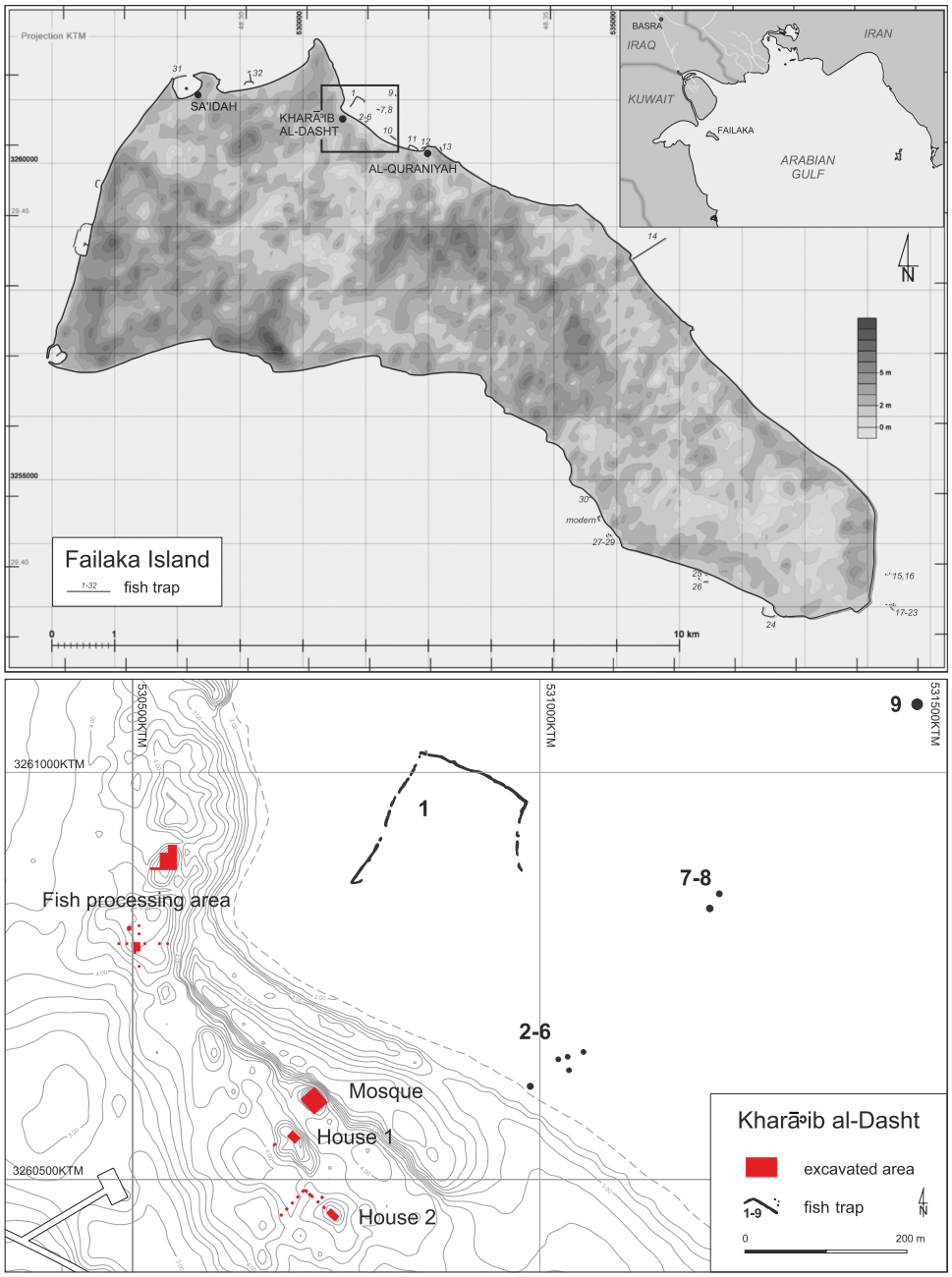

Fig. 1 Location of Failaka Island and Kharā'ib al-Dasht (top) (S. Lenarczyk, P. Zakrzewski), map of the site (bottom) (drawing by M. Puszkarski); fish traps are numbered from 1 to 8

Archaeological Mission, co-organised by the Polish Centre of Mediterranean Archaeology, University of Warsaw, and the National Council for Culture, Arts and Letters, Kuwait. Six seasons of excavation uncovered parts of the settlement — a small hill with a cluster of ovens, hearths and fireplaces in the north, and the remains of two houses and a mosque in the east (Fig. 1). The site yielded numerous finds characteristic of fishing, mostly fishing net weights, anchors and metal hooks. In addition, numerous animal remains were excavated inside the structures and around them, including many fish bones. The waterfront area of the site was also investigated, and several fish traps were registered there.

The goal of this paper is to present the analysis of the fish remains demonstrating that fishing and fish processing were conducted by the Late Islamic inhabitants of Kharā'ib al-Dasht.

Chronology

Two main chronological phases have been identified at the site. Research of the earliest phase, I, in over a dozen test trenches below the foundation levels of the houses and the mosque has, to date, not uncovered any structural remains

that would indicate residential activity. The presence of clay ovens and hearths of the same type as were found within the houses and in the northern part of the site dated to the later phase was characteristic here. Based on the pottery recovered from the test trenches, which was excavated below the foundation level of the mosque, phase I was dated to the Late Islamic 1a (approximately AD 1650–1720). Phase II, evidenced by the fishing huts in the fish processing area and the houses, was dated to the Late Islamic 1b–2a (AD 1720–1870) based on the pottery found on the plateau in the northern part of the site and from the two houses. As the mosque yielded only scarce ceramic material, it is impossible to provide reliable dating on this basis (Mierzejewska 2021).

Based on the accounts of a plague in AD 1839 that led to the depopulation of Failaka (Jones 1856, p. 51), Kharā'ib al-Dasht was likely deserted in the mid-nineteenth century. However, it is possible that some seasonal activities continued in the northern part of the site, perhaps even until the beginning of the twentieth century, as indicated by the presence of pottery that has been found in modern pits and landfills (Mierzejewska 2021).

Material and methods

Based on concentrations of pottery as well as the installations, including the presence of structures identified during a survey, several areas were selected for excavation. It is important to note that the research is still at a preliminary stage and the following paper only discusses the material uncovered from selected ovens and layers identified in the fish processing area, in house 1 and below the foundation level of the mosque.

Animal remains were successively registered and collected by hand and by sieving through a 5-mm mesh during field work. Archaeoichthyological material was separated from other remains and has been undergoing continued identification since 2017. The remains of cuttlefish (Mollusca) were also included in the analysis as a common marine resource that can be obtained using the same techniques as for fish. Mammal bones await analysis. The fish remains were dry and partially weathered to a similar degree, but a large proportion of them were preserved, including complete or nearly complete skeletons. Most of the contexts (especially the lower parts of the ovens and layers adjacent to the ovens) contained a large proportion of the burned bones and had been mixed with ash. The total number of the studied remains amounted to 12,182 fragments.

The identification of the fish remains was carried out at the Royal Belgian Institute of Natural Sciences, Brussels. The excavated remains were also compared to specimens from the collection of the institute to estimate the size of sharks and fish of the Ariidae family. The identification of fish remains from the Persian Gulf region is, in general, problematic (Yeomans and Beech 2021). The similarity of the remains of fish from the same family complicates precise determination of the bones, as does the state of preservation of the remains and their fragmentation. Therefore, most of the remains from Kharā'ib al-Dasht were identified to the family level, while identification to the genus or species level was only possible in a very limited number of cases. The characteristic elements used for the identification of the fish remains depended on the level of accuracy of the determinations. In the case of the determination to the family level, well-preserved characteristic cranial elements and vertebrae were used. In the case of the identification to the genus/species level, only some elements were taken into consideration:

a. Vertebrae: cartilaginous fish, *Chanos chanos*, *Pampus argenteus*, *Pseudorhombus* sp., *Euthynnus affinis* (exclusively last caudal vertebrae) and *Sarda sarda* (exclusively last caudal vertebrae)
b. Neurocranium: *Pomadasys* sp., *Pomadasys stridens*, *Otolithes* sp., *Argyrops spinifer*, *Tenualosa ilisha*
c. Oromandibular, hyoid and pectoral bones: *Pomadasys* sp. (articular, basioccipital, ceratohyal, cleithrum, dentary, entopterygoid, epihyal, interopercular, maxilla, opercle, palatinum, parasphenoid, pharyngeal plate, postcleithrum, posttemporal, premaxilla, preopercle, quadrate, supracleithrum and vomer); *Platycephalus indicus* (articular, basioccipital, ceratohyal, cleithrum, dentary, epihyal, hyomandibular, palatinum and quadrate); *Otolithes* sp. (articular, dentary and premaxilla); *Acanthopagrus* sp. (dentary, maxilla and premaxilla); *Argyrops spinifer* (premaxilla); *Sparidentex* sp. (maxilla and premaxilla); *Chelon* sp. (vomer); *Chirocentrus nudus* (dentary); *Plectorhinchus* sp. (premaxilla); *Pseudotolithus* sp. (premaxilla); and *Siganus* sp. (cleithrum)

The variations in size between fish of different species within a family group were too significant to undertake the assessment of size without knowing the species. Therefore, the discussion concerning the established size of fish must be limited to catfish of the Ariidae family and cartilaginous fish widely represented in the reference collection.

According to the FAO and other guides (Kuronuma and Abe 1972; Fischer and Bianchi 1984; Carpenter et al. 1997, pp. 121–122) as well as the updated checklist by Bishop (Bishop 2003), the Ariidae family is represented in the region by only four species: *Netuma bilineata*, *Plicofollis*

dussumieri, *Plicofollis layardi* and *Netuma thalassina*. Only *Netuma thalassina* may exceed 75 cm SL, reaching up to 185 cm TL (Sommer et al. 1996, p. 376). However, according to Randall (1995), the length of individuals > 100 cm should be carefully verified. On the other hand, the common length in this species is similar to the length of the remaining three species. Based on the shape of the neurocrania, it seems that only two of them were present in the archaeoichthyological material from Kharā'ib al-Dasht, but due to the lack of reference material, it is impossible to determine the species with certainty. Therefore, the remains present in the assemblage from the site were compared with specimens of *Netuma thalassina*, the only Ariidae species from the region available in the reference collection. The size of catfish (SL) was, for the most part, provided in three groups: small (< 30 cm), medium-sized (30–40 cm) and large (> 50 cm).

The size of sharks was also established based on the reference collection. The analysed vertebrae were compared with the vertebrae of individuals of known size. The shark size groups were defined based on the proportions of vertebrae depending on their position in the skeleton characteristic of the orders/families of these cartilaginous fish. The last caudal vertebrae were not used for the size estimation. The size (TL) was analysed in the following class groups: < 50 cm, 51–100 cm, 101–150 cm, 151–200 cm and > 200 cm.

The material contained a large number of vertebrae of bony fish. Therefore, the series of measurements of the maximum width of the vertebral centrum were taken. The differences in size between the different precaudal vertebrae of one individual are much smaller than those of caudal vertebrae; for that reason, only the measurements of precaudal vertebrae were taken into consideration. The results were presented as a series of diagrams and showed only general tendencies.

