Reports from the Environmental Archaeology Unit, York **94/53**, 36pp.

Pre publication report: Analysis of the fish remains; including a brief description of the bird and mammal remains from Saar Temple, Bahrain.

by

Brian G. Irving.

Summary

The analysis, reported here, has been submitted for inclusion in :-

Killick, R. (ed), (in preparation). *Saar Temple, Bahrain.*

Five years of excavation on the Dilmun period site of Saar, Bahrain, has produced an estimated 150,000 fish bone fragments. Reported here is the analysis of the fish remains from a single building (the Temple) which has produced a total of 10,087 fish bone fragments. It is pointed out that the temple, being a religious building, is unlikely to reflect the local food economy but can reveal the local marine environment and fish exploitation practices. Further to this, burned material may be evidence for the votive offering of fishes to the Dilmunite gods.The bird and mammal remains are also, selectively, reported here, concentrating on those bones which are new to the site record or enhance previous zooarchaeological work on it.

Author's address

Environmental Archaeology Unit
University of York
Heslington
York YO1 5DD

Telephone: (0904) 433846-51
Fax: (0904) 433850

Prepared for:

London Bahrain Archaeological Expedition
P.O. Box 452
Manama
Bahrain.

1/12/94.

ANALYSIS OF THE FISH REMAINS;
Including a brief description
of the
bird and mammal remains.

from

SAAR TEMPLE, BAHRAIN.

INTRODUCTION

The animal remains from Saar temple constitute an assemblage which cannot reflect either the environment or the economy of the site as a whole. The perceived function of the temple excludes the preparation, consumption and trade of animals, although their use as sacrificial offerings cannot be overlooked. The animal remains from the temple do, however, reflect the importance of the marine resource exemplified in the animal assemblage from the rest of the site (Dobney & Jaques 1994; Irving, in preparation).

The temple assemblage probably represents both the casual discard of bone material and the waste products from votive offerings to the Dilmunite gods. The assemblage is relatively small but shows some interesting aspects hitherto unrecorded from the rest of the site. The pre/proto temple phases have produced a number of species which have not been identified from the rest of the site' which suggests a higher reliance on wild mammal resources (both marine and terrestrial) during the pre-Dilmunite occupation of Bahrain. This was identified as a consequence of the deep excavation within the temple, necessary to establish the complex phasing of this building (Farid, this volume).

This report represents the first detailed account of an animal assemblage from a religious building anywhere in the Arabian Gulf and, as such, detailed comparisons with other sites cannot be made.

METHODS

All of the contexts which have produced animal remains were dry sieved to 1mm. There were also a number of hand collected surface finds, which consisted mainly of articulated fish vertebrae and large mammal bones.

The samples come from both excavated areas and a series of spits which were sampled from the sondage (see Farid, this volume).

The material was identified using the modern reference collection established by the London Bahrain Archaeological Expedition from local markets and material from the Al-Areen wildlife reserve.

Fish bone measurements were adapted from Morales and Rosenlund (1979), while bird and mammal measurements were taken from Von Den Driesch (1976). Most of the fish bone measurements were adapted in response to the fragmentary nature of the material (see taphonomy section). A summary of the measurements will be given when larger areas of the site are reported (Irving, in preparation)

TAPHONOMY.

Generally, bone preservation is variable across the site, the temple being no exception. A range of preservation states were recorded along with the type of bone surface texture.

Within deposits from the two temple phases the mammalian remains are chalky and moderately decalcified with a high percentage of fresh breaks, these are possibly a result of handling during excavation and sieving. The bird material seems more robust and less chalky. The fish material is variable, possibly as result of the variation in oil content across the families. Salt damage is also evident on most of the bone material from the temple. This can be seen from bone surface pitting which is usually found in conjunction with adheering salt crystals.

Preservation is best within the sondage (pre-temple) deposits, and is probably due to less trampling and reworking. Faster burial, which would protect the bones from aerial weathering and carnivore damage, is thought to be consistent with the non-anthropogenic nature of the taphonomic variables within the pre-temple deposits.

The fragmentation of the fish bone has been scored using a five point system as follows;

1. Complete: 100% of bone intact.
2. Slight damage: 80-95% of bone intact.
3. Moderate damage: 40-79% of bone intact.
4. Much damage: 20-39% of bone intact.
5. Identifiable as fish bone: 1-19% of bone intact.

A recent study, (Irving *in press,*) has highlighted the potential sample bias caused by the gutting in antiquity of large piscivorous fishes on the site. A single grouper (Serranidae) which was prepared for skeleton reference material still had the digestive tract intact when placed into a bath of enzyme based de-fleshing agent. The gut was found to contain the remains of at least 9 individual small fish (see Figure 1) showing a range of attritional states. These findings cannot be ignored when dealing with the waste products of a primary fishing community. Such a sample bias could be very large (based on a single fish) giving a ratio of 9:1 in favour of accidental anthropogenically derived material within the assemblage. This is probably also true of the mollusc feeding Sparidae (breams) which could potentially bias the molluscan assemblage. The three sparids within the gut contents of the grouper appear to have deposited over 40 fragments of molluscan shell.

In general, the taphonomic processes identified on the site are consequent upon four main factors:

1. Human and other carnivore damage in antiquity.
2. Chemical damage.
3. Fragmentation due to reworking within the deposits.
4. Excavation and storage damage.

THE FISH BONES.

A total of 10,087 fragments of fish material were fully recorded of which 7,811 were not referable to family. The majority of the fish remains were fragments of cranium and fin spine and as these cannot be identified higher than order they have biased the identifiable : unidentifiable ratio in favour of the latter. Rib fragments were left out of the analysis as they are also not identifiable more closely than order. From the remaining 2,276 fragments a range of species from fourteen families were identified, (see Table 1 for a summary).

The fish material has been recorded and subsequently reported here using those skeletal elements which were comparable across a number of families. The elements themselves are all cranial and are paired biosymetrically. This has created a data set which can be compared on the basis of a number of fragments, but more importantly using the minimum number of individuals. The skeletal elements involved are shown in Figure 2. The set of fishes include the breams (Sparidae), groupers (Serranidae), snappers (Lutjanidae), emperors (Lethrinidae), grunts (Haemulidae) and the jacks (Carangidae). This group contains most of the major economic species on Bahrain at the present time except the rabbit fishes (Siganidae), which are represented within the assemblage by vertebrae only. The post-cranial elements of the comparative group, all vertebrae, have been clumped together, as direct comparison of these elements would not be fruitful, the general morphology of the vertebrae also causes specific identification problems. The group of vertebrae, identified to the six families described above, have been placed into the 'vertebrae group' and number 1,248. Some species and families are represented by vertebrae only and are reported here in the standard way, i.e. number of vertebrae etc. (see Table 2). However, it would be misleading to compare them with those families identified using other elements.

As the ichthyofaunal assemblage from the temple is relatively small, when compared to that from the rest of the site, the fish taxa have been split into families as this makes comparison much clearer, consequently the numbers of individuals for each family is higher. The inshore families of gulf fishes usually inhabit the same environments. Looking at the assemblage in this way gives a clearer indication of the types of fishes being procured.

The analytical approach, outlined above, is the outcome of contact with local fishermen and traders who group a range of species from the same family under a local name. Although modern studies are important it can only be speculated that fishes were grouped in this way during the Dilmunite occupation. However it does serve as a basis for grouping fishes: this is usually described as 'ethnotaxonomy'. The justification for this approach in the faunal analysis is that it addresses the role of man as the accumulating agent, but also includes the relevant zooarchaeological information.

The habitat preferences of the taxa listed below are summarised in Figure 3, the information on behaviour, habitats and food being summarised from Al-Baharna (1986).

SPARIDAE (breams, porgies).

A total of 216 cranial bone fragments have been identified to this family, this produced a minimum number of individuals of 45, this breaks down as 29 individuals in the pre-temple phase, three in the early phase and 13 in the late phase, this data being summarised in Table 3.

The breams and porgies feed on mollusca and crustaceans from sandy, coral reef and rocky bottoms giving them a very wide habitat niche; it is therefore difficult to pinpoint their place of capture. Some of the species are also semi-herbivorous. There is a slight size variation within the material but this is a result of the different species (at least three) within the group. The individuals are all around 30 - 50cm standard length (SL), a size typical of those on the market in 1993. The average size suggests that the fish were caught in deeper water and not in the coastal region, as smaller individuals, 5 - 25cm (SL) tend to be caught further inshore (Irving, personal observation; Van Neer 1994).

SERRANIDAE (groupers).

A total of 99 cranial bones were identified to this family (Table 1). The pre-temple phase produced eight individuals, the early temple two and the late temple three, see Table 4.

This family includes the most prized fish in Bahrain today fetching the highest market prices. The individual species vary greatly in size but all are caught both offshore and inshore usually above the fringing and secondary coral reefs. The material from the temple has a very wide range of sizes (20 - 95cm SL) reflecting the size range on Bahrain fish market today. The bone morphology within this family is very similar, making identification to species level very difficult. Those skeletal elements which can be used, such as the opercular, are usually too damaged in archaeological material. Like those identified by Van Neer (1994) from Qala'at al-Bahrain the bones are referable to *Epinephalus* spp.

