The Roman trade in salted Nilotic fish products: some examples from Egypt

Wim Van Neer[1], Sheila Hamilton-Dyer[2], René Cappers[3], Konjev Desender[4] and Anton Ervynck[5]

[1] Royal Belgian Institute of Natural Sciences, Rue Vautier 29, B-1000 Brussels, Belgium and Katholieke Universiteit Leuven, Laboratory of Comparative Anatomy and Biodiversity, Ch. Deberiotstraat 32, B-3000 Leuven, Belgium

[2] 5 Suffolk Avenue Shirley, Southampton Hampshire SO15 5EF, United Kingdom

[3] Groningen Institute of Archaeology, University of Groningen, Poststraat 6, NL-9712 ER Groningen, The Netherlands

[4] Royal Belgian Institute of Natural Sciences, Entomology Department, Rue Vautier 29, B-1000 Brussels, Belgium

[5] Flemish Heritage Institute, Koning Albert II-laan 19 box 5, B-1210 Brussels, Belgium

Abstract/Zusammenfassung

A description is given of two fish bone assemblages found at Mons Claudianus, a Roman site in the Eastern Desert of Egypt, and one from Quseir al-Qadim, a contemporaneous settlement on the Red Sea coast. The material is interpreted as the skeletal remains of salted fish products that were imported from the Nile Valley. In two cases the reconstructed sizes of the fish and the presence of articulating bones allow the definition of the fish product as *salsamenta* made from small Nilotic fish, rather than as fish sauce. Information about the seasoning of the product is provided in two cases by archaeobotanical data, and the analysis of the insect remains found in one of the assemblages provides evidence for local attack by carrion feeders feeding on the spoiled fish product. In addition, the presence of some of the beetle taxa representing pests typical for stored plant foods can only be explained as resulting from of the use of already infested plant ingredients during the preparation of the product. The analysis permits a comparison of these Nilotic fish bone assemblages to fish products found elsewhere in the Roman world. Older and more recent parallels are also briefly discussed.

Zwei Fischknochenkomplexe aus Mons Claudianus, eine römische Fundstelle in der Ostwüste Ägyptens, sowie eine aus Quseir al-Qadim, eine zeitgleiche Siedlung an der Rotmeerküste werden beschrieben. Das Material wird als Skelettreste gesalzener Fischprodukte, welche aus dem Niltal importiert wurden interpretiert. In zwei Fällen, erlaubte die Rekonstruktion der Fischgröße und das Vorhandensein artikulierender Knochen, eine Bestimmung des Fischproduktes als *salsamenta*, die aus kleinem nilotischen Fisch gemacht wurde, und nicht als Fischsoße. In zwei Fällen lieferten archäobotanischen Daten Informationen über die Würzung des Produktes. Die Untersuchung von Insektenresten aus einem der Komplexe, lieferte Beweise dafür, dass Assfresser die lokalen verdorbenen Fischprodukten aßen. Das Vorhandensein einiger Käfertaxa, welche typisches Ungeziefer für gelagerte Nutzpflanzen sind, zeigte, dass pflanzliche Zutaten die bereits mit Insekten befallen waren, für dieses Produkt verwendet wurden. Die Analyse erlaubt einen Vergleich der vorliegenden nilotischen Fischknochenkomplexe mit anderen Fundkomplexen der römischen Welt. Auch ältere sowie rezente Parallelen werden diskutiert.

Keywords: Roman period, Egypt, *salsamenta*, fish sauce, ichthyology, botany, entomology
Römische Zeit, Ägypten, *salsamenta*, Fischsoße, Ichthyologie, Botanik, Entomologie

Introduction

The aim of this paper is to provide a detailed description of three bone assemblages comprising the remains of small fish. Two of them were found in Roman contexts at Mons Claudianus and one at Quseir al-Qadim (Fig. 1). Mons Claudianus is located approximately 120 km east of the Nile Valley and about 50 km from the Red