A number of individual specimens (NISP) were recorded for all contexts. The minimum number of individuals (MNI) was counted only for closed contexts, such as ovens, hearths, fireplaces and pits that were most likely sealed naturally or artificially shortly after the deposition of supplies or waste. The MNI of each taxon was estimated based on the single element of the skeleton most frequently represented, taking the size of the bones into consideration as well.

The presentation of families is based on the latest taxonomic classification of recent fish (Van Der Laan et al. 2014).

Cut marks were recorded as well as traces of burning; however, the processes of butchery were not discussed in the paper as only three cranial elements of Haemulidae excavated in house 1 bore them.

Description of the contexts and general results

Phase I (Late Islamic 1a, AD 1650–1720).

Fish remains from the mosque area

The mosque at Kharā'ib al-Dasht was situated a few dozen metres north of house 1 (Fig. 1). It was most likely located outside the residential area as no residential structures were found in the proximity of the mosque. The outline was typical for small mosques of the Late Islamic period found in the region (Petersen and Grey 2012; Al-Mutairi 2017, 276–83; King 2004, pls. 4, 7, 11). The entire unit measured 19 × 20 m and consisted of a prayer room with pillars and a courtyard (*ṣaḥn*) surrounded by a wall. Nearly no animal remains were found in the mosque, except for two small unidentified fish bones that were recovered from the walking level of the courtyard (Table 1). Test trenches, however, revealed remains of clay ovens below the foundation level of the mosque. Due to the limited scale of the excavations in this area, the ovens remained unexplored, but a small number of fish remains were found in the layers around them, providing the only evidence of fish processing from the oldest phase, I. Details of the fish composition are given in Table 1. Cranial elements of catfish of the Ariidae family are most common (35 fragments) followed by the vertebrae of the requiem sharks (Carcharhinidae). Six other taxa were represented by only a few bone fragments. A fragment of a cuttlebone of the cuttlefish (Sepiidae) was also registered (Table 1).

Phase II (Late Islamic 1b–2a, AD 1720–1870).

Fish remains from the fish processing area

Research in the northern part of the site was concentrated on a small plateau, 40 × 60 m (Fig. 2), which was distinctive due to the abundance of small clay ovens and hearths (88 recorded, 20–40 cm in diameter) (Fig. 3) as well as refuse pits. The only excavated remains of architecture were two small single-roomed structures measuring approximately 4 × 8 m each, both very poorly preserved. The remains of hut 1 were identified only by the lowest series of stones. Its walls, 0.6–0.8 m wide, were built from beachrock slabs arranged in two rows and bonded with silt mortar mixed with lime, while the space between the stones was filled with smaller rocks. In the case of hut 2, the outline of the structure was established based on a barely visible shadow foundation wall.

A preliminary stratigraphic analysis suggests the presence of two phases of use in this area. The oldest phase, I, was

Table 1 Fish remains from Kharā'ib al-Dasht: NISP and relative frequencies of the finds

Taxon		Late Islamic 1a	Islamic 1b–2a													
		Mosque area	Fish processing area								House 1					
		Layers	Layers		Pits		Installations		Total		Layers		Pits		Installations		Total	
		n	n	%	n	%	n	%	n	%	n	%	n	%	n	%	**n**	%
Orectolobiformes	Orectolobidae (carpet sharks)												21	0.49			21	0.20
Lamniformes	Lamnidae (mackerel sharks)		1	0.10					1	0.07	2	0.05					2	0.02
Carcharhiniformes	Triakidae (houndsharks)		3	0.29	1	0.33	1	0.77	5	0.34	3	0.07					3	0.03
	Carcharhinidae (Requiem sharks)	13	225	21.66	113	36.93	29	22.31	367	24.88	228	5.28	115	2.67	46	2.41	389	3.70
	Sphyrnidae (hammerhead sharks)		31	2.98	6	1.96	9	6.92	46	3.12	5	0.12					5	0.05
Myliobatiformes	Myliobatidae (eagle rays)										76	1.76					76	0.72
Batoidea (rays) indet		1	35	3.37	20	6.54	3	2.31	58	3.93	102	2.36	65	1.51	29	1.52	196	1.86
Chondrichthyes (cartilaginous fish) indet		1	5	0.48	3	0.98	1	0.77	9	0.61	8	0.19	6	0.14			14	0.13
Total Chondrichthyes		15	300	28.87	143	46.73	43	33.08	486	32.95	424	9.82	207	4.81	75	3.93	706	6.71
Clupeiformes	Clupeidae (herrings, sardines, shads)		11	1.06	18	5.88	6	4.62	35	2.37	20	0.46	98	2.28	26	1.36	144	1.37
	Chirocentridae (wolf herrings)				2	0.65	1	0.77	3	0.20	1	0.02	16	0.37	14	0.73	31	0.29
Gonorynchiformes	Chanidae (milkfish)		1	0.10	2	0.65	3	2.31	6	0.41	9	0.21			1	0.05	10	0.10
Siluriformes	Ariidae (sea catfish)	35	42	4.04	9	2.94	3	2.31	54	3.66	711	16.47	851	19.79	529	27.70	2091	19.87
Beloniformes	Belonidae (needlefish)										1	0.02					1	0.01
Scorpaeniformes	Platycephalidae (flatheads)		8	0.77	2	0.65	5	3.85	15	1.02	31	0.72	47	1.09	13	0.68	91	0.86
Perciformes	Serranidae (groupers)		13	1.25	14	4.58	3	2.31	30	2.03	73	1.69	58	1.35	14	0.73	145	1.38
	Carangidae (jacks, jack mackerels, trevally)	3	7	0.67	1	0.33	1	0.77	9	0.61	28	0.65	6	0.14	9	0.47	43	0.41
	Lutjanidae (snappers)										4	0.09					4	0.04
	Haemulidae (grunts, sweetlips, rubberlips, hotlips)	2	5	0.48	8	2.61	1	0.77	14	0.95	376	8.71	111	2.58	14	0.73	501	4.76
	Sparidae (porgies, seabreams)	1	3	0.29	5	1.63			8	0.54	34	0.79	33	0.77	1	0.05	68	0.65
	Lethrinidae (emperors)		5	0.48					5	0.34	6	0.14	2	0.05	5	0.26	13	0.12
	Nemipteridae (threadfin breams)												5	0.12			5	0.05
	Sciaenidae (drums, croakers)	8	55	5.29	12	3.92	4	3.08	71	4.81	159	3.68	185	4.30	81	4.24	425	4.04
	Polynemidae (threadfins)										1	0.02					1	0.01
	Mugilidae (mullets)	2	13	1.25	3	0.98			16	1.08	4	0.09	1	0.02	6	0.31	11	0.10
	Siganidae (rabbitfish)										2	0.05	1	0.02			3	0.03
	Sphyraenidae (barracuda)		1	0.10					1	0.07	2	0.05			3	0.16	5	0.05
	Trichiuridae (cutlassfishes)		1	0.10	4	1.31			5	0.34	8	0.19	33	0.77			41	0.39
	Scombridae (mackerels)		2	0.19	2	0.65			4	0.27								
	Stromateidae (silver pomfret)				1	0.33			1	0.07								

Table 1 (continued)

Taxon		Late Islamic 1a		Islamic 1b–2a															
		Mosque area		Fish processing area						House 1									
		Layers		Layers		Pits		Installations		Total		Layers		Pits		Installations		Total	
		n		n	%	n	%	n	%	n	%	n	%	n	%	n	%	**n**	%
Pleuronectiformes	Paralichthyidae (large-tooth flounders)											2	0.05	13	0.30	1	0.05	16	0.15
Teleostei (bony fish) indet		54		572	55.05	80	26.14	60	46.15	712	48.27	2420	56.07	2633	61.23	1118	58.53	6171	58.63
Total Teleostei		105		739	71.13	163	53.27	87	66.92	989	67.05	3892	90.18	4093	95.19	1835	96.07	9820	93.29
Mollusca	Sepiidae (cuttlefish)	1				2				2		39		6		13		58	

only partially investigated and yielded 12 ovens and hearths which were not explored. Seventy-six of the 88 installations and two huts, corresponding to phase II in house 1, suggest the period of most intense activity. The analysed archaeoichthyological material from this area was collected from only ten ovens and five pits (Table 1).

The activities associated with fishing and fish processing in this part of the site were confirmed by bones discovered in layers, pits and installations; specifically, these were five pits, three fireplaces, four hearths and three ovens (Appendix Table 5), all dated to the Late Islamic 1b–2a period.

Elements of fish bones were predominant in the fills of three pits (pits 2–4). It is very interesting that in the case of pits 3 and 4, where cartilaginous fish vertebrae were more frequent, the number of bony fish remains was small, represented mostly by cranial elements and some vertebrae. On the other hand, cartilaginous fish vertebrae were scarce in pit 2, where bony fish elements were the most abundant (with similar amounts of cranial elements and vertebrae). Additionally, two fragments of cuttlebone were discovered in pit 2. Pits 1 and 5 contained only a few fish remains (Appendix Table 5).

Almost no fish bones were registered in the fireplaces (fireplaces 6, 7 and 9), while most of the hearths (hearths 2, 8 and 10) and the ovens (ovens 3, 4 and 5) yielded sparse archaeoichthyological material. Only hearth 1 contained a somewhat larger amount of bones, but these were small fragments, and most of them remain unidentified (Appendix Table 5).

More abundant deposits of fish remains were found in the layers between the huts and inside the huts. The number of bony fish remains was almost twice as high as that of sharks and rays (Table 1). Cartilaginous fish were represented exclusively by vertebrae from four families (Lamnidae, Triakidae, Carcharhinidae and Sphyrnidae), among which requiem sharks predominated and some unidentified rays and sharks. Bony fish remains belonged to 16 families, with the bones of the Sciaenidae and Ariidae being the most numerous. In addition, bony fish material had a much higher proportion of vertebrae than cranial elements. The remains of Sciaenidae in particular were characterised by the prevalence of vertebrae, while some other families, such as Carangidae, Chanidae, Clupeidae, Mugilidae, Platycephalidae, Scombridae, Sphyraenidae and Trichiuridae. were exclusively represented by vertebrae. Cranial elements were predominant only in the case of catfish of the Ariidae family. The representation of fish in installations and pits varied; in general, the remains of the more numerous specimens were recorded in pits (Appendix Table 6).