All of the groupers are highly piscivorous and may contribute to the ichthyofaunal assemblage of the site as their guts are usually full of small fish (Irving, in press); see also taphonomy section.

LUTJANIDAE (snappers)

The snappers are represented by 29 cranial bone fragments with none occurring in the early temple phase. Two individuals have been identified from the pre-temple deposits and four from the late temple, see Table 5. This family has a wide range of habitats from coastal mangrove to coral reefs. They feed on crustaceans and fishes and are usually caught over both inshore and offshore reefs at the present time.

A wide habitat range limits the use of this family in the reconstruction of fishing areas and techniques.

LETHRINIDAE (emperors)

The emperors are the largest family from the temple assemblage, having a total of 380 identified cranial bones. From these a minimum number of seventeen, calculated from premaxillae, was identified from the pre-temple deposits, four from the early temple based on articulars and 21 individuals from the late temple, again calculated from articulars (see Table 6).

The emperors have a very wide habitat range from coastal mangrove creeks to sandy bottoms and coral reefs. Smaller individuals inhabit inshore waters while the larger specimens are usually found offshore over coral reefs. The emperors are the most common fish in today's markets, all year round. The material from the temple deposits contains at least three species. The reconstructed sizes for this family are between 10 - 50cm (SL).

As this family has a very wide habitat range it is impossible to locate place of capture or fishing method.

HAEMULIDAE (grunts)

The grunts form the smallest family from the total assemblage with only five cranial fragments and two individuals from both the pre-temple and the late temple, see Table 7. They are a popular food fish on the island at the present time. They have a wide set of habitat preferences from inshore lagoons to offshore reefs.

CARANGIDAE (jacks, trevallies and yellowtails)

The jacks trevallies and yellowtails are represented by 72 cranial bones and a total of 8 individuals, see Table 8. They are fast-moving predatory fishes which inhabit both inshore waters and offshore reefs.

PLATYCEPHALIDAE (spiny flatheads)

The spiny flatheads are represented by a single vertebral centrum from the late temple phase, see Table 1. They are usually found within intertidal zones including estuaries. They are piscivorous.

SCOMBRIDAE (mackerels tunas)

From the late temple phase fourteen vertebrae have been identified as belonging to the mackerel genus *Scomberomorus* sp, see Table 1. The mackerels and tunas usually feed both offshore and inshore at certain times of the year. The diet is exclusively carnivorous and includes fishes, crustacea and mollusca. The resource is seasonal on Bahrain at the present time.

SIGANIDAE (rabbitfishes)

Eight vertebrae have been identified as those of rabbitfish and are all from the pre-temple deposits, see Table 1. The rabbitfishes feed on benthic algae and are seasonal, coming inshore into the intertidal zone during high tide. They are a popular food fish in Bahrain at the present time. The fishery is seasonal and very focused on the capture of the rabbitfish using the Gagoor trap baited with algae (Basson 1989) (see discussion).

SPHYRAENIDAE (barracudas)

The barracudas live in a wide range of habitats and are piscivorous. They exploit coral reefs and also follow smaller fish into intertidal areas where they usually form shoals. There are 190 bones from the assemblage identified as barracuda and are all vertebrae with the exception of a single dentary and a single premaxilla. The pre-temple deposits produced 41 fragments and 140 from the late temple deposits, see Table 1. At the present time only one species of barracuda occurs within Bahraini waters, the yellowfinned barracuda *Sphyraena obtusata* Cuvier, 1829, but all of the material identified showed slight morphological differences from this species. It may be that another species inhabited the Arabian Gulf in antiquity.

Other Familes.

Tylosurus crocodilus (LeSuer, 1821)
crocodile needlefish

This species has been identified from a single vertebra within the late temple phase, see Table 1. They occur across a wide range of coastal habitats and are piscivorous.

Pomacanthus maculosus (Forsskål, 1775)
yellowbar angelfish

A single dentary from the late temple has been identified as this species, see Table 1. They are coral feeders living exclusively on coral reefs.

Rachycentron canadus (Linnaeus 1776)
cobia

The cobia is represented by four caudal vertebrae from both the early and late temple occupations, see Table 1. It has a narrow habitat range, living on coral reefs and rocky bottoms in coastal waters, and is carnivorous.

A single vertebra fragment of a shark which is too eroded for identification higher than order (Lamniformes). is from an early temple deposit.

There are number of fish bones which show signs of burning or heat damage. The type of surface damage ranges from blackened, probably caused by direct burning by flame to white (calcined) which may result from either intense contact heat, eg, in the base of a fire, or cooking in boiling liquid. Surface cracking is also evident on the lighter coloured material. The burned and heat damaged fish bones come from both the pre-temple and late temple deposits and include a broad range of skeletal elements and families.

Evidence for butchery, ie, cut marks, are very rare, the most notable example being a grouper dentary from the late temple phase which had very clear knife marks on the lateral surfaces.

THE BIRD BONES

Few birds are present in the assemblage and they were mainly obtained from the pre-temple deposits. All of the species are wild and occur in the area at the present time. Identifications are based on comparison with the skeletal reference collection of the Environmental Archaeology Unit, University of York, UK.

cf *Phalocrocorax nigrogularis* **Ogilvie-Grant and Forbes, 1899**
socotra cormorant.

A complete femur (Figure 4) has been identified as cormorant from a deposit of unknown phase, the size of which matches that of the socotra. The socotra cormorant is common in the area at the present time, having large breeding colonies on the southern part of the main island and on the Hawar Islands (Gallagher and Hill 1994). Socotra cormorant has also been identified from the sites of Umm an-Naar (Hoch 1979), Qala'at al-Bahrain (Uerpmann and Uerpmann 1994) and Failaka Island (Desse and Desse-Berset (1990).

Chlamydotis undulata **(Jacquin, 1784)**
houbara bustard.

This species, identified from a tarsometatarsus distal fragment (Figure 5), is from a pre-temple deposit. This species is now very rare in the western Gulf region. Bahrain is situated on the migration route from southern Arabia to northern Pakistan (Gallagher and Hill 1994). It is a prized prey species for falconry and has probably been hunted to the brink of extinction. This identification on archaeological material is the first for the region .

THE WILD MAMMAL BONES.

The mammals were identified using both of the previously mentioned reference collections. The mammals identified are both wild and domesticated, with the largest proportion coming from the pre-temple samples. Zooarchaeological data have been excluded here but will be included in later publications where larger datasets can be compared from the whole site.

The mammalian material reported here covers those identifications which are thought to be interesting or represent additional records to those of Dobney and Jaques (1994). Interestingly, all of the material comes from the pre-temple levels with the exception of the Indian grey mongoose.

Family: Dephinidae
dolphin

Two carpals were found together within the pre-temple deposits and are highly polished on their lateral and medial surfaces (Figure 6). Such wear may be the result of human use. Their function can only be speculated upon but the unusual wear would be consistent with rubbing in a cloth bag or other textile receptacle. The morphology of the carpals is very distinctive, with a unique type of bone structure on the articulating surfaces (Figure 6). Uerpmann and Uerpmann (1994) have also identified dolphin from Qala'at Al-Bahrain.

Herpestes edwardsi (E Geoffroy, 1818)
Indian grey mongoose.

An almost complete left mandible which is morphologically identical to *Herpestes edwardsi*. was found within the early temple deposits (figure 7). This find, along with the specimens identified by Dobney and Jaques (1994) is interesting in that the species was thought to have been introduced from the Indian Sub-continent in the historic period. The Indian grey mongoose is a burrowing animal and hence may be intrusive. However, the bone preservation is consistent with other bones from the site, suggesting contemporaneity with the rest of the assemblage. Dobney and Jaques (1994) also discuss the possibility that the Indian grey mongoose was part of the indigenous fauna of Arabia at this time.

Dugong dugon (Müller 1776)
dugong or sea cow.

The material consists of three female tooth fragments from the pre-temple phase (Figure 8). Dobney and Jaques (1994) have identified this animal from other parts of the site, as have Uerpmann and Uerpmann (1994) from Qala'at Al-Bahrain. The dugong is rare in the region today but was once common and economically important, the large assemblage of dugong bones from the Island of Umm an-Naar (Hoch 1979) attesting to this.

Oryx leucoryx (Pallas 1777)
Arabian Oryx

A single left proximal metacarpal (Figures 9 and 10) from the pre-temple phase has been identified as this species. The Arabian oryx has also been identified from Qala'at Al-Bahrain, (Uerpmann and Uerpmann 1994) and from Umm an-Naar (Hoch 1979). This find is not surprising as the animal's natural distribution covers the western gulf. However its remains are quite rare from sites of Dilmun age.

THE DOMESTIC MAMMAL BONES.

The remains of caprines (sheep/goat) and cattle have been identified in small numbers from the temple. Remains of these animals have been found on other parts of the site and on other sites of this age. These animals make up the major economic mammal species at Saar. None of the material has evidence for burning, although some ovicaprid ribs have knife marks close to the proximal articulation.