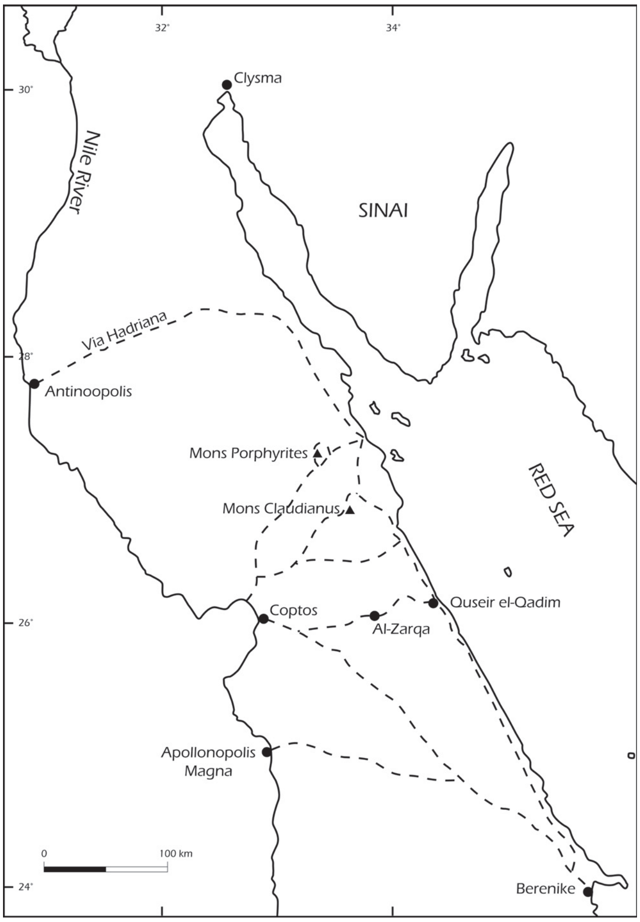

Fig. 1: Location of the sites mentioned in the text.

Sea. It was occupied mainly during the 1st and 2nd centuries AD and functioned as an important quarry site (Bingen et al. 1992; Maxfield 2001; Maxfield & Peacock 2001a). Due to its remote location, Mons Claudianus was heavily dependant upon imported foodstuffs and goods. The major meat providers at the site were donkeys and pigs, the former often after having served as working animals (although they were slaughtered while still relatively young), the latter included both piglets that were raised locally as well as animals whose meat was most probably imported from the Nile Valley in the form of salted pork (Hamilton-Dyer 2001a). The diet was supplemented with products deriving from sheep, goats, dromedaries and birds. Red Sea fish, together with some molluscs were a vital food source and provided a major contribution to fulfilling basic nutritional needs. In addition, Nilotic fish were imported, albeit in small proportions.

The site of Quseir al-Qadim, identified as the historically documented ancient harbour of Myos Hormos (Peacock 1993, Young 2001, Peacock & Blue 2006, Van Rengen 2000), is located just north of modern Quseir and was the Red Sea terminus of the central desert road coming from Coptos (present day Quft) in the Nile Valley (Fig. 1). Its Roman occupation lasted from the 1st to the late 2nd, possibly early 3rd, century AD. Besides marine fish, molluscs and turtles, domestic mammals also provided inhabitants with animal proteins. Sheep and goats were the major domestic food species, followed by pig, cattle and dromedary (Wattenmaker 1979, 1982, Van Neer 1997, Hamilton-Dyer 2001b in prep). Pigs and cattle were probably imported from the Nile Valley, but thus far the import of Nilotic fish has not been documented.