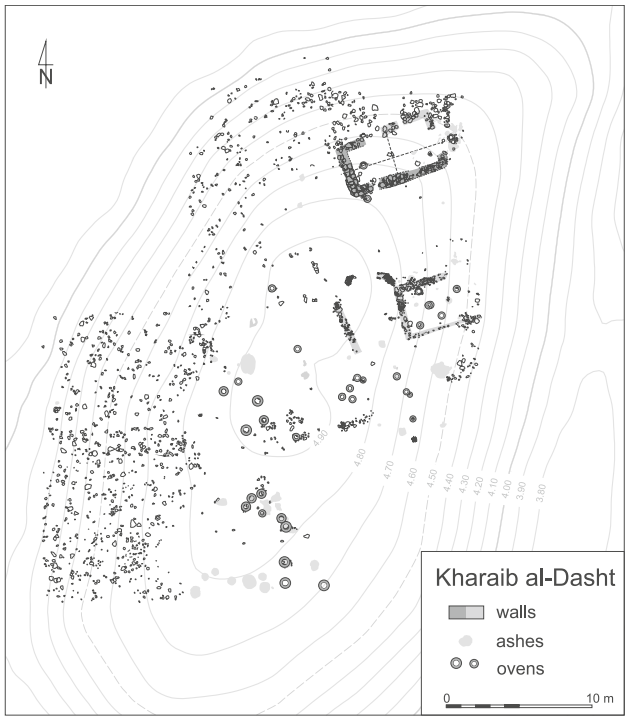

Fig. 2 Plan of the northern part of the site (drawing by E. Mizak, P. Zakrzewski)

Fish remains from house 1

The uncovered fragment of house 1 comprised a courtyard and four rooms adjoining it from the north and east (Fig. 4). The courtyard (locus 11) was 6.5 m wide and, so far, has been excavated to a length of approximately 7.5 m. The largest of the unearthed rooms, locus 3, measured 5.0 × 2.5 m and bordered the courtyard from the north. The best studied eastern part of the house consisted of three rooms. All were approximately 1.5 m wide. The middle room (locus 5) was 4.0 m long, flanked by smaller rooms (loci 4 and 10) only 2.5 m in length. It is plausible that yet another narrow room was located to the east of the courtyard, as suggested by an uncovered wall fragment leading in that direction. Such houses with central courtyards surrounded from all sides by narrower rooms are well-known from other Islamic sites, such as Quraniya nearby (Grassili and Di Miceli 2018). House 1 was built from beachrock using a simple method — its walls, 0.4–0.5 m wide, were composed of a single row of stones, bonded by a mortar of silt and lime.

Every locus in house 1 yielded remains of clay ovens and hearths (Fig. 3), with the largest concentration located in the northern corner of the courtyard, where a sequence of ovens was found arranged one on top of the other. Apparently, it seems that unused ovens were not removed but served as a support for a new installation. In locus 3, ovens and hearths were placed along the two longer walls. Loci 4 and 5 revealed only two ovens each, though it is necessary to stress that both of these rooms were only partially explored. The analysis of the stratigraphic position of the wall indicates that locus 3 was built first, while the remaining rooms were added at a later time. The final usage phase of the ovens in the northern corner of the courtyard damaged the walls of locus 3, indicating that this area remained in use after locus 3, was abandoned.

Fish bones were found in layers and installations registered in the courtyard and inside the rooms, but a few installations in house 1 have not yet been explored. Among the remains that provide evidence of fish processing, fish skeletal elements seem to be the most significant. Although we were not able to precisely identify a large number of them, as they lacked diagnostic features, many elements were determined to either the family or genus level (Table 1, Appendix Table 7).

An abundance of archaeoichthyological material was found on the walking levels of the courtyard (locus 11) and three rooms (loci 3–5). Skeletal elements of bony fish were dominant, but numerous vertebrae of sharks and rays of at least four families and tooth plates of rays of the Myliobatidae family were also discovered. Sharks were represented exclusively by vertebrae, rays by both vertebrae and tooth plates, while in the case of bony fish, cranial elements were the most frequent find; vertebrae, fragments of spines and ribs were also found. As far as the remains of bony fish are concerned, specimens of the Ariidae and Haemulidae (*Pomadasys* sp.) families were most numerous. In addition, a few fragments of cuttlebone were found in this assemblage (Table 1).

Fish remains were found in five pits and 13 installations (ovens 3–6, 8–15 and hearth 1) discovered in the courtyard and inside the rooms (loci 3–5) (Appendix Table 7).

Pits 1–4 contained very few remains, and these were almost exclusively bone fragments of bony fish (Table 1, Appendix Table 6). Vertebrae and cranial elements were equally represented in pits 2 and 4, while pits 1 and 3 contained only a few unidentified bone fragments. The number of individuals varied in these pits, yet in general, MNI was low (Appendix Table 8).

Although it is still uncertain whether pit 5, located east of the courtyard (locus 11), belonged to house 1 or not, it was most likely associated with it. It was the only pit that contained such a large number of fish bones as well as some scales (Appendix Table 7). Bony fish remains were the most prevalent, with a large number of cranial and postcranial elements of a catfish of the Ariidae family (almost 2/3 of the identified bones), *Pomadasys* sp. and fish of the Sciaenidae family. Shark and ray vertebrae and ray tooth plates were also registered in greater numbers in this assemblage, while other families were less frequent. Additionally, six fragments of cuttlebone were excavated from pit 5 (Appendix Table 6).

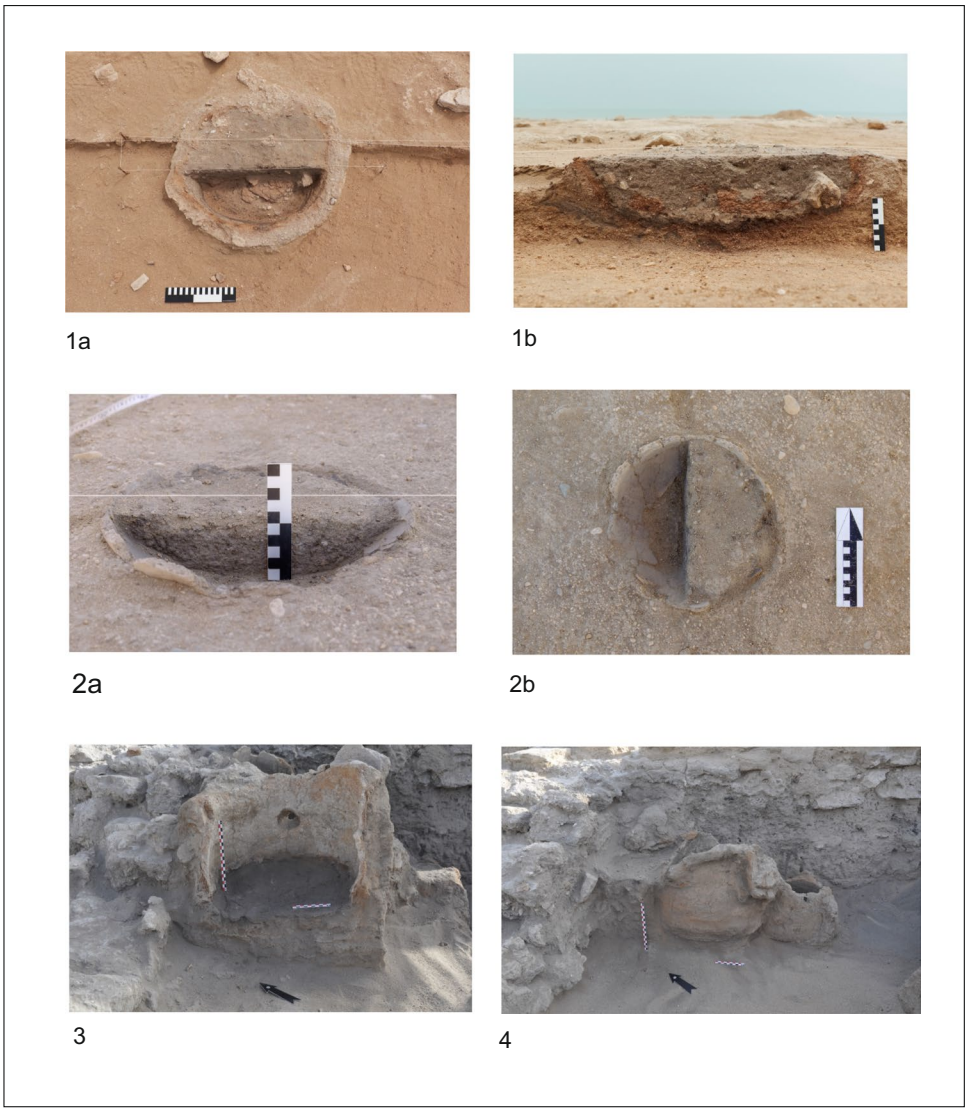

Fig. 3 Typical ovens at Kharā'ib al-Dasht (photo A. Oleksiak, M. Iskra)

In total, the remains of 70 individuals of fish from different families, including 22 remains belonging to catfish (Ariidae), were discovered (Appendix Table 8).

The ovens yielded skeletal elements of cartilaginous and bony fish, of which the latter was prevalent (Table 1). Among the bony fish remains, cranial fragments and vertebrae of a catfish of the Ariidae family were the most numerous. In the case of oven 5, an entire skeleton was found inside the installation with two additional fragments of bone present in the bottom layer. Other cranial and postcranial fragments belonged to fish from 13 families, yet determination to the genus or species level was possible only in a few cases. Cartilaginous fish were represented by vertebrae of sharks of the Carcharhinidae family and some unidentified ray vertebrae. Additionally, in oven 12, large parts of two partially articulated skeletons of fish from the Ariidae and Sciaenidae families were uncovered. The MNI in some of the ovens (ovens 4–6, 8, 12, 13 and 14) was relatively high, while others held the remains of only one or two individuals (ovens 3, 9, 10 and 15). The hearth also contained a low number of individuals (Appendix Table 8).

Summary: fish remains from phase II (Late Islamic 1b–2a, AD 1720–1870)

Overall, 28 fish families were present in the material (Table 1) although most of these are represented in very low numbers. Due to a lack of sieving using a 2 mm mesh, it is impossible to give clear statements about possible catches of small fishes like schooling Clupeidae and other kinds of small fishes that live close to the coast.

A considerable disproportion in the archaeoichthyological material was observed between the assemblages from the fish processing area and house 1. Therefore, only an approximate comparison between these two assemblages

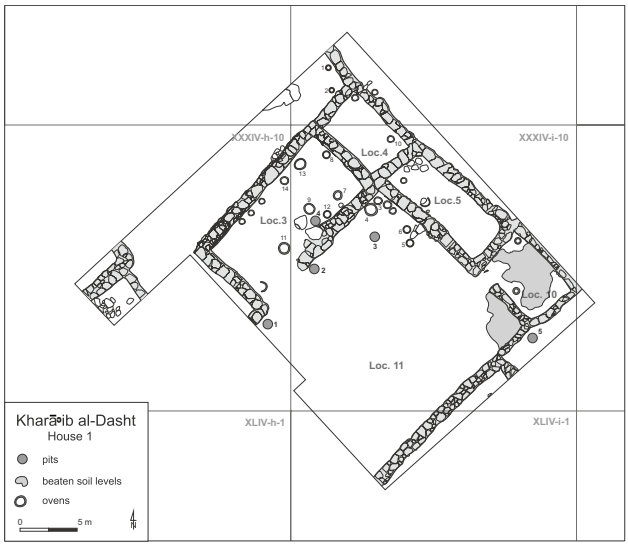

Fig. 4 Plan of house 1 (drawing by M. Iskra and Z. Kowarska, digitising by M. Puszkarski)

can be made. There was a significant difference in the share of bony and cartilaginous fish between the fishing huts and house 1. Cartilaginous fish was very scarcely represented in house 1, while material from the fishing huts contained a relatively large share of the remains of sharks, especially of the Carcharhinidae family (Table 2).

Only three cranial elements of Haemulidae bore cut marks, while burned bones were numerous. The differences concerned the state of preservation of the fish remains within the contexts. The large share of burned bones was observed inside the installations, both in house 1 and the fish processing area. Such bones were also registered in a greater number in pits from house 1 but were rare in other contexts (Table 3).