DISCUSSION AND CONCLUSIONS

The ichthyofaunal assemblage from the Saar Temple, (a single building), is larger, in terms of number of fish bone fragments, than any other reported from the Arabian Gulf region (see Table 9 for a summary). The ichthyofauna from the temple also constitutes less than 1% of the total fish remains recovered to date from Saar. This situation prevents any form of economic reconstruction based on what is essentially a sub-assemblage and any reconstruction should be left for future reports.

With this in mind is it worth considering the value of other site faunas from the region, some of which are hand collected and comparatively small, in the reconstruction of site economy and environment,

The strongest line of interpretation from this assemblage is the reconstruction of local marine environments and exploitation strategies (fishing techniques). The three phases are not properly comparable in terms of species exploited because the faunal remains may not have become incorporated by the same means. The pre-temple phase may be pre-Dilmunite squatter occupation and the faunal remains from the two Dilmunite temple phases are probably not reflecting the range of species being brought into the site as a whole.

The ichthyofaunal resources of Bahrain fall into three main zones or areas with potential for exploitation by man (see Figure 3). At the present time there is an inshore fishery which uses fixed nets, 'hadra', within the intertidal (littoral) areas around the island. These intertidal areas fall into two major habitat types. Freshwater springs around the north of the island have created, in certain discreet areas, brackish intertidal environments which support mangrove and seaweed. The mangrove on Bahrain is restricted to a very small area at the present time but is thought to have been very extensive in the past; this assertion is based on the presence of a very large aquifer which could potentially supply the freshwater necessary to sustain large mangal areas. Maps of Bahrain, drawn within the past 70 years, show that until recently, tidal inlets were larger and could have allowed a more extensive intertidal zone.

The second zone is the tidal mudflats, which support a large number of marine invertebrates including crustacea, mollusca and polychaete worms. This habitat attracts a range of species during the flood and ebb tides; today these are caught using the hadra.

The third zone covers the coral reefs and consist primarily of habitats which contain the highest fish species diversity in the gulf waters.

The fish remains are all from inshore species, most of which are piscivorous. The largest of them, the grouper, is capable of taking herbivorous fishes as well as other piscivorous fishes; and when brought into the site by man, complete with internal organs, is capable of biasing the assemblage with these 'secondary' products (taphonomy section, Irving *in press*). As this is an identified probable source of sample bias then it is also worth considering that the 'primary' fish assemblage, (consisting of carniverous species) was taken using hooks (baited with flesh) and did not include herbivores which would have to be caught using nets and traps.

A number of metal fishhooks have been found at Saar the size of which would only take fishes which feed on flesh, herbivores would not be taken by this method. As both of these groups of fishes have been identified at Saar then it is highly likely that some sort of sample bias is occurring if the fishery was exploited purely by hook and line, which points to the herbivores being brought in with the gut contents of piscivores. The size classes of this group back up this assertion, as they are, with very few exceptions across the whole site, quite small.

The fishes identified from Saar Temple are wide ranging in their habitat preferences so cannot reflect any specific area of capture. It is therefore safe to suggest that the fishes were taken from habitats ranging from coastal intertidal bays to secondary coral reefs.

The fish species representation throughout the three phases shows change, based on numbers of individuals. It is thought that these changes are not significant, species change will be addressed later (Irving *in prep*) when a larger dataset is compiled using material from the rest of the site.

Finally, the many fish bones from the temple levels which are burned may have been so as a consequence of temple offerings. Little is known about the religious beliefs of the Dilmun people, but, as the islands, economy and trade is dominantly maritime, then fish, by association, may have been a sacrificial item. Indeed, a small assemblage of burned fish bones were recovered from the plinth of the southern temple altar (context 1661).

ACKNOWLEDGEMENTS.

I would like to thank a number of people who helped in many ways during fieldwork; Steve Green, Nabiel al Sheik, Dr Jaimie Samour and Dr Mohamed Aladdin Ashour. Thanks also to the excavation team for useful discussion and help especially Shahina Farid.

Back at the laboratory Keith Dobney, Deborah Jaques and Harry Kenward provided fruitful discussion and ruthless editing,

BIBLIOGRAPHY

Al-Baharna, W. (1986) *The Fishes of Bahrain.* Ministry of Commerce and Agriculture, Directorate of Fisheries, Bahrain.

Basson, P. W. (1989) Fish Bait Algae. *Economic Botany, 43* (2). pp 271-278.

Desse, J. and Desse-Berset, N. (1990) La Faune les Mammiferes et les Poissons. in Calvet, Y. and Gachet, J. (eds) Failaka, Fouilles Francaises 1986-1988. *Travaux de la Maison de l'Orient. No 18.* pp 51-70.

Dobney, K.M. and Jaques, D (1994) Preliminary Report on the Animal Bones from Saar. *Arabian Archaeology and Epigraphy 1994 3* . pp 106-120.

Driesch, A. von den, (1976) *A Guide to the Measurement of Animal Bones from Archaeological Sites.* Peabody Museum Bulletin 1. Harvard.

Gallagher, M. and Hill, M. (1994) *The Birds of Bahrain.* Immel Publishing. London.

Hoch, E. (1979) Reflections on Prehistoric Life at Umm an-Narr (Trucial Oman) Based on Faunal Remains from the Third Milleneum BC. in Taddei, M. (ed), *South Asian Archaeology 1977. Volume 1,* Minor Series 6. Naples. pp 589-638.

Irving, B.G. (in press) Over-representation of fish remains on archaeological sites; the effect of piscivorous fishes on fish bone assemblages. *Circaea.*

Irving, B.G. (in prep) A preliminary report on the Fish Remains from Saar, Bahrain. *Arabian Archaeology and Epigraphy*

Morales, A. and Rosenlund, K. (1979) *Fish Bone Measurements; An Attempt to Standardise the Measuring of Fish Bones from Archaeological Sites.* Steenstrupia. Copenhagen

Uerpmann, M. and Uerpmann, H-P. (1994) *Animal bone finds from Excavation 520 at Qala'at al-Bahrain.* in Højlund, F. and Andersen. H.H. Qala'at al-Bahrain volume 1 The Northern City Wall and the Islamic Fortress. Jutland Archaeological Society Publications XXX:1. pp417-444

Van-Neer, W. and Uerpmann, M. (1994) *Fish remains from Excavation 520 at Qala'at al-Bahrain.* in Højlund, F. and Andersen. H.H. Qala'at al-Bahrain volume 1 The Northern City Wall and the Islamic Fortress. Jutland Archaeological Society Publications XXX:1. pp 445-454.

LIST IF FIGURES.

FIGURE 1. Cranium (top) of Serranidae (grouper) defleshed for reference material. Below are the gut contents of the individual. top row, three crania of Sparidae (bream), middle row, five crania of Serranidae (grouper) and bottom row, one cranium of a Carangidae (snapper). Bone attrition increases from left to right.

FIGURE 2. Head of fish showing the main bones used in this analysis.

FIGURE 3. The major habitats used by the inshore fishes of Bahrain showing the families identifed from Saar Temple.

FIGURE 4. Femur of cf *Phalocrocorax nigrogularis* Ogilvie-Grant and Forbes, 1899, socotra cormorant.

FIGURE 5. Distal fragment tarsometatarsus of *Chlamydotis undulata* (Jacquin, 1784) houbara bustard.

FIGURE 6. Two carpals of dolphin (Delphinidae) showing highly polished surfaces.

FIGURE 7. Mandible of *Herpestes edwardsi* (E Geoffroy, 1818), Indian grey mongoose.

FIGURE 8. Inscissor tooth fragments of *Dugong dugon* (Müller 1776), dugong or sea cow.

FIGURE 9. Proximal metacarpus fragment of *Oryx leucoryx* (Pallas 1777), Arabian Oryx.

FIGURE 10. Proximal metacarpal fragment of *Oryx leucoryx* (Pallas 1777), Arabian Oryx showing dorsal surface.

LIST OF TABLES.

TABLE 1. The fish remains from Saar Temple, Bahrain by taxon and site phase.

TABLE 2. The fish remains from Saar Temple, Bahrain by taxon and skeletal element.

TABLE 3. The minimum number of individuals and number of identified paired cranial bones by site phase of Sparidae (breams, porgies). MNI is bold and underlined.

TABLE 4. The minimum number of individuals and number of identified paired cranial bones by site phase of Serranidae (groupers). MNI is bold and underlined.

TABLE 5. The minimum number of individuals and number of identified paired cranial bones by site phase of Lutjanidae (snappers). MNI is bold and underlined.

TABLE 6. The minimum number of individuals and number of identified paired cranial bones by site phase of Lethrinidae (emperors). MNI is bold and underlined.

TABLE 7. The minimum number of individuals and number of identified paired cranial bones by site phase of Haemulidae (grunts). MNI is bold and underlined.

TABLE 8. The minimum number of individuals and number of identified paired cranial bones by site phase of Carangidae (jacks, trevallies and yellowtails). MNI is bold and underlined.

TABLE 9. Comparison of the number of fish bones from three sites with Dilmun occupation from the western Arabian Gulf.