During the Roman period, Myos Hormos was, just like Berenike (Fig. 1), a major port at the Red Sea coast that ensured the import of goods into Egypt from India, Arabia and more southerly parts of Africa (Casson 1989; Young 2001, 27-89). Via the desert roads, these goods were transported overland by pack animals to emporia along the Nile Valley from where they were then shipped to Alexandria and from thence to other Mediterranean ports. The same route was also taken in reverse for exports via Egypt to other Red Sea - Indian Ocean destinations. Although it has been suggested that traffic along the desert routes must have been most intense when the seasonal monsoons allowed ships to enter and exit the Red Sea, there must have been a steady flow of traffic throughout the year to supply the inhabitants of the ports, the Eastern Desert garrisons and people working

a) b)

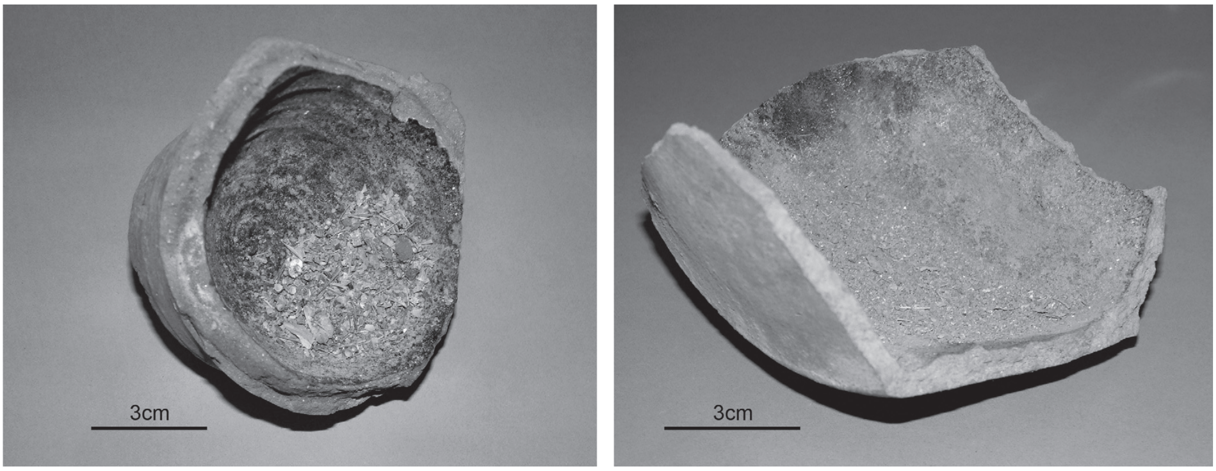

Fig. 2: a) Pitch-lined 'costrel' pot from Fort West II at Mons Claudianus; b) pitch-lined Nile fabric amphora from the Fort South-East corner of Mons Claudianus.

in the quarries and mines (Zitterkopf & Sidebotham 1989). Detailed information on the commodities traded overseas is provided by the *Periplus* (Casson 1989) and other literary sources, and by archaeological data (Young 2001, 38). Ostraca and papyri also inform us about victuals that were transported along the desert routes to provision the desert stations and the Red Sea ports with the necessities of life (for Myos Hormos: Bagnall 1986, for Mons Claudianus: Bingen et al. 1992, for Al-Zarqa: Bülow-Jacobsen et al. 1994). Fish are sometimes mentioned in these documents and fish products are evidenced by jar labels, but these sources rarely provide details on the exact nature of the product or on the species used. The fish bone assemblages described here, therefore represent a contribution to the knowledge of the commodities traded along the desert roads.

Description of the assemblages

Mons Claudianus Fort West II

The first sample from Mons Claudianus is relatively small and consists of salt crystals and 190 identifiable bone remains (see Tables 1 and 2). The material was found adhering to the broken remains of a pitch-lined 'costrel' pot (Fig. 2a). This pot had been recovered from the mid to late 2nd cent. AD rubbish deposit infilling room L1 (FWII, L1, SW, layer 4), part of a location labelled 'Fort West II'. The finds have been mentioned earlier in the literature (Hamilton-Dyer 1994, 2001a), but have now been re-analysed in more detail with the aid of the modern reference collections stored at the Royal Belgian Institute of Natural Sciences (Brussels). Data on the modern distribution of Nile fish were also taken into account and have been obtained from Boulenger (1907), Bishai and Khalil (1997) and Froese and Pauly (2005).