The percentage of catfish bones from the Ariidae family found in house 1 was a few times higher than in the fishing huts (Table 2). Their remains seem to be more concentrated in the installations than in the pits or layers. The ovens, hearths and fireplaces from house 1 contained a large share of catfish bones, while in the case of installations located in the fishing huts, over a half of the remains belonged to cartilaginous fish (Table 4).

Fish traps

Investigations conducted in the coastal waters surrounding the island revealed 32 large stone fish traps. Their fences were not preserved, as they were likely made of less durable materials, possibly palm branches and leaves (Serjeant 1968). As many as nine fish traps were located directly opposite Kharā'ib al-Dasht (Fig. 5). The largest structure (no. 1) had a roughly rectangular shape and measured

Table 2 Comparison between the most important fishes in the fish processing area and house 1

	Fish processing area		House 1	
	n	%	n	%
Carcharhinidae	367	52.7	389	9.4
Other identified cartilaginous fish	52	7.5	107	2.6
Ariidae	54	7.8	2091	50.4
Other identified bony fish	223	32.0	1558	37.6
Total	696	100	4145	100

200 × 150 × 30 m. The remaining structures were circular, with the largest one (no. 9) measuring 14 m in diameter and the other seven (nos. 2–8) ranging between 4.5 and 7.0 m in diameter (Pieńkowska et al. 2015; Pieńkowska and Mierzejewska 2018). Unfortunately, we have no way of confirming beyond any reasonable doubt that these fish traps functioned concurrently with the settlement; such structures, although quite common throughout the Arabian Gulf, are extremely hard to date (Blue et al. 2013; Beech 2004, 45–47, 71; Breeze et al. 2011, 20–21). Still, it is plausible to assume that they were used at that time, since early twentieth century texts demonstrate that fish traps were the prevalent fishing method used in Kuwait and throughout the Gulf region (Qatar Digital Library File 9/23 1944, 52).

Fish size

The analysis of the relative size of bony fish was based exclusively on precaudal vertebrae and provided an opportunity to explore general trends in the sizes of fish from the represented families. The results indicate that the maximum width of the centrum of precaudal vertebrae was between 2 and 15 mm which suggests rather small- and medium-sized fish in the case of most families (Fig. 6).

Only in the case of the most abundant vertebrae of fish from the Sciaenidae and Serranidae families it was possible to compare the measurements from two different locations — the fish processing area and house 1. The differences in size are evident only in the case of these two families (Fig. 7) in which the share of the measurements above 15 mm is much higher than in other groups. However, the comparison of the results for house 1 and the fish processing area proved to be the most interesting. In both cases, the groups of small-/medium-sized and large vertebrae were present, but the latter contained evidently larger vertebrae.

The most common established length of catfish was between 30 and 40 cm; individuals smaller than 30 cm were rare as were those exceeding 50 cm (Fig. 8). The low number of the remains of small individuals should be not due to the recovery technique employed as the bones

Table 3 Proportions of burned bones inside the different contexts

Location		NSP	Burned remains	
			n	%
Fish processing area	Layers	1039	50	4.81
	Installations	130	83	63.85
	Pits	308	12	3.90
House 1	Layers	4355	302	6.93
	Installations	1923	1387	72.13
	Pits	91	30	32.97
	Pit 5	4209	66	1.57
Mosque	Layers	121	2	1.65

of even very small catfish are large enough to be obtained by sieving with 5 mm mesh. A few cases of really large individuals, probably measuring over 60 cm, were also registered. Catfish remains were most frequently discovered inside the installations but were also found in the layers, though usually in the vicinity of the installations. No size preference was visible in the installations and layers. Pit 5, the only pit containing a large number of catfish bones, yielded mostly medium-sized individuals and one specimen that was clearly bigger. The measurements of the maximum width of centrum of precaudal vertebrae came almost exclusively from house 1; they also confirmed the presence of small- and medium-sized catfish (Fig. 6).

Based on the established size of the fish, it is possible to say that sharks of 50 to 100 cm TL were most abundant at the site. Larger sharks and rays were found in the layers, although small fish < 50 cm, as well as medium-sized, were also registered. However, large sharks measuring 200 cm or more were small in numbers at the site (Fig. 9). The installations and pits yielded fish of a relatively smaller size, but the remains found inside the installations were additionally standardised to individuals measuring 50–100 cm TL. Variation in size among the specimens found in the

Table 4 Comparison of the spatial distribution of cartilaginous and bony fish in the fish processing area and house 1

	Fish processing area						House 1					
	n			%			n			%		
	Layers	Pits	Install	Layers	Pits	Install	Layers	Pits	Install	Layers	Pits	Install
Carcharhinidae	225	113	29	52.7	55.7	43.9	228	115	46	12.8	7.2	6.0
Other identified cartilaginous fish	35	7	10	8.2	3.4	15.2	86	21	0	4.8	1.3	0.0
Ariidae	42	9	3	9.8	4.4	4.5	711	851	529	39.8	53.3	69.3
Other identified bony fish	125	74	24	29.3	36.5	36.4	761	609	188	42.6	38.2	24.6
Total	427	203	66	100	100	100	1786	1596	763	100	100	100

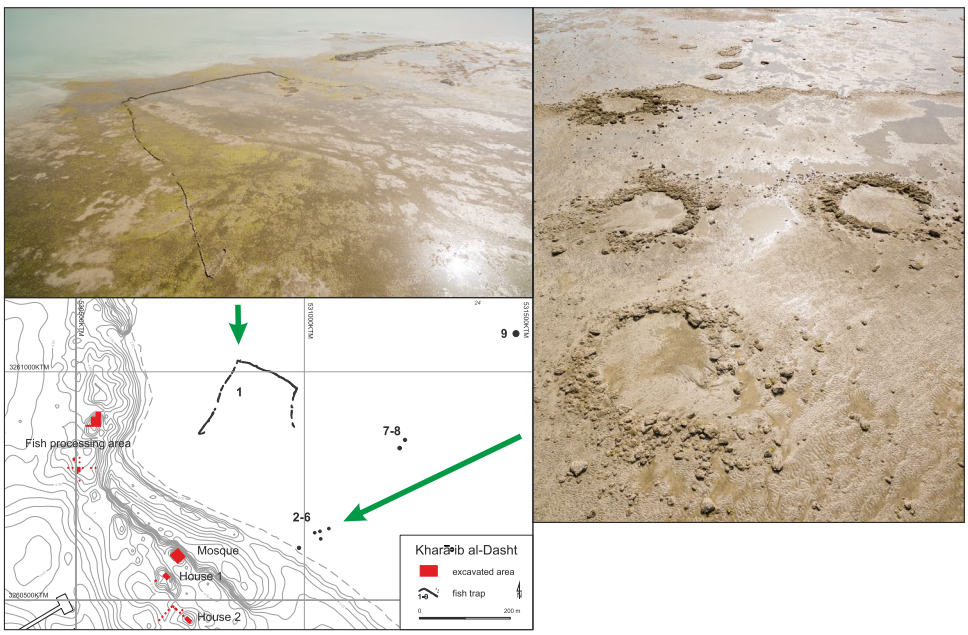

Fig. 5 Aerial photograph showing fish traps (A. Oleksiak)

installations was observed only in the case of the Carcharhinidae family (Fig. 9).

Discussion

Very little is known about fishing and fish processing at Kharāʾib al-Dasht in the earliest phase, I. Although such activities certainly took place, as attested by several installations and infrequent fish remains, their nature is rather uncertain. Perhaps they were only seasonal, as no structures dated to the Late Islamic period 1a (phase I) were recorded at the site. On the other hand, evidence of a permanent settlement, accompanied by very intensive fishing activity in the Late Islamic period 1b and 2a (phase II), is provided by the large number of excavated structures and fish remains.

Given that the necessary factor for husbandry and agriculture — fresh water — was scarce on the island in the Late Islamic period, fishing must have been of great

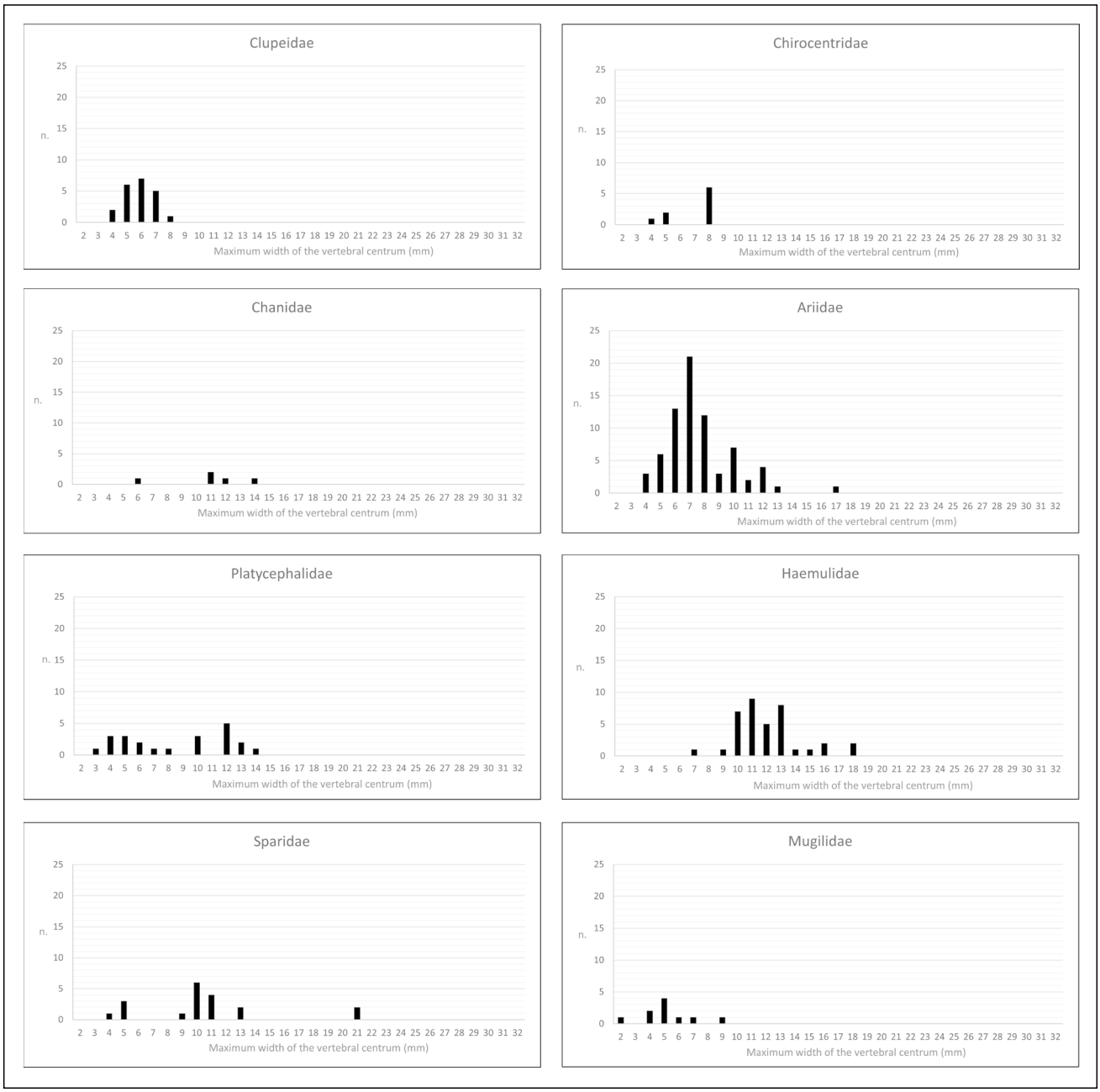

Fig. 6 Comparison of the maximum breadth of the vertebral centrum of families represented in the material