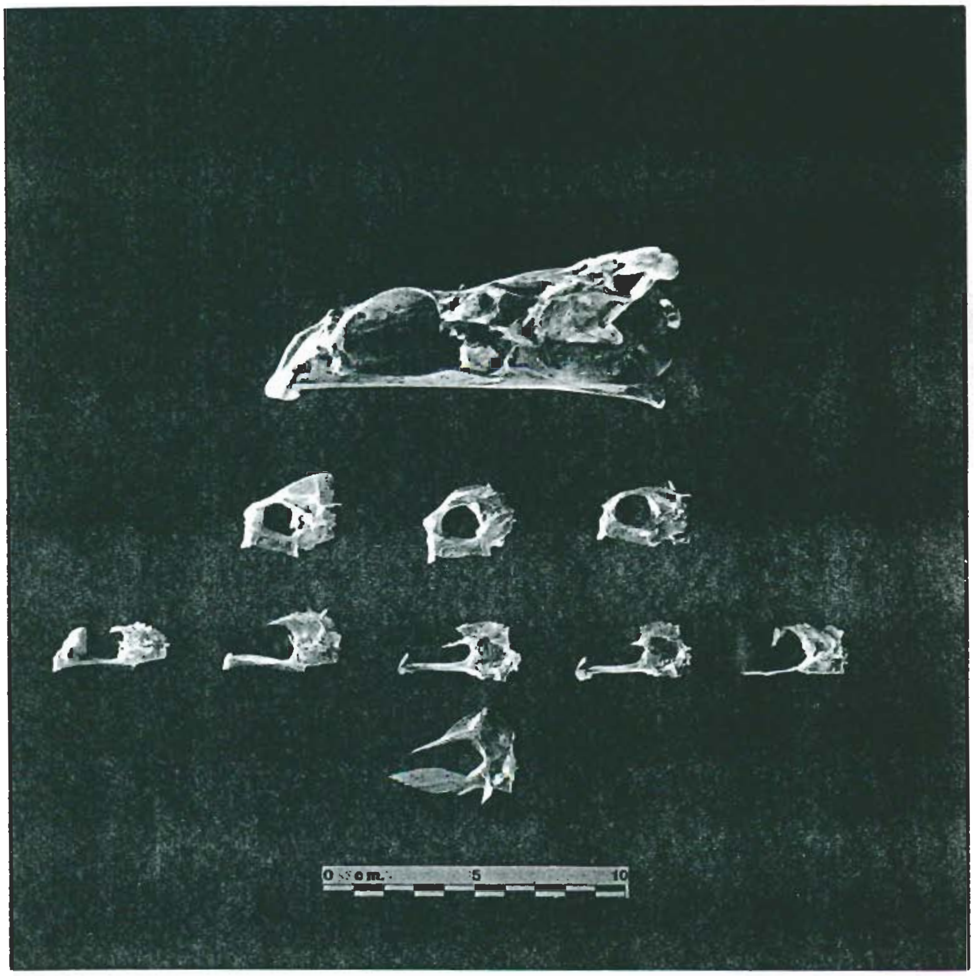


FIGURE 1. Cranium (top) of Serranidae (grouper) defleshed for reference material. Below are the gut contents of the individual. top row, three crania of Sparidae (bream), middle row, five crania of Serranidae (grouper) and bottom row, one cranium of a Carangidae (snapper). Bone attrition increases from left to right.

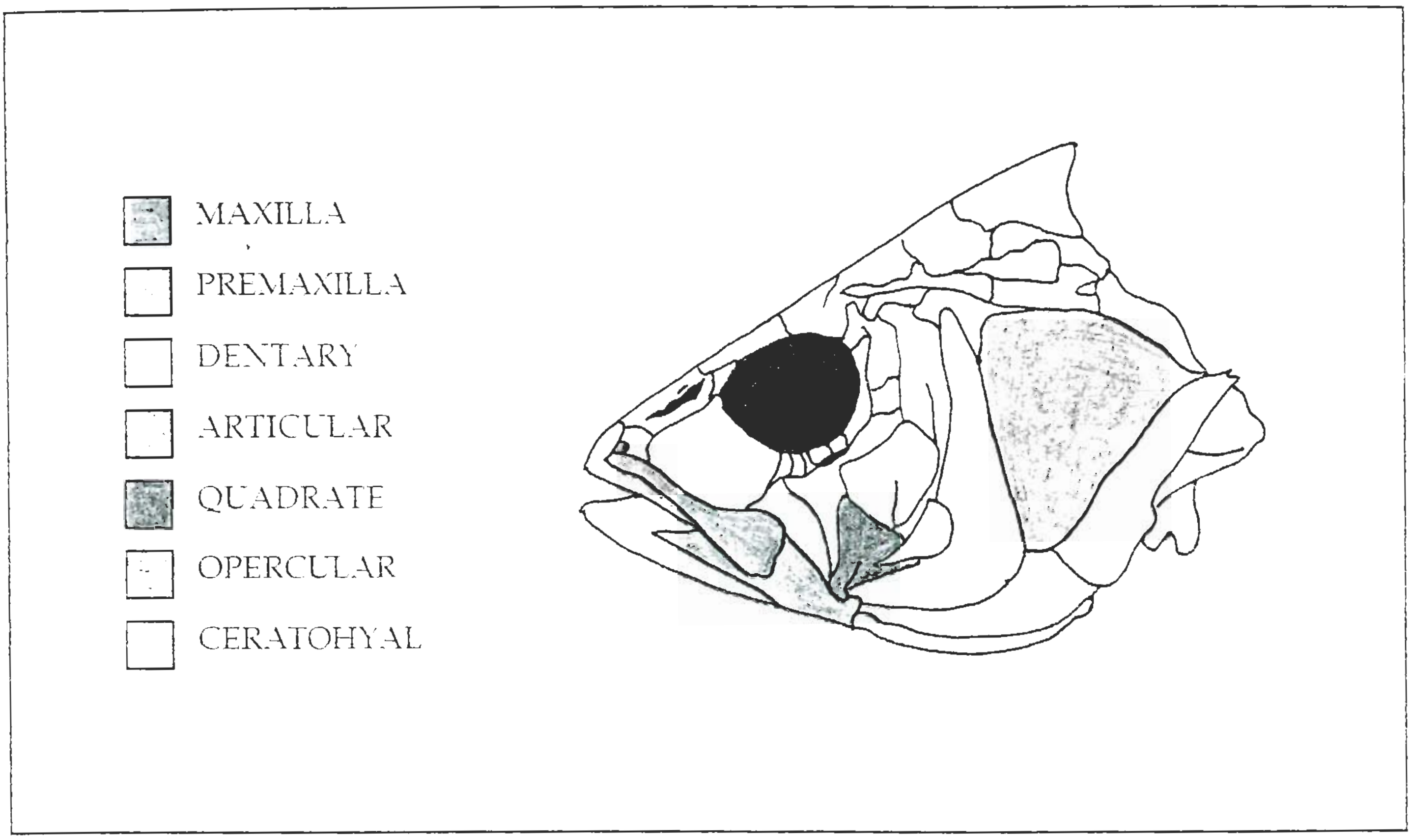


FIGURE 2. Head of fish showing the main bones used in this analysis.