When first examined the material had a strong and distinctive odour, not unlike 'gentlemen's relish' (salted, spiced anchovy paste). The 190 fish remains consist mainly of cyprinid (carp family) material (89%) and all the bones that show diagnostic traits allowing identification beyond family level are from the genus *Labeo* (mudcarp). On some of these skeletal elements, morphological traits occur that permit a species identification. A complete left maxilla shows serrations along the anterior part of the inferior edge (Fig. 3a), a shape that is seen in *Labeo niloticus*, but not in the three other species found in the Egyptian Nile (*L. horie*, *L. coubie* and *L. forskalii*). The presence of *Labeo niloticus* is also indicated by a right dentary with a relatively slender corpus (Fig. 3b). In *L. horie* the corpus is also rather slender, but it is shorter than in *L. niloticus*. The dentaries of *L. coubie* and *L. forskalii* are much sturdier and cannot be confused with the two preceding species. Five of the seven cyprinid precaudal vertebrae have a very elongate centrum that only matches perfectly with *Labeo coubie*. In the other *Labeo* species, and in the other cyprinid genera of the Egyptian Nile, the vertebral centra are much shorter. The minimum number of individuals (MNI) has only been established to genus level, on the basis of the most common element, in this case the isolated pharyngeal teeth. A minimum of six individuals needs to be accepted to account for the 124 pharyngeal teeth found. In all four *Labeo* species the tooth formula is 5.4.2, meaning that each individual has 22 teeth. Size reconstructions were carried out by direct comparison of the faunal remains with modern fish specimens of known length. It appears that the cyprinid bones all belong to individuals measuring between 7 and 8 cm SL (standard length, i.e. the distance from the tip of the snout to the base of the tail).

The remaining material belongs to three taxa: Alestiidae, Cichlidae and *Synodontis*. Four bones of Alestiidae (African tetras) cannot be identified with certainty to species level. In the Egyptian Nile this family comprises four genera, namely *Hydrocynus*, *Alestes*, *Brycinus* and *Micralestes*. The alestiids from this sample all differ morphologically from *Hydrocynus* (tigerfish) The comparative material at our disposal does not include all the Nilotic species, but the mesethmoid and the articular from Mons Claudianus match very well with the *Brycinus nurse* (nurse tetra) specimens from the reference collection. The articular belonged to an individual measuring between 10 and 12 cm SL, whereas the mesethmoid and the two precaudal vertebrae are from smaller fish (5-7 cm SL). The remains of Cichlidae (cichlids) could not be identified beyond family level; either because they are poorly preserved (a subopercular), or because they are not diagnostic (precaudal vertebra, dorsal spines and pterygiophores). The presence of only one individual needs to be taken into account since all the remains are from fish of the same size class (5-7 cm SL). Finally, a single individual of *Synodontis* catfish is represented by a caudal vertebra of an animal that measured 8-9 cm SL.

Mons Claudianus Fort South-East Corner

The second sample consists of 111 fish elements and was found in the broken base of a pitch-lined Nile fabric amphora (Fig. 2b). This assemblage was found near the bottom of the fill of room R1 (FSE, R1, SE, context 23) in Mons Claudianus' Fort South-East corner, an area of rubbish dumping in the late 2nd century. These finds have been mentioned earlier in the literature (Hamilton-Dyer 1994, 2001a), but have now been re-analysed in more detail, in the same way as the first context discussed.

The sample is composed of cyprinids (81%) and mormyrids (elephantfishes) (19%). Among the 90 cyprinid remains an os suspensorium, a pharyngeal tooth and three subcleithra were identifiable as *Labeo* sp., but all the other remains were undiagnostic. The minimum number of individuals for *Labeo* is two, based on the supracleithra. These individuals measured between 12 and 15 cm SL. All the unidentified cyprinids that allowed a body length reconstruction are also from animals of that size, and the MNI, on the basis of the vertebrae, is also two. This means that the MNI for all cyprinids remains two. The 21 mormyrid bones represent a MNI of one. Moreover, all the remains are from fish measuring about 15 cm SL, and in the case of the precaudal vertebrae at least four centra articulate perfectly. In addition, the nine caudal vertebrae match perfectly and could belong to the same individual as the precaudal elements. Most probably, the mormyrid bones thus come from a single (partial) skeleton. Besides fish this assemblage also yielded remains of wheat, coriander (*Coriandrum sativum*) and crushed *Cordia* (Egyptian plum) (Hamilton-Dyer 2001a).