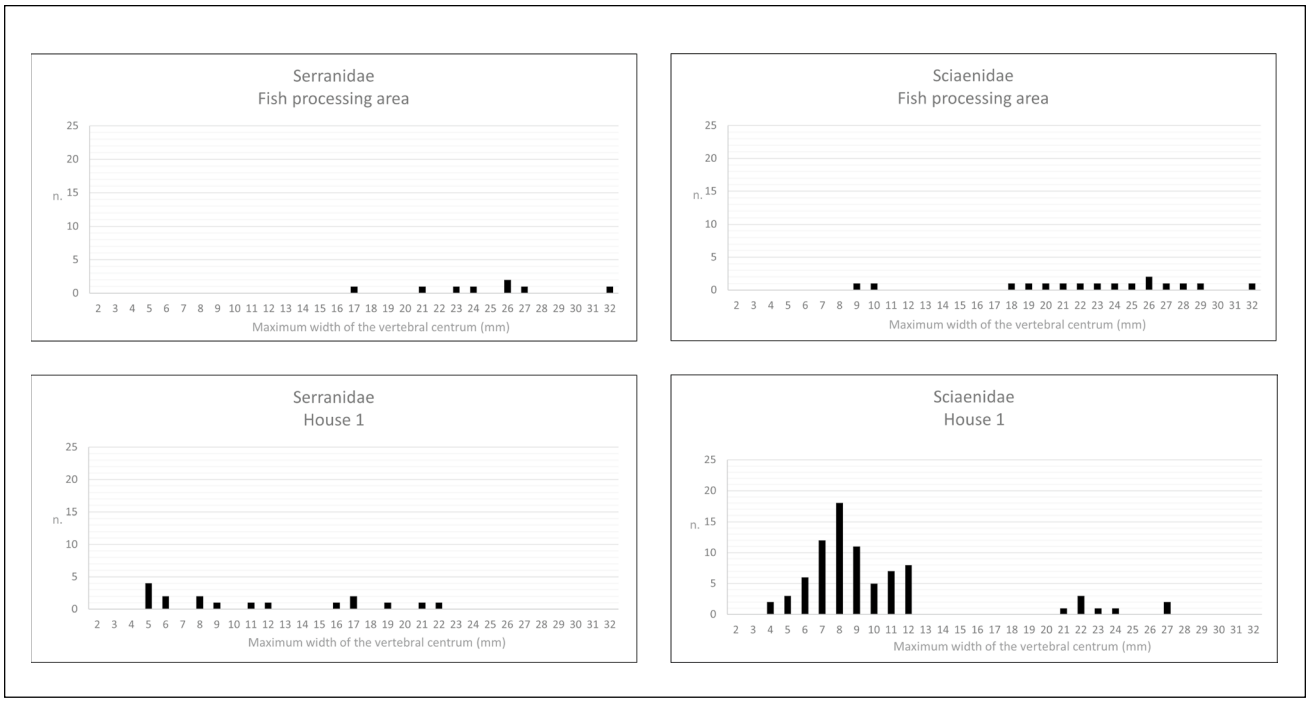

Fig. 7 Comparison of the maximum breadth of the vertebral centrum of Sciaenidae and Serranidae families from different locations

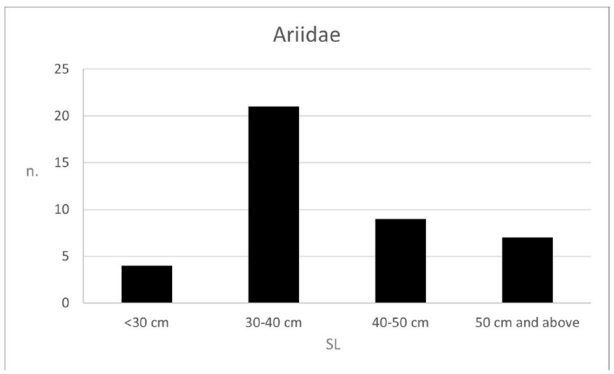

Fig. 8 Standard length (SL) of fish from the Ariidae family

importance to the inhabitants of Kharā'ib al-Dasht, as demonstrated by the architecture, installations, artefacts and large amounts of fish remains uncovered there. The archaeological evidence points to the existence of a fishing village at the site in the eighteenth and the nineteenth centuries. Only a few settlements of this period has been excavated on Failaka so far, including a few clusters of sites in the vicinity of Al-Awazim (Makharadze et al. 2017; Chkhvimiani et al. 2021) and the remains of the villages in Al-Qurainiyah and Al-Sabbahiya (Pawlicki 2012; Grassili and Di Miceli 2018), but the analyses of fish remains have not yet been published. Furthermore, given the lack of adequate parallels from the northern Arabian Gulf, any knowledge concerning preferences and fish processing in the Late Islamic period is limited to Kharā'ib al-Dasht exclusively. Still, the numerous fish families recorded in the bone assemblage of the settlement are also known from other Gulf sites from different regions and periods, including the Islamic Period (Beech 1998, 2004, 2005; Von den Driesch and Dockner 2002; Russ and Petersen 2013; Yeomans 2015; Vorenger 2016; Uerpmann 2017). We must keep in mind that the type of seafloor, depth of the sea level, salinity and biodiversity differ in the southern and northern part of the Arabian Gulf and the salinity, temperature and circulation changes show seasonal variability (Al-Ghadban 2002; Reynolds 2002; Swift and Bower 2003; Kampf and Sadrinasab 2006; Rakha et al. 2007; Naser 2014) which is undoubtedly reflected in the taxonomic composition of fish. Recent research concerning fishing in the coastal waters of Kuwait shows a very different species composition from modern-day fish traps than those identified in the material from Kharā'ib al-Dasht, as well as a smaller range of fish species in recent catches (Al-Baz et al. 2003, 2007). Earlier research by Abou-Seedo (Abou-Seedo 1992, pp. 94–95) shows differing results — the abundance of the represented families is comparable with the assemblages from Kharā'ib al-Dasht which was probably linked to the favourable environmental conditions of the intertidal zones of Kuwait Bay. The fish caught in the recent fish

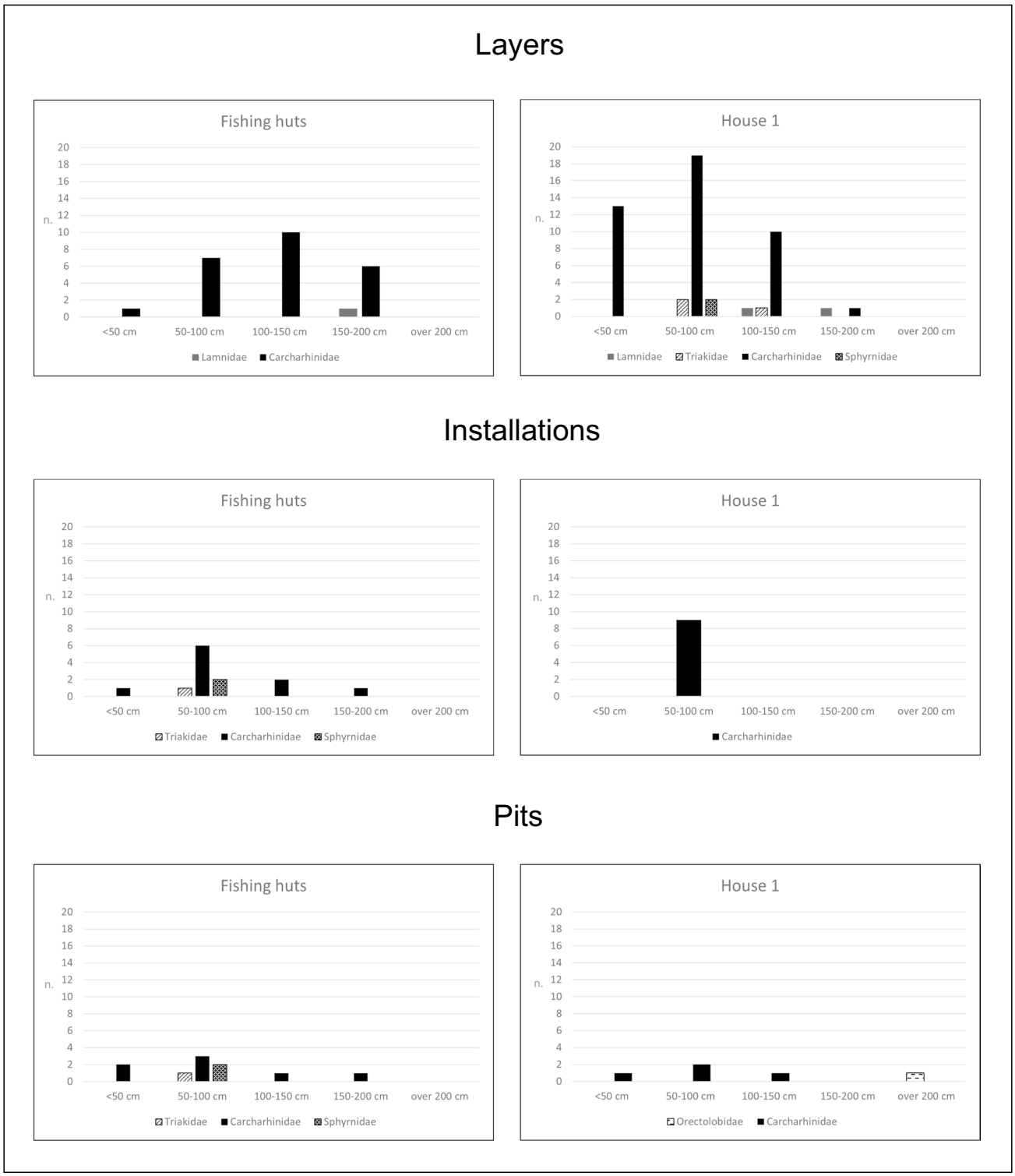

Fig. 9 Total length (TL) of sharks and rays from different locations

traps on the Failaka shoreline were small- or medium-sized, < 44 cm TL (Al-Baz et al. 2007, pp. 206, Table 3). This shows that only small species or younger individuals of larger species could have been caught in the fish traps in the shallow inshore waters. This picture is also evident in the case of Kharā'ib al-Dasht where most of the assemblages contained only small- and medium-sized fish. The size of the fish from the experimental

fish traps described by Al-Baz and co-authors (2007) does not indicate that this fishing method could have been used to catch larger fish; such fish were available offshore. It seems that the changing environment of the Northern Arab Gulf strongly influenced the fishing activity, with changes in the catch rate and species composition. The large spectrum of the fish families demonstrated by the bones discovered at Kharā'ib al-Dasht suggests that probably all the fish that could be caught were processed and consumed. Cultural preferences seem to be less important here, though they are certainly not without significance.