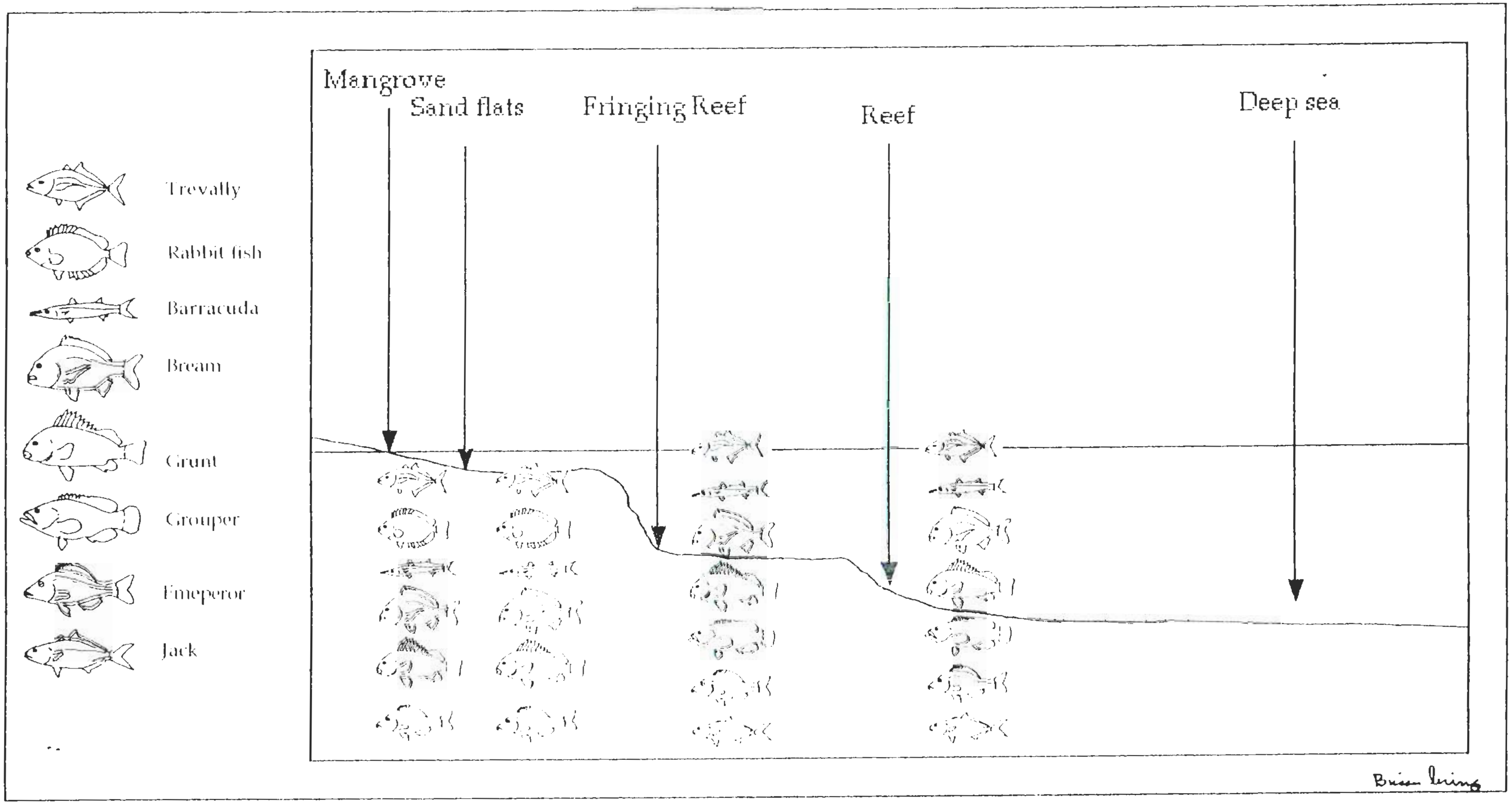


FIGURE 3. The major habitats used by the inshore fishes of Bahrain showing the families identifed from Saar Temple.

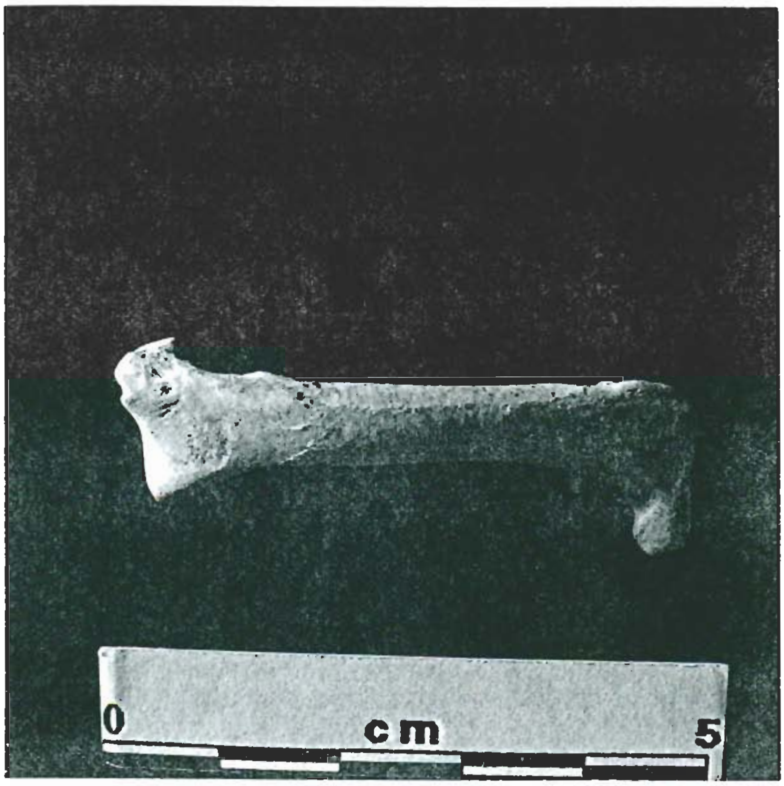


FIGURE 4. Femur of cf *Phalocrocorax nigrogularis* Ogilvie-Grant and Forbes, 1899, socotra cormorant.

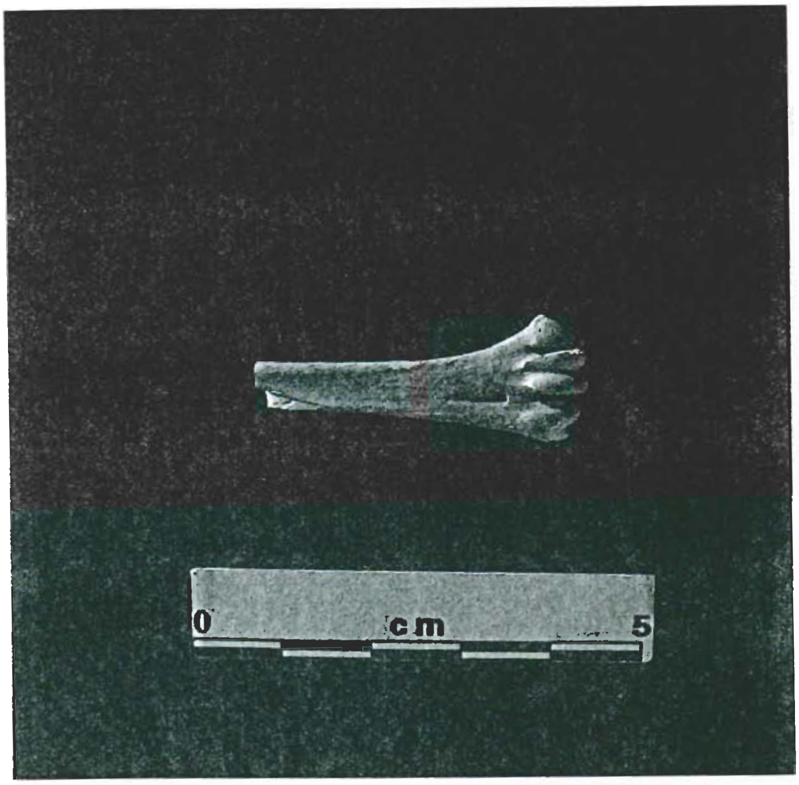


FIGURE 5. Distal fragment tarsometatarsus of *Chlamydotis undulata* (Jacquin, 1784) houbara bustard.

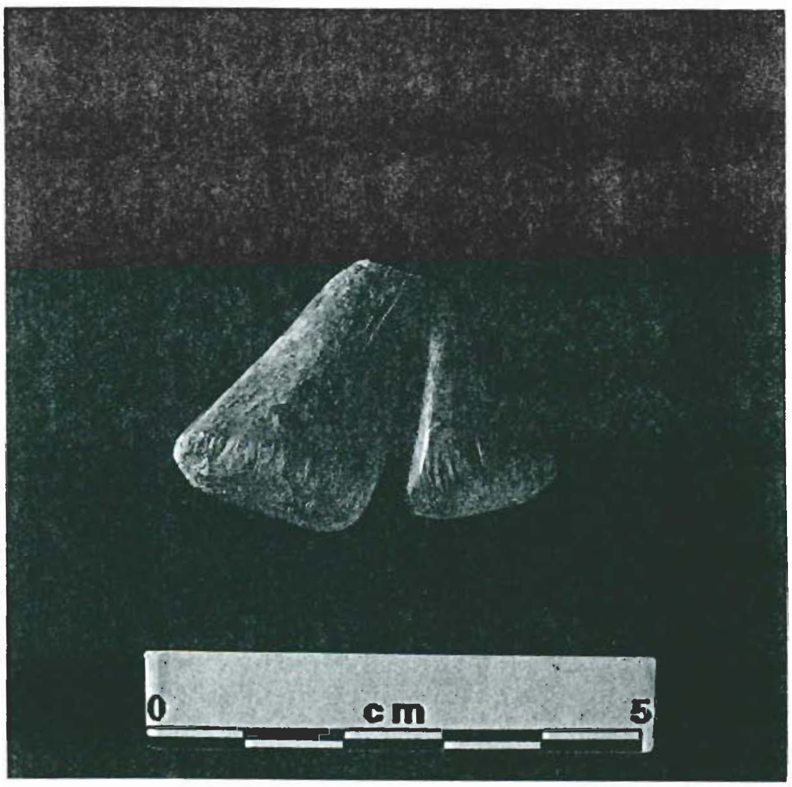


FIGURE 6. Two carpals of dolphin (Delphinidae) showing highly polished surfaces.