Quseir

Numerous remains of small fish were found in a single large dump from Area 2B, several litres in volume that looked like the spilt or discarded contents of a large container of a salted fish product. A precise dating of the assemblage cannot be given, but the deposit is certainly Roman and most of the Quseir material is broadly contemporary with the main activity at Mons Claudianus, i.e., mid-1st to late 2nd century AD. A subsample weighing 8.61 grams was analysed in detail. Only 2.70 grams were fish remains, the rest consisted of sand grains and salt crystals (4.99 g), plant (0.88 g) and insect remains (0.04 g).

The fish remains

A total of 938 fish remains were identifiable (Table 1 and 3) and another 1266 could not be determined. The unidentifiable fraction consists mainly of fin rays, fragments of flat bones from the skull, ribs, and branchial fragments. The identifiable material is predominantly from cyprinids (77%), followed by alestiids (22%) and some catfish (1%). Most striking about the sample from Quseir is the fact that many bones are still articulated (Fig. 3c) and that soft tissue is frequently preserved.

Among the cyprinids three taxa were recognised, of which *Barbus* (barbel) was the most common. Indeed, of the 77 cyprinid bones that were identifiable at genus level, 73 were from *Barbus*. This genus is also the most common in terms of MNI (15 as indicated by the number of basioccipitals). The *Barbus* dentaries (Fig. 3d) perfectly match those from *Barbus bynni* in the reference collection, and they differ from *Barbus perince* in the number of lateral line pores. Since the three other species that can be expected in the Egyptian Nile (*B. anema, B. neglectus* and *B. werneri*) are not available in the modern reference material, it was not possible to fully confirm the specific identification of the remains as *Barbus bynni*. Only one bone, a basioccipital, was identifiable as *Labeo*, whereas the presence of *Leptocypris niloticus* is indicated by a left pharyngeal plate and by a left and right dentary, probably from the same small individual (5-6 cm SL). *Leptocypris* has a very elongated dentary (Fig. 3e); a shape that is also seen in *Raiamas* (silver fish), but that genus has a larger symphysis. All the cyprinid remains that allowed a reconstruction of body size, again by direct comparison to modern specimens of known length, show that the fish were between 5 and 10 cm SL.

Eighty-two of the 207 alestiid remains were identifiable at genus level, and they all belong to *Hydrocynus*. A distinction between the Nilotic species *H. vittatus*, *forskahlii* and *brevis* was not possible based on the isolated bones. Most of the remains are from fish that measured about 10 cm SL, or a little less, which indicates that the

	Mons Claudianus Fort West		Mons Claudianus Fort South-East		Quseir	
	total NISP	MNI	total NISP	MNI	total NISP	MNI
Mormyridae	-	-	21	1	-	-
Barbus sp.	-	-	-	-	73	15
Labeo sp.	152	6	5	2	1	1
Leptocypris niloticus	-	-	-	-	3	1
Cyprinidae indet.	27	-	85	-	646	-
all Cyprinidae	179	6	90	2	723	17
Alestes/Brycinus	4	2	-	-	-	-
Hydrocynus sp.	-	-	-	-	82	10
Alestiidae indet.	-	-	-	-	125	-
all Alestiidae	4	2	-	-	207	10
Bagrus sp.	-	-	-	-	4	1
Synodontis sp.	1	1	-	-	1	1
siluroids indet.	-	-	-	-	3	-
all siluroids	1	1	-	-	8	2
Cichlidae	6	1	-	-	-	-
totals	190	10	111	3	938	29

Table 1: Overview of the fish remains from the three fish products presented in this study. NISP = number of identified specimens; MNI = minimum number of individuals.

	Fort West					Fort South-East		
	Labeo sp.	Cyprinidae	*Alestes/Brycinus*	*Synodontis* sp.