Fishing techniques applied at the site

Fishing was most likely undertaken with the use of fish traps, but other methods of capture in the inshore areas were probably also carried out. Fish traps were located close to the village, which supports the hypothesis that its inhabitants used them. Structures of this type were also located in other areas surrounding the island, with concentrations of fish traps being registered close to other settlements dated to the Late Islamic period (Qatar Digital Library File 9/23 1944, p. 52; Pawlicki 2015). Serjeant described fish traps of a similar shape called *hadrah* known from Bahrain, which were always built in the waters belonging to the nearby village (Serjeant 1968, p. 503), although their location was determined "by the nature of the terrain" (Serjeant 1968, p. 491). *Hadrah* were common along the shallow shore waters of the Arabian Gulf but not used on the South Arabian coasts (Serjeant 1968, p. 489). They were usually the property of those who built them, and as such, they could have been inherited or rented. It seems probable that in the case of a small village, like Kharā'ib al-Dasht, only the owners of the fish traps held the fishing rights. Although collecting the catch from fish traps was rather easy and could have been done by hand, ethnographic sources indicate that the preparation and maintenance of such structures required considerable expertise (Serjeant 1968, p. 495). According to some sources, fish for local use were caught in the summer (Qatar Digital Library File 17/16 1944), yet fish that could be caught using traps differed depending on the season (Serjeant 1968, p. 509; Beech 2004, pp. 35–42). It seems that usually small- and medium-sized fish were obtained in this manner. Large and very large specimens, especially sharks, could probably be caught from a boat as attested to by the presence of anchors (Serjeant 1968, p. 510). A private letter from February 1947 (Qatar Digital Library File 17/16 1944) confirms that sharks were caught in the offshore waters not far from Failaka Island. The remains of large and very large fish from the layers and pits in house 1 and the fish processing area, as well as the presence of the artefacts like anchors and fishing hooks, suggest that offshore fishing was also practised by the fishers from Kharā'ib al-Dasht.

Fishing as subsistence strategy

Based on the archaeological sources, the culinary preferences in the Late Islamic period varied from those of the present-day market. For example, the catfish (Ariidae), which was a frequent find at the discussed site, is now largely ignored by the market (both fishers and consumers), although the fish is still present in abundance in Kuwaiti waters (Beech 2004, 20–21). It is not clear if this is due to cultural influences or a low social standard of the people of Kharā'ib al-Dasht. Other fish, like sharks, are a food taboo for many people in the region, yet they were in fact consumed by the inhabitants of this Late Islamic fishing village. Written accounts also confirm shark consumption in Kuwait. For instance, according to Lorimer, sharks were very popular among Arab fishers, even though only Sunnis would eat them, as they consider them to be aphrodisiacs, but also used them as manure (Lorimer 1915, p. 2316; Serjeant 1968, pp. 488–489). Although shark consumption was confirmed at numerous sites located throughout the entire Gulf region from the Neolithic to the Late Islamic periods (Beech 2004), the finds do not have a stable pattern. Of the five sites compared by Monchot (Monchot et al. in press), proportions of cartilaginous fish vary between 1 and 40.8%, however, only at Failaka F5, dated to the Hellenistic period, the number of cartilaginous fish was elevated (40.8%). It is not defined how many sharks were included in this number. Most of these fish seem to have been of medium-sized or have come from juveniles, thus caught close to the shore (Desse and Desse-Berset 1990).

Fish preparation and preservation

There are three traditional methods of fish processing known from historical and ethnographic sources, namely, salting, drying and grilling (ElMahi 2000). Direct proof for salting fish is almost impossible to identify archaeologically (Maritan et al. 2018). There is also no clear evidence for drying fish, but some of the architectural remains, such as the huts located in the northern part of the site, as well as similar structures found in other areas of Failaka (Pawlicki 2012, pp. 51–52), were most probably used for this purpose, given that they seem to be too

small to have had a residential function. Moreover, such structures are also known from the Omani coast (Costa 1988), where fishing stations, located at some distance from villages, included these kinds of small buildings to shelter drying fish from the wind, birds and carnivores (Costa 1988, p. 5).

Traditionally, fish intended for drying can be of two sizes, either very small or large. Very small fish were either consumed in the region by humans as snacks or used as animal feed as described by Marco Polo in the thirteenth century: "Another thing you will much wonder at is, that all the animals, sheep, oxen, and camels, eat fish, because there is no grass, for it is the most arid place in the world. These fishes are very small, caught in March, April, and May, in wonderful quantities. They are dried, lodged in houses, and given as food to the animals during the whole year. The people eat them also when quite alive and newly taken. There are also plenty of large ones, which being made into a kind of biscuit, by cutting them into small pieces and drying them in the sun, are preserved under cover during the whole year" (Murray 1845, pp. 329–330). Such a purpose of drying fish is also known from more recent sources (Qatar Digital Library File 17/16 1944). Even though the material was sieved, the share of small fish remains was not high at the site. In particular, the bones of fish of the Clupeidae family, the most commonly dried fish in the region (ElMahi 2000, 101–2), were infrequent. However, especially in the case of small species such as clupeids, it might have been due to the 5 mm mesh chosen during the excavation, which is too wide to keep all the small bones. On the other hand, this scarcity may be explained by the fact that such fish would generally be consumed in their entirety, while if it was fed to animals, it would not appear in the material inside the structures. Conversely, the remains of large fish, like sharks and rays, were discovered in the layers in greater numbers, although this might only be an indirect evidence of this kind of processing. Before it could be dried, a large fish had to be cut into smaller pieces (usually fillets) and soaked in brine for a day or two (ElMahi 2000, 103–4). Meat prepared in this manner should have been edible for a long time.

While the usage of fireplaces and hearths (open sources of fire found in a large number especially in the northern part of the site) is rather clear, the construction of the ovens is difficult to interpret. The clay walls of the intact and usually well-preserved ovens were open with the formed rim without any visible remains of a grate (Mierzejewska 2019, pp. 10, Table 2). The lower parts of the discovered ovens contained ashes, usually mixed with some fish bones. The presence of a large part of an unburned catfish skeleton found in the upper part of ovens 5 and 12 from house 1 may suggest that grilling (understood as baking fish on a grate) was done directly inside the installation, in the inner partition found in the middle of the height of the oven. Such a structure was present only in some of the ovens. On the other hand, the constructions could be interpreted as heating installations with fish bones used as fuel; however, such an interpretation seems doubtful given their large number inside the rooms and a lack of known analogies on the island (Mierzejewska 2019, pp. 10–11). On this basis, grilling seems to have been a common practice at the site, at least judging by the number of installations inside house 1 as well as in the northern part of the village (Mierzejewska 2019). Although meat preserved in this manner remains safe to eat for only a few days (ElMahi 2000, p. 105), it seems to have been sufficient for everyday meals. Grilling could also be understood as a means of smoking fish. This technique is impossible to attest based on archaeological remains, but some pits, at least in house 1, could have been used for such a goal taking into consideration the elevated number of burned bones. In general, fish intended for grilling were usually small, while sharks also had a standardised size of between 50 and 100 cm. The most frequently grilled specimens were small- and medium-sized catfish, though many other families were also represented in the assemblages from ovens and hearths. It should be noted that different fish were processed in the installations depending on the part of the village. Sharks and rays were grilled mostly in the fish processing area, while catfish were found in a greater number only in house 1. In a publication by Monchot and co-authors (Monchot et al. in press), a comparison was already made for the most important taxa present at three sites in Failaka Island of the earlier chronology — Failaka F5 (Hellenistic fortress) and Failaka F6 (a site dated to the Ur III and Dilmun periods), as well as Al-Qusur (a village from the Early Islamic period located in the middle of the island) and Tell Akkaz (inland Kuwait). The high number of Ariidae was only present in Tell Akkaz (Desse-Berset and Desse 2011), where 31.5% of the fish bones come from this family and belonged to large fish measuring 90 cm up to 1 m, which is very different from the finds from Kharā'ib al-Dasht. Interestingly, catfish remains were, in general, rare or even absent, as was the case of oven deposits excavated at Julfar in the UAE (Beech 1998) dated to mid-fourteenth to sixteenth century, yet numerous bones of catfish of the Ariidae family were identified in the installations from Late Islamic sites, such as Al Zubārah in northern Qatar (Yeomans

2015). At this site, the proportion of catfish tended to decrease after the initial occupation phase of the settlement, namely, from 10% of the bones to less than 4% only years later (Yeomans 2015). This may indicate that the presence of catfish bones at the sites may be connected with the seasonal availability of the fish in the inshore fishing area or the preferences of the consumers.

There is no doubt that the northern part of Kharā'ib al-Dasht fulfilled an economic function, given the abundance of hearths, ovens and refuse pits found there and a large fish trap nearby. The division of the settlement into two parts with fishing huts in the north and a village in the east seems reasonable, as fish processing is a rather foul-smelling activity. Fishing huts were most probably used primarily for fish processing. It is uncertain whether the fish caught here were intended only for the fishers and their families or if any surplus was used for local trade with the interior of the island. It seems plausible that at least a part of the fish processed here was preserved as commercial products. Some written sources suggest that Failaka provided a large share of the Kuwaiti fish supply (Qatar Digital Library File 17/16 1944), which may indicate the involvement of the inhabitants of Kharā'ib al-Dasht in long-distance trade. The high share of shark remains and the larger size of fish in the fish processing area suggest that the fish processed in this location were destined for the market. These fish had economic value and were probably preserved to sell elsewhere. The fish remains from this area include almost certainly other bones that were preserved for consumption in the village. There is supporting evidence for this hypothesis found in the fish traps nearby. While the large fish trap no. 1 was built close to the fish processing area, the small fish traps 2 to 8 were adjacent to the village.

The discovery of pit 5, located either in one of the rooms surrounding the courtyard or just outside the house, may be important for our understanding of how food supplies were stored. Some of the numerous fish remains found in the pit were articulated, especially the almost complete catfish and of *Pomadasys* sp. skeletons, with cranial elements as well as vertebrae, which were reported by the archaeologists, although they were not documented in situ. The assemblage also contained numerous fish of different sizes. Therefore, the interpretation of a structure as a storage pit and not a waste pit is more probable. It also indicates that these fish were kept in a preserved state. Probably this was a reserve against times when fresh fish was difficult to obtain. The fish traps yielded less fish in winter and during the warmest months in summer, due to cold or too warm water temperatures (Abou-Seedo 1992). Moreover, similar structures in Oman, called *bakakir*, made of walls lined with stone, were used for keeping dried and salted fish (Costa 1988, p. 6). Other pits from house 1 yielded a very low number of fish remains, which may suggest that they had a different function. The pits located in the fish processing area contained far less fish bones which makes interpretation difficult.

Conclusions

Although the scale of the excavations at Kharā'ib al-Dasht is still very small and the investigated structures generate even more questions than answers, we now have a better understanding of fishing and fish processing at the site. Fish remains, artefacts and structures associated with fishing found at the site provide evidence of a small community that lived mostly off the sea and its resources, and fish were their main source of protein. Very little is known about fishing and fish processing at Kharā'ib al-Dasht in the earliest phase. Although such activities certainly took place, the low number of fish remains does not permit any detailed interpretation. The archaeological evidence suggests that in the younger phase, fish were probably grilled for both direct consumption and short-term preservation, although other methods of preservation, including drying and perhaps salting, could also have taken place. The families' composition and the difference in fish sizes suggest that bigger fish were processed in the fish processing area, while smaller fish were used as food resources in the village itself. The small fish traps near the village delivered probably enough food for daily consumption. Offshore fishing was certainly another way to supply the village of large fish which were most probably prepared and sold for the market. If preservation was drying or salting or a combination, it is impossible to state. It seems that fishers used diversified methods for catching fish; it is more than probable that they used fish traps but also practised offshore fishing. There is no direct or indirect evidence for other fishing methods, including the use of baskets or similar organic tools, as these types of remains were not preserved in the archaeological materials from Kharā'ib al-Dasht. Nonetheless, the rich fish bone assemblage from Kharā'ib al-Dasht contributes additional information concerning to the role of fish in this region.