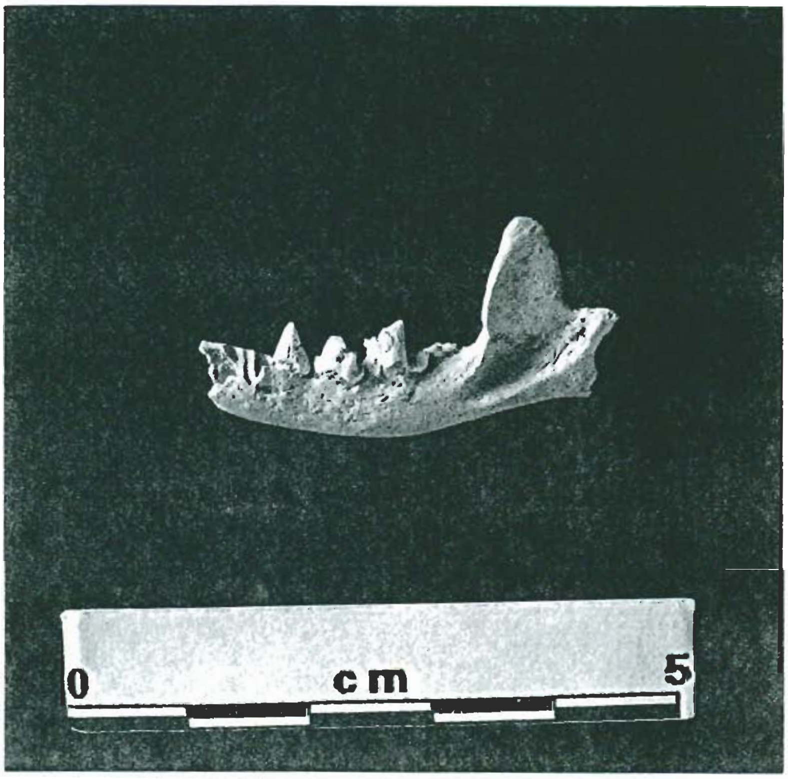


FIGURE 7. Mandible of *Herpestes edwardsi* (E Geoffroy, 1818) Indian grey mongoose.

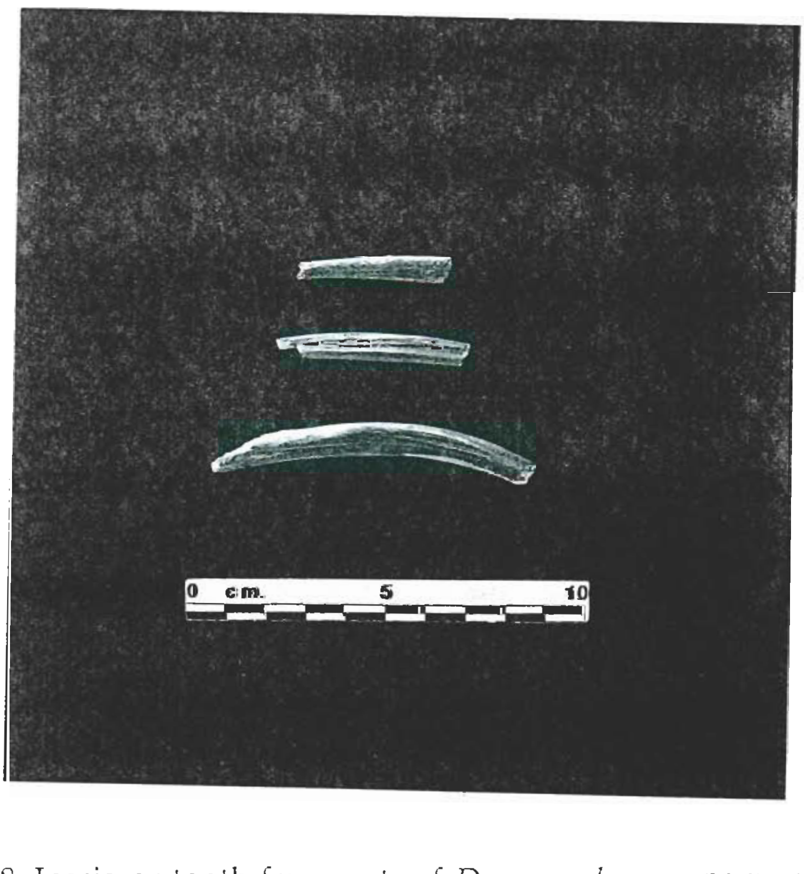


FIGURE 8. Inscissor tooth fragments of *Dugong dugon* (Müller 1776) dugong or sea cow.

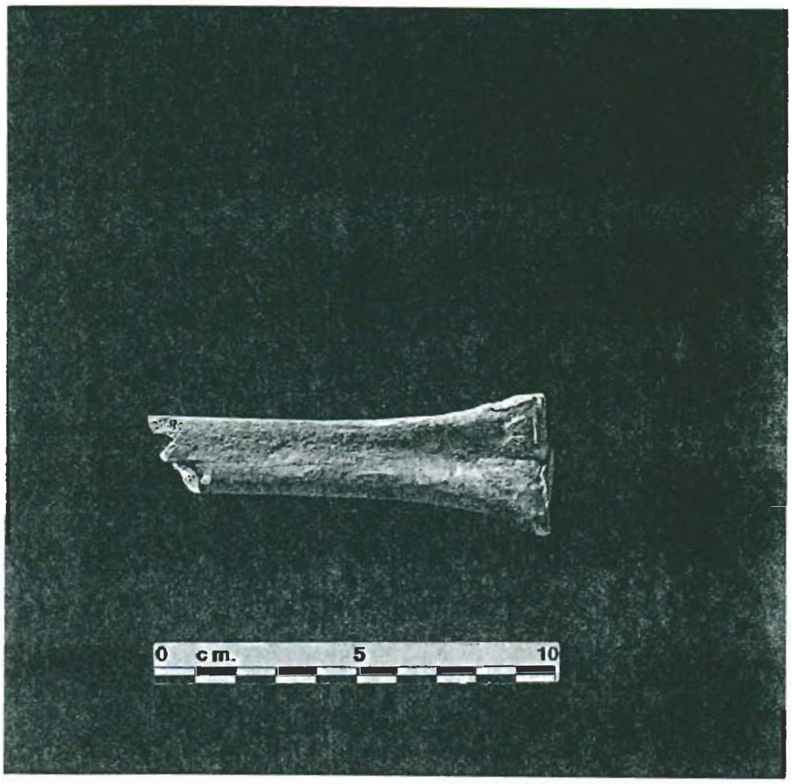


FIGURE 9. Proximal metacarpus fragment of *Oryx leucoryx* (Pallas 1777) Arabian Oryx.

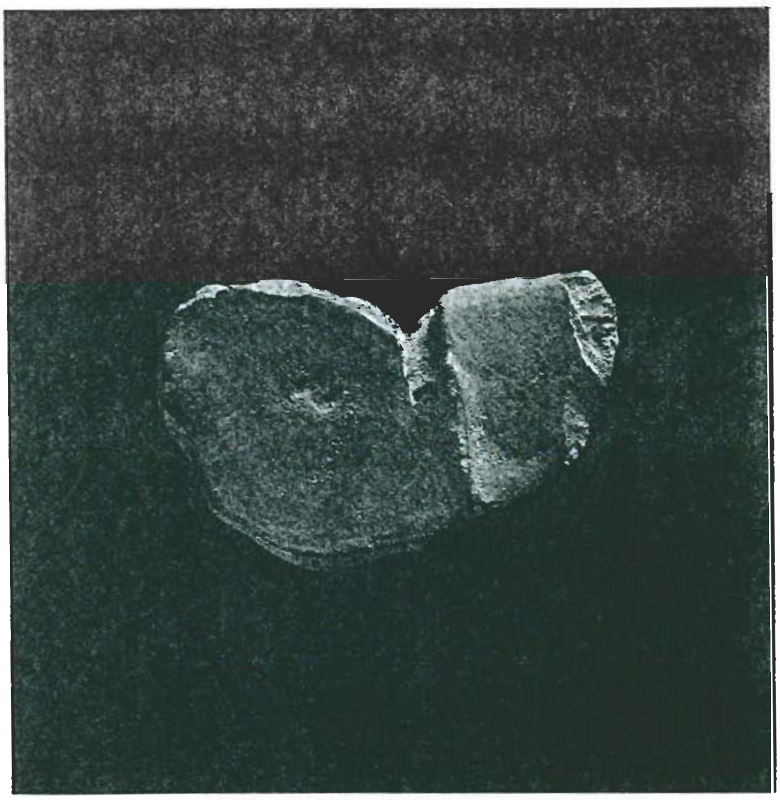


FIGURE 10. Proximal metacarpus fragment of *Oryx leucoryx* (Pallas 1777) Arabian Oryx showing dorsal surface.

		PRE-TEMPLE	EARLY	LATE	NOT KNOWN	Grand Total
Tylosurus crocodilus crocodile needlefish	CERVICAL VERTEBRA	0	0	1	0	1
Tylosurus crocodilus crocodile needlefish Total		0	0	1	0	1
Carangidae (jacks trevallies yellowtails)	ETHMOID	0	0	1	0	1
	ARTICULAR	1	0	3	0	4
	DENTARY	3	1	9	1	14
	MAXILLA	4	1	6	1	12
	PREMAXILLA	1	2	10	0	13
	QUADRATE	3	1	4	1	9
	CERATOHYAL	2	0	8	0	10
	HYOMANDIBULAR	0	0	3	0	3
	OPERCULAR	2	0	3	1	6
Carangidae (jacks trevallies yellowtails) Total		16	5	47	4	72
Haemulidae (grunts)	PREVOMER	0	0	1	0	1
	PTEROSPHENOID	1	0	0	0	1
	ARTICULAR	0	0	1	0	1
	DENTARY	1	0	0	0	1
	QUADRATE	0	0	1	0	1
Haemulidae (grunts) Total		2	0	3	0	5
Lethrinidae (emperors)	PREVOMER	1	0	0	0	1
	POSTTEMPORAL	11	3	20	7	41
	ARTICULAR	8	4	37	8	57
	DENTARY	20	0	24	6	50
	MAXILLA	15	2	23	7	47
	PREMAXILLA	27	5	24	21	77
	QUADRATE	9	2	20	3	34
	CERATOHYAL	16	0	18	9	43
	OPERCULAR	4	1	20	5	30
Lethrinidae (emperors) Total		111	17	186	66	380
Lutjanidae (snappers)	ARTICULAR	1	0	2	1	4
	DENTARY	0	0	7	4	11
	MAXILLA	2	0	1	0	3
	PREMAXILLA	2	0	6	1	9
	CERATOHYAL	0	0	1	0	1
	OPERCULAR	0	0	1	0	1
Lutjanidae (snappers) Total		5	0	18	6	29
Mullidae (goatfishes)	CENTRUM	0	0	4	4	8
Mullidae (goatfishes) Total		0	0	4	4	8
Platycephalidae (spiny flatheads)	CENTRUM	0	0	1	0	1
Platycephalidae (spiny flatheads) Total		0	0	1	0	1
Pomacanthus maculosus yellowbar angelfish	DENTARY	0	0	1	0	1
Pomacanthus maculosus yellowbar angelfish Total		0	0	1	0	1
Rachycentron canadus cobia	CAUDAL VERTEBRA	0	1	3	0	4
Rachycentron canadus cobia Total		0	1	3	0	4
Scombridae (mackerels tunas)	CAUDAL VERTEBRA	0	0	1	0	1
	CENTRUM	0	0	13	0	13
Scombridae (mackerels tunas) Total		0	0	14	0	14
Serranidae (groupers)	PREVOMER	0	0	1	1	2
	LACRIMAL	0	0	1	0	1
	POSTTEMPORAL	1	0	0	0	1
	ARTICULAR	4	1	5	5	15
	DENTARY	11	0	3	6	20
	MAXILLA	3	0	3	4	10
	PREMAXILLA	13	0	5	2	20
	QUADRATE	3	2	2	1	8
	CERATOHYAL	11	0	3	2	16
	HYOMANDIBULAR	0	0	1	0	1
	HYPOHYAL	0	0	1	0	1

	OPERCULAR	1	1	0	1	3
	OTOLITH	0	0	1	0	1
Serranidae (groupers) Total		47	4	26	22	99
Siganidae (rabbitfishes)	CERVICAL VERTEBRA	3	0	0	0	3
	ABDOMINAL VERTEBRA	1	0	0	0	1
	CENTRUM	4	0	0	0	4
Siganidae (rabbitfishes) Total		8	0	0	0	8
Sparidae (porgies breams)	ARTICULAR	0	0	2	0	2
	DENTARY	51	2	20	6	79
	MAXILLA	5	0	3	1	9
	PREMAXILLA	51	5	22	6	84
	QUADRATE	2	1	1	0	4
	CERATOHYAL	4	0	10	0	14
	OPERCULAR	0	0	3	0	3
	OTOLITH	1	0	3	0	4
	TOOTH	0	0	2	0	2
	FIN SPINE	15	0	0	0	15
Sparidae (porgies breams) Total		129	8	66	13	216
Sphyraenidae (barracudas)	DENTARY	0	0	1	0	1
	PREMAXILLA	0	0	1	0	1
	CAUDAL VERTEBRA	34	0	29	0	63
	CENTRUM	7	0	109	9	125
Sphyraenidae (barracudas) Total		41	0	140	9	190
Vertebrae group	CAUDAL VERTEBRA	249	178	701	120	1248
Vertebrae group Total		249	178	701	120	1248
Indeterminate	BASIOCCIPITAL	1	0	0	0	1
	DENTARY	0	1	0	0	1
	QUADRATE	1	0	1	0	2
	HYOMANDIBULAR	0	0	24	0	24
	CENTRUM	219	1	164	1	385
	ACANTHOTRICH	28	0	0	0	28
	CRANIAL FRAG	1850	411	2299	592	5152
	TOOTH	2	0	2	9	13
	FIN SPINE	568	409	1074	154	2205
Indeterminate Total		2669	822	3564	756	7811
Grand Total		3277	1035	4775	1000	10087

TABLE 1. The fish remains from Saar Temple, Bahrain by taxon and site phase.

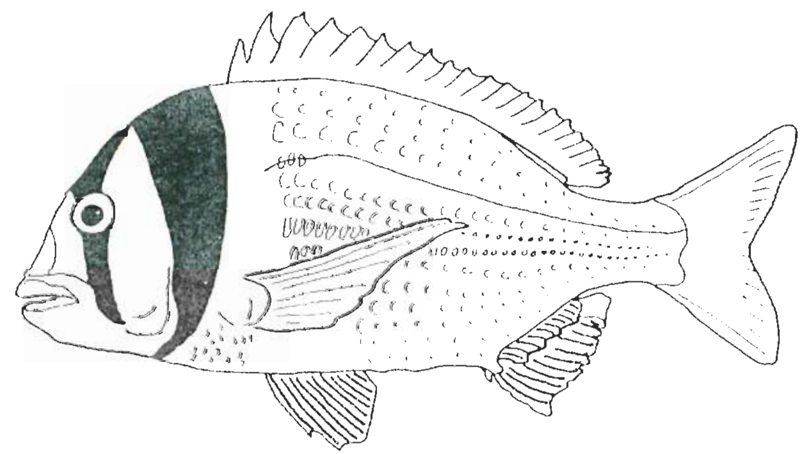
	ETHMOID	PREVOMER	BASIOCCIPITAL	LACRIMAL	PTEROSPHENOID	POSTTEMPORAL	ARTICULAR	DENTARY	MAXILLA	PREMAXILLA	QUADRATE	CERATOHYAL	HYOMANDIBULAR	HYPOHYAL	OPERCULAR	CERVICAL VERTEBRA	ABDOMINAL VERTEBRA	CAUDAL VERTEBRA	CENTRUM	ACANTHOTRICH	OTOLITH	CRANIAL FRAG	TOOTH	FIN SPINE	Grand Total
Tylosurus crocodilus crocodile needlefish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Carangidae (jacks trevallies yellowtails)	1	0	0	0	0	0	4	14	12	13	9	10	3	0	6	0	0	0	0	0	0	0	0	0	72
Haemulidae (grunts)	0	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Lethrinidae (emperors)	0	1	0	0	0	41	57	50	47	77	34	43	0	0	30	0	0	0	0	0	0	0	0	0	380
Lutjanidae (snappers)	0	0	0	0	0	0	4	11	3	9	0	1	0	0	1	0	0	0	0	0	0	0	0	0	29
Mullidae (goatfishes)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0	8
Platycephalidae (spiny flatheads)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Pomacanthus maculosus yellowbar angelfish	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Rachycentron canadus cobia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	4
Scombridae (mackerels tunas)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	13	0	0	0	0	0	14
Serranidae (groupers)	0	2	0	1	0	1	15	20	10	20	8	16	1	1	3	0	0	0	0	0	1	0	0	0	99
Siganidae (rabbitfishes)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	0	4	0	0	0	0	0	8
Sparidae (porgies breams)	0	0	0	0	0	0	2	79	9	81	4	14	0	0	3	0	0	0	0	0	4	0	2	15	216
Sphyraenidae (barracudas)	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	63	125	0	0	0	0	0	190
Vertebrae group	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1248	0	0	0	0	0	0	1248
Indeterminate	0	0	1	0	0	0	0	1	0	0	2	0	24	0	0	0	0	0	385	28	0	5152	13	2205	7811
Grand Total	1	4	1	1	1	42	83	178	81	201	58	84	28	1	43	4	1	1316	536	28	5	5152	15	2220	10087

TABLE 2. The fish remains from Saar Temple, Bahrain by taxon and skeletal element.