Appendix

Table 5 Number of identified specimens (NISP) from the fish processing area

Taxon		Late Islamic 1b–2a																
		Layers	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5	Fireplace 6	Fireplace 7	Fireplace 9	Hearth 1	Hearth 2	Hearth 8	Hearth 10	Oven 3	Oven 4	Oven 5	Total
Lamniformes	Lamnidae (mackerel sharks)	1																1
Carcharhiniformes	Triakidae (hound-sharks)	3				1							1					5
	Carcharhinidae (requiem sharks)	225		2	48	62	1		3	4	2	10	5		1		4	367
	Sphyrnidae (hammerhead sharks)	31		2	3								6		3			45
	Sphyrnidae: *Sphyrna* sp. (hammerhead shark)			1														1
Batoidea (rays)		35		1	4	15			1	1				1				58
Chondrichthyes (cartilaginous fish) indet		5			2	1									1			9
Total Chondrichthyes		300	0	6	57	79	1	0	4	5	2	10	12	1	5	0	4	486
Clupeiformes	Clupeidae: *Tenualosa ilisha* (hilsa shad)			3														3
	Clupeidae (herrings, sardines, shads) indet	11		12		3		3					3					32
	Chirocentridae: *Chirocentrus nudus* (whitefin wolf-herring)			2														2
	Chirocentridae (wolf herrings) indet									1								1
Gonorynchiformes	Chanidae: *Chanos chanos* (milkfish)	1			2						3							6
Siluriformes	Ariidae (sea catfish) indet	42	2	2		5					3							54
Scorpaeniformes	Platycephalidae: *Platycephalus indicus* (bartail flathead)	8			1	1		1		2	2							15
Perciformes	Serranidae (groupers) indet	13	1	9		4			2			1						30
	Carangidae (jacks, jack mackerels, trevally) indet	7		1													1	9

Table 5 (continued)

Taxon		Late Islamic 1b–2a																
		Layers	Pit 1	Pit 2	Pit 3	Pit 4	Pit 5	Fireplace 6	Fireplace 7	Fireplace 9	Hearth 1	Hearth 2	Hearth 8	Hearth 10	Oven 3	Oven 4	Oven 5	Total
	Haemulidae: *Pomadasys* sp. (grunt)			1		4												5
	Haemulidae (grunts, sweetlips, rubberlips, hotlips) indet	5		1	2				1									9
	Sparidae: *Acanthopagrus* sp. (seabream)			1														1
	Sparidae (porgies, seabreams) indet	3		4														7
	Lethrinidae (emperors) indet	5																5
	Sciaenidae (drums, croakers) indet	55		4	3	5				2	1	1						71
	Mugilidae (mullets) indet	13		2	1													16
	Sphyraenidae (barracuda) indet	1																1
	Trichiuridae (cutlassfishes) indet	1			4													5
	Scombridae: *Euthynnus affinis* (tuna)			1														1
	Scombridae (mackerels) indet	2				1												3
	Stromateidae: *Pampus argenteus* (silver pomfret)					1												1
Teleostei (bony fish) indet		572	3	63	4	10			3	1	36	7	2	1	6	4		712
Total Teleostei		739	6	106	17	34	0	4	6	6	45	9	5	1	6	4	1	989
Mollusca	Sepiidae (cuttlefish)			2														2

Table 6 Number of identified specimens (NISP) and minimum number of individuals (MNI) in the installations and pits located in the fish processing area

Taxon	NISP	MNI
Fireplace 6		
Clupeidae (herrings, sardines, shads) indet	3	1
Platycephalidae: *Platycephalus indicus* (bartail flathead)	1	1
Fireplace 7		
Batoidea (rays) indet	1	1
Carcharhinidae (Requiem sharks) indet	3	1
Haemulidae (grunts, sweetlips, rubberlips, hotlips) indet	1	1
Serranidae (groupers) indet	2	1
Fireplace 9		
Batoidea (rays) indet	1	1
Carcharhinidae (Requiem sharks) indet	4	1
Chirocentridae (wolf herrings) indet	1	1
Platycephalidae: *Platycephalus indicus* (bartail flathead)	2	1
Sciaenidae (drums, croakers) indet	2	1
Hearth 1		
Carcharhinidae (requiem sharks) indet	3	2
Ariidae (sea catfish) indet	2	1
Chanidae: *Chanos chanos* (milkfish)	3	1
Platycephalidae: *Platycephalus indicus* (bartail flathead)	2	1
Sciaenidae (drums, croakers) indet	1	1
Hearth 2		
Carcharhinidae (requiem sharks) indet	10	3
Sciaenidae (drums, croakers) indet	1	1
Serranidae (groupers) indet	1	1
Hearth 8		
Carcharhinidae (requiem sharks) indet	5	1
Sphyrnidae (hammerhead sharks) indet	6	1
Triakidae (houndsharks) indet	1	1
Clupeidae (herrings, sardines, shads) indet	3	2
Hearth 10		
Batoidea (rays) indet	1	1
Oven 3		
Carcharhinidae (Requiem sharks) indet	1	1
Sphyrnidae (hammerhead sharks) indet	3	1
Oven 5		
Carcharhinidae (Requiem sharks) indet	4	1
Carangidae (jacks, jack mackerels, trevally) indet	2	1
Pit 1		
Ariidae (sea catfish) indet	2	1
Serranidae (groupers) indet	1	1
Pit 2		
Batoidea (rays) indet	1	1
Carcharhinidae (Requiem sharks) indet	2	1
Sphyrnidae: *Sphyrna* sp. (hammerhead shark)	3	1
Sparidae: *Acanthopagrus* sp. (seabream)	1	1
Ariidae (sea catfish) indet	2	1
Carangidae (jacks, jack mackerels, trevally) indet	1	1
Chirocentridae: *Chirocentrus nudus* (whitefin wolf-herring)	2	1
Scombridae: *Euthynnus* sp. (tuna)	1	1
Haemulidae (grunts, sweetlips, rubberlips, hotlips) indet	1	1
Mugilidae (mullets) indet	2	1
Haemulidae: *Pomadasys* sp. (grunt)	1	1
Sciaenidae (drums, croakers) indet	4	1
Serranidae (groupers) indet	9	2
Sparidae (porgies, seabreams) indet	1	1
Clupeidae: *Tenualosa ilisha* (hilsa shad)	15	1
Pit 3		
Batoidea (rays) indet	4	2
Carcharhinidae (Requiem sharks) indet	48	3
Sphyrnidae (hammerhead sharks) indet	3	1
Chanidae: *Chanos chanos* (milkfish)	2	1
Haemulidae (grunts, sweetlips, rubberlips, hotlips) indet	2	1
Mugilidae (mullets) indet	1	1
Platycephalidae: *Platycephalus indicus* (bartail flathead)	1	1
Sciaenidae (drums, croakers) indet	3	3
Trichiuridae (cutlassfishes) indet	4	1
Pit 4		
Batoidea (rays) indet	15	2
Carcharhinidae (Requiem sharks) indet	62	2
Triakidae (houndsharks) indet	1	1
Ariidae (sea catfish) indet	5	1
Clupeidae (herrings, sardines, shads) indet	3	1
Stromateidae: *Pampus argenteus* (silver pomfret)	1	1
Platycephalidae: *Platycephalus indicus* (bartail flathead)	1	1
Haemulidae: *Pomadasys* sp. (grunt)	4	1
Sciaenidae (drums, croakers) indet	5	2
Scombridae (mackerels) indet	1	1
Serranidae (groupers) indet	4	1
Pit 5		
Carcharhinidae (Requiem sharks) indet	1	1

Table 7 Number of identified specimens (NISP) from house 1

Taxon		Late Islamic 1b–2a																								
		Locus 11 (courtyard)										Locus 3							Locus 4		Locus 5	East of locus 11 (courtyard)	West of loci 3 and 4		Total
		Layers	Oven 3	Oven 4	Oven 5	Oven 6	Oven 8	Oven 9	Pit 1	Pit 2	Pit 3	Layers	Oven 11	Oven 12	Oven 13	Oven 14	Oven 15	Pit 4	Layers	Oven 10	Layers	Pit 5	Layers	Hearth 1	
Orectolobiformes	Orectolobidae (carpet sharks) indet																					21			21
Lamniformes	Lamnidae (mackerel sharks) indet	2																							**2**
Carcharhiniformes	Triakidae (hound-sharks) indet	2										1													**3**
	Carcharhinidae (Requiem sharks) indet	106	1	2	1		5					17	1		4	27	2	1	38	2	58	114	9	1	**389**
	Sphyrnidae (hammerhead sharks) indet	4																	1						**5**
Myliobatiformes	Myliobatidae (eagle rays) indet	11																	34		31				**76**
Batoidea (rays) indet		73		9	1		4			1		8			14	1		6	10		6	58	5		**196**
Chondrichthyes (cartilaginous fish) indet		4																	1			6	3		**14**
Total Chondrichthyes		202	1	11	2	0	9	0	0	1	0	26	1	0	18	28	2	7	84	2	**95**	**199**	**17**	**1**	**706**
Clupeiformes	Clupeidae: *Tenualosa ilisha* (hilsa shad)																					1			**1**

Table 7 (continued)

Taxon		Late Islamic 1b–2a																								
		Locus 11 (courtyard)										Locus 3							Locus 4		Locus 5	East of locus 11 (courtyard)	West of loci 3 and 4		Total
		Layers	Oven 3	Oven 4	Oven 5	Oven 6	Oven 8	Oven 9	Pit 1	Pit 2	Pit 3	Layers	Oven 11	Oven 12	Oven 13	Oven 14	Oven 15	Pit 4	Layers	Oven 10	Layers	Pit 5	Layers	Hearth 1	
	Clupeidae (herrings, sardines, shads) indet	13		5	6	6								9					6		1	97			**143**
	Chirocentridae (wolf herrings) indet			13										1							1	16			**31**
Gonorynchiformes	Chanidae: *Chanos chanos* (milkfish)	6		1								1							2						**10**
Siluriformes	Ariidae (sea catfish) indet	394	1	38	211	17	40	2				111	3	192	1	23		7	74		106	844	26	1	**2091**
Beloniformes	Belonidae (needlefish) indet											1													**1**
Scorpaeniformes	Platycephalidae: *Platycephalus indicus* (bartail flathead)	15		1	7	2	1					12			1	1		5	1		2	42	1		**91**
Perciformes	Serranidae (groupers) indet	30			4	2	3					4		2	1				29	1	3	58	7	1	**145**

Table 7 (continued)