Sparidae (porgies breams)

	PRE-TEMPLE			EARLY		LATE			Grand Total
	L	R	U	L	R	L	R	U	
ARTICULAR	0	0	0	0	0	1	1	0	2
DENTARY	25	25	1	1	1	7	12	1	73
MAXILLA	4	1	0	0	0	2	0	1	8
PREMAXILLA	**29**	20	2	**3**	2	8	**13**	1	78
QUADRATE	2	0	0	0	1	1	0	0	4
CERATOHYAL	1	3	0	0	0	4	6	0	14
OPERCULAR	0	0	0	0	0	1	2	0	3
OTOLITH	0	1	0	0	0	1	1	1	4
TOOTH	0	0	0	0	0	0	0	2	2
FIN SPINE	0	0	15	0	0	0	0	0	15
Grand Total	61	50	18	4	4	25	35	6	203

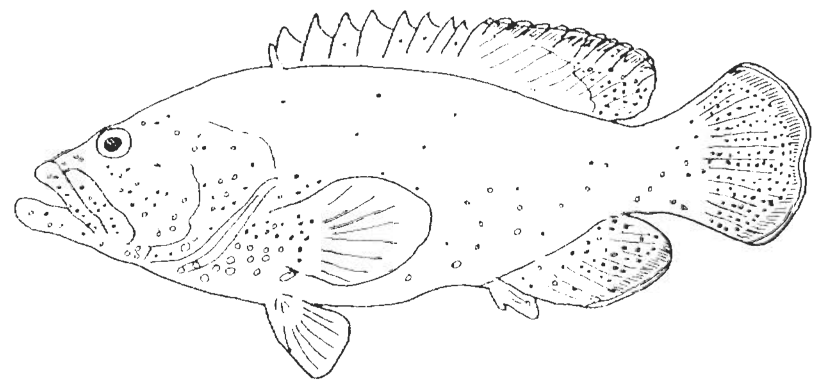
TABLE 3. The minimum number of individuals and number of identified paired cranial bones by site phase of Sparidae (breams, porgies). MNI is bold and underlined.



Serranidae (groupers)

	PRE-TEMPLE			EARLY		LATE			Grand Total
	L	R	U	L	R	L	R	U	
PREVOMER	0	0	0	0	0	0	0	1	1
LACRIMAL	0	0	0	0	0	1	0	0	1
POSTTEMPORAL	0	0	1	0	0	0	0	0	1
ARTICULAR	1	3	0	1	0	**<u>3</u>**	2	0	10
DENTARY	3	**<u>8</u>**	0	0	0	2	1	0	14
MAXILLA	1	2	0	0	0	1	2	0	6
PREMAXILLA	6	7	0	0	0	2	3	0	18
QUADRATE	1	2	0	**<u>2</u>**	0	0	2	0	7
CERATOHYAL	7	3	1	0	0	3	0	0	14
HYOMANDIBULAR	0	0	0	0	0	0	1	0	1
HYPOHYAL	0	0	0	0	0	0	1	0	1
OPERCULAR	0	1	0	0	1	0	0	0	2
OTOLITH	0	0	0	0	0	0	1	0	1
Grand Total	19	26	2	3	1	12	13	1	77

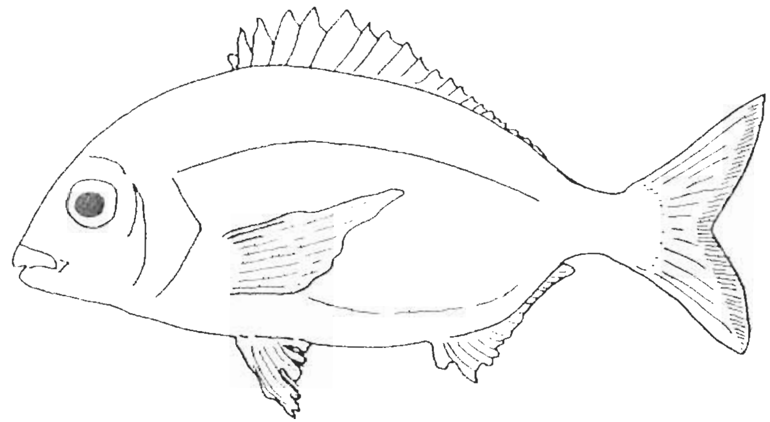
TABLE 4. The minimum number of individuals and number of identified paired cranial bones by site phase of Serranidae (groupers). MNI is bold and underlined.



Lutjanidae (snappers)

	PRE-TEMPLE		LATE			Grand Total
	L	R	L	R	U	
ARTICULAR	0	1	1	1	0	3
DENTARY	0	0	**<u>4</u>**	3	0	7
MAXILLA	**<u>2</u>**	0	1	0	0	3
PREMAXILLA	2	0	1	3	2	8
CERATOHYAL	0	0	1	0	0	1
OPERCULAR	0	0	1	0	0	1
Grand Total	4	1	9	7	2	23

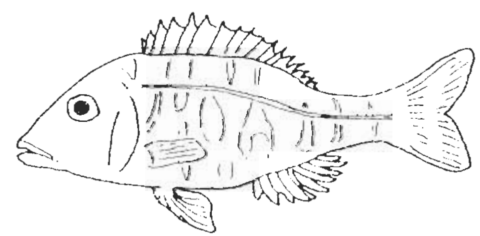
TABLE 5. The minimum number of individuals and number of identified paired cranial bones by site phase of Lutjanidae (snappers). MNI is bold and underlined.



Lethrinidae (emperors)

	PRE-TEMPLE			EARLY		LATE			Grand Total
	L	R	U	L	R	L	R	U	
PREVOMER	0	0	1	0	0	0	0	0	1
POSTTEMPORAL	7	4	0	2	1	6	13	1	34
ARTICULAR	5	3	0	**<u>4</u>**	0	16	**<u>21</u>**	0	49
DENTARY	11	9	0	0	0	9	14	1	44
MAXILLA	7	8	0	1	1	11	12	0	40
PREMAXILLA	**<u>17</u>**	10	0	3	2	15	8	1	56
QUADRATE	5	4	0	2	0	11	9	0	31
CERATOHYAL	7	9	0	0	0	10	8	0	34
OPERCULAR	2	2	0	1	0	6	14	0	25
Grand Total	61	49	1	13	4	84	99	3	314

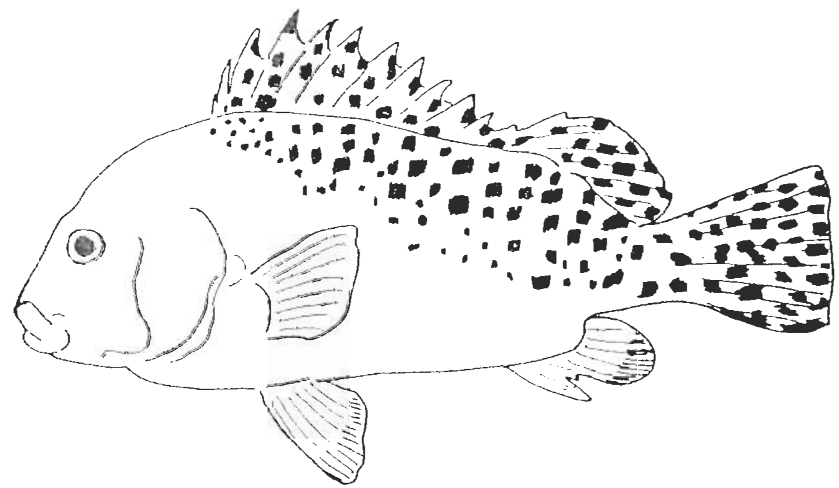
TABLE 6. The minimum number of individuals and number of identified paired cranial bones by site phase of Lethrinidae (emperors). MNI is bold and underlined.



Haemulidae (grunts)

	PRE-TEMPLE	LATE			Grand Total
	L	L	R	U	
PREVOMER	0	0	0	1	1
PTEROSPHENOID	1	0	0	0	1
ARTICULAR	0	0	**1**	0	1
DENTARY	**1**	0	0	0	1
QUADRATE	0	1	0	0	1
Grand Total	2	1	1	1	5

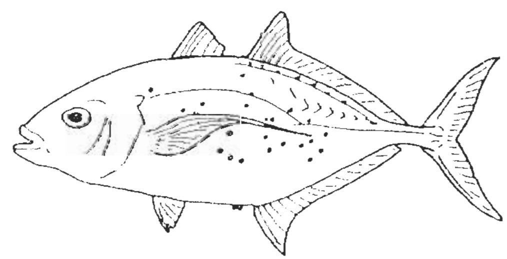
TABLE 7. The minimum number of individuals and number of identified paired cranial bones by site phase of Haemulidae (grunts). MNI is bold and underlined.



Carangidae (jacks trevallies yellowtails

	PRE-TEMPLE		EARLY		LATE			Grand Total
	L	R	L	R	L	R	U	
ETHMOID	0	0	0	0	1	0	0	1
ARTICULAR	0	1	0	0	1	2	0	4
DENTARY	2	1	0	1	6	3	0	13
MAXILLA	**3**	1	1	0	1	4	1	11
PREMAXILLA	0	1	0	**2**	4	**6**	0	13
QUADRATE	1	2	0	1	2	2	0	8
CERATOHYAL	0	2	0	0	4	4	0	10
HYOMANDIBULAR	0	0	0	0	2	1	0	3
OPERCULAR	0	2	0	0	0	3	0	5
Grand Total	6	10	1	4	21	25	1	68

TABLE 8. The minimum number of individuals and number of identified paired cranial bones by site phase of Carangidae (jacks, trevallies and yellowtails). MNI is bold and underlined.



SITE	NUMBER OF FISH BONES
SAAR TEMPLE	10087
FAILAKA	703
QALA'AT AL-BAHRAIN	4227

TABLE 9. Comparison of the number of fish bones from three sites with Dilmun occupation from the western Arabian Gulf.