Taxon	Late Islamic 1b–2a																						
	Locus 11 (courtyard)										Locus 3							Locus 4		Locus 5	East of locus 11 (courtyard)	West of loci 3 and 4		Total
	Layers	Oven 3	Oven 4	Oven 5	Oven 6	Oven 8	Oven 9	Pit 1	Pit 2	Pit 3	Layers	Oven 11	Oven 12	Oven 13	Oven 14	Oven 15	Pit 4	Layers	Oven 10	Layers	Pit 5	Layers	Hearth 1	
Carangidae: *Scomberoides* sp. (queenfish)																						1		**1**
Carangidae (jacks, jack mackerels, trevally) indet	21		1	1		2							3	1	1		3				3	6		**42**
Lutjanidae (snappers) indet	1																			3				**4**
Haemulidae: *Plectorhinchus* sp. (sweetlip)																						1		**1**
Haemulidae: *Pomadasys stridens* (striped piggy)																				1				**1**
Haemulidae: *Pomadasys* sp. (grunt)	160			3	1	1			2		37	2	1		1		2	10		26	100	89		**435**

Table 7 (continued)

Taxon	Late Islamic 1b–2a																						
	Locus 11 (courtyard)										Locus 3							Locus 4		Locus 5	East of locus 11 (courtyard)	West of loci 3 and 4		Total
	Layers	Oven 3	Oven 4	Oven 5	Oven 6	Oven 8	Oven 9	Pit 1	Pit 2	Pit 3	Layers	Oven 11	Oven 12	Oven 13	Oven 14	Oven 15	Pit 4	Layers	Oven 10	Layers	Pit 5	Layers	Hearth 1	
Haemulidae (grunts, sweetlips, rubberlips, hotlips) indet	32		1	2							8			1			2	1		6	5	5	1	**64**
Sparidae: *Acanthopagrus* sp. (seabream)											1										2			**3**
Sparidae: *Argyrops spinifer* (king soldier bream)	1																							**1**
Sparidae: *Spariidentex* sp. (seabream)																					3			**3**
Sparidae (porgies, seabreams) indet	20										6			1						4	28	2		**61**
Lethrinidae (emperors) indet	2			2		2					2			1			2	1		1				**13**
Nemipteridae (threadfin breams) indet																					5			**5**

Table 7 (continued)

Taxon	Late Islamic 1b–2a																							
	Locus 11 (courtyard)										Locus 3							Locus 4		Locus 5	East of locus 11 (courtyard)	West of loci 3 and 4		Total
	Layers	Oven 3	Oven 4	Oven 5	Oven 6	Oven 8	Oven 9	Pit 1	Pit 2	Pit 3	Layers	Oven 11	Oven 12	Oven 13	Oven 14	Oven 15	Pit 4	Layers	Oven 10	Layers	Pit 5	Layers	Hearth 1	
Sciaenidae: *Otolithes* sp. (tiger-tooth croaker)	1				1				1		5	1									5		2	**16**
Sciaenidae: *Pseudotolithus* sp. (croaker)																					4			**4**
Sciaenidae (drums, croakers) indet	78		2	13	2	7			2		44	6	44		1	1	6	6		12	167	13	1	**405**
Polynemidae (threadfins) indet											1													**1**
Mugilidae (mullets) indet	2		1		1						2		3		1						1			**11**
Siganidae: *Siganus* sp. (rabbitfish)											1													**1**
Siganidae (rabbitfish) indet											1										1			**2**
Sphyraenidae (barracuda) indet	2				3																			**5**

Table 7 (continued)

Taxon		Late Islamic 1b–2a																							
		Locus 11 (courtyard)										Locus 3							Locus 4		Locus 5	East of locus 11 (courtyard)	West of loci 3 and 4		Total
		Layers	Oven 3	Oven 4	Oven 5	Oven 6	Oven 8	Oven 9	Pit 1	Pit 2	Pit 3	Layers	Oven 11	Oven 12	Oven 13	Oven 14	Oven 15	Pit 4	Layers	Oven 10	Layers	Pit 5	Layers	Hearth 1	
	Trichiuridae (cutlassfishes) indet											7									1	33			**41**
Pleuronectiformes (flatfish)	Paralichthyidae: *Pseudorhombus* sp. (largetooth flounder)																					13			**13**
	Paralichthyidae (largetooth flounders) indet																				2				**3**
Teleostei (bony fish) indet		1692	4	38	505	45	94		12	6	2	294	19	351	7	48	2	31	191	1	173	2582	70	4	**6171**
Total Teleostei		2470	5	101	754	80	150	2	12	11	2	538	31	606	14	76	3	58	321	2	342	**4010**	**221**	**10**	**9820**
Mollusca	Sepiidae (cuttlefish)	26										12	3	9	1							6	1		**58**
																						4209			

Table 8 Number of identified specimens (NISP) and minimum number of individuals (MNI) in the installations and pits located in house 1

Taxon	NISP	MNI
Hearth 1, west of locus 3		
Carcharhinidae (requiem sharks)	1	1
Ariidae (sea catfish)	1	1
Haemulidae (grunts, sweetlips, rubberlips, hotlips)	1	1
Otolithes sp. (tigertooth croaker)	2	1
Sciaenidae (drums, croakers)	1	1
Serranidae (groupers)	1	1
Hearth 2, west of locus 3		
Sciaenidae (drums, croakers)	1	1
Oven 3, locus 11 (courtyard)		
Carcharhinidae (requiem sharks)	1	1
Ariidae (sea catfish)	1	1
Oven 4, locus 11 (courtyard)		
Batoidea (rays)	9	1
Carcharhinidae (requiem sharks)	2	1
Ariidae (sea catfish)	38	1
Carangidae (jacks, jack mackerels, trevally)	1	1
Chanos chanos (milkfish)	1	1
Chirocentridae (wolf herrings)	13	1
Clupeidae (herrings, sardines, shads)	5	1
Haemulidae (grunts, sweetlips, rubberlips, hotlips)	1	1
Mugilidae (mullets)	1	1
Platycephalus indicus (bartail flathead)	1	1
Sciaenidae (drums, croakers)	2	1
Oven 5, locus 11 (courtyard)		
Batoidea (rays)	1	1
Carcharhinidae (Requiem sharks)	1	1
Ariidae (sea catfish)	211	10
Carangidae (jacks, jack mackerels, trevally)	1	1
Clupeidae (herrings, sardines, shads)	6	1
Haemulidae (grunts, sweetlips, rubberlips, hotlips)	2	1
Lethrinidae (emperors)	2	1
Platycephalus indicus (bartail flathead)	7	1
Pomadasys sp. (grunt)	3	2
Sciaenidae (drums, croakers)	13	1
Serranidae (groupers)	4	1
Oven 6, locus 11 (courtyard)		
Ariidae (sea catfish)	17	2
Clupeidae (herrings, sardines, shads)	6	1
Pleuronectiformes (flatfish)	1	1
Mugilidae (mullets)	1	1
Otolithes sp. (tigertooth croaker)	1	1
Platycephalus indicus (bartail flathead)	2	1
Pomadasys sp. (grunt)	1	1
Sciaenidae (drums, croakers)	2	1
Serranidae (groupers)	2	1
Sphyraenidae (barracuda)	3	1
Oven 8, locus 11 (courtyard)		
Batoidea (rays)	4	1
Carcharhinidae (Requiem sharks)	5	1
Ariidae (sea catfish)	40	2
Carangidae (jacks, jack mackerels, trevally)	2	1
Lethrinidae (emperors)	2	1
Platycephalus indicus (bartail flathead)	1	1
Pomadasys sp. (grunt)	1	1
Sciaenidae (drums, croakers)	7	1
Serranidae (groupers)	3	1
Oven 9, locus 11 (courtyard)		
Ariidae (sea catfish)	2	1
Oven 10, locus 4		
Carcharhinidae (Requiem sharks)	2	1
Serranidae (groupers)	1	1
Oven 11, locus 3		
Carcharhinidae (Requiem sharks)	1	1
Ariidae (sea catfish)	3	1
Otolithes sp. (tigertooth croaker)	1	1
Pomadasys sp. (grunt)	2	1
Sciaenidae (drums, croakers)	6	1
Oven 12, locus 3		
Ariidae (sea catfish)	192	6
Carangidae (jacks, jack mackerels, trevally)	3	1
Chirocentridae (wolf herrings)	1	1
Clupeidae (herrings, sardines, shads)	9	1
Mugilidae (mullets)	3	1
Pomadasys sp. (grunt)	1	1
Sciaenidae (drums, croakers)	44	1
Serranidae (groupers)	2	1
Oven 13, locus 3		
Batoidea (rays)	14	1
Carcharhinidae (Requiem sharks)	4	1
Ariidae (sea catfish)	1	1
Carangidae (jacks, jack mackerels, trevally)	1	1
Haemulidae (grunts, sweetlips, rubberlips, hotlips)	1	1
Lethrinidae (emperors)	1	1
Platycephalus indicus (bartail flathead)	1	1
Serranidae (groupers)	1	1
Sparidae (porgies, seabreams)	1	1
Oven 14, locus 3		
Batoidea (rays)	1	1
Carcharhinidae (Requiem sharks)	27	1
Ariidae (sea catfish)	23	1
Carangidae (jacks, jack mackerels, trevally)	1	1
Mugilidae (mullets)	1	1
Platycephalus indicus (bartail flathead)	1	1
Pomadasys sp. (grunt)	1	1
Sciaenidae (drums, croakers)	1	1

Table 8 (continued)

Taxon	NISP	MNI
Oven 15, locus 3		
Carcharhinidae (requiem sharks)	2	1
Sciaenidae (drums, croakers)	1	1
Pit 2, courtyard (locus 11)		
Batoidea (rays)	1	1
Otolithes sp. (tigertooth croaker)	1	1
Pomadasys sp. (grunt)	2	1
Sciaenidae (drums, croakers)	2	1
Pit 4, locus 3		
Batoidea (rays)	6	1
Carcharhinidae (requiem sharks)	1	1
Ariidae (sea catfish)	7	1
Carangidae (jacks, jack mackerels, trevally)	3	1
Haemulidae (grunts, sweetlips, rubberlips, hotlips)	2	1
Lethrinidae (emperors)	2	1
Platycephalus indicus (bartail flathead)	5	1
Pomadasys sp. (grunt)	2	1
Sciaenidae (drums, croakers)	6	1
Pit 5, east of locus 11 (courtyard)		
Batoidea (rays)	58	2
Carcharhinidae (requiem sharks)	114	3
Orectolobidae (carpet sharks)	21	1
Acanthopagrus sp. (seabream)	2	1
Ariidae (sea catfish)	844	22
Carangidae (jacks, jack mackerels, trevally)	3	1
Chelon sp. (mullet)	1	1
Chirocentridae (wolf herrings)	16	1
Clupeidae (herrings, sardines, shads)	97	2
Haemulidae (grunts, sweetlips, rubberlips, hotlips)	5	1
Mugilidae (mullets)	7	1
Nemipteridae (threadfin breams)	5	1
Otolithes sp. (tigertooth croaker)	5	3
Platycephalus indicus (bartail flathead)	42	2
Pomadasys sp. (grunt)	100	5
Pseudotolithus sp. (croaker)	4	2
Pseudorhombus sp. (large-tooth flounder)	13	1
Sciaenidae (drums, croakers)	167	7
Serranidae (groupers)	58	7
Siganidae (rabbitfish)	1	1
Sparidae (porgies, seabreams)	28	2
Sparidentex sp. (seabream)	3	1
Tenualosa ilisha (hilsa shad)	1	1
Trichiuridae (cutlassfishes)	33	1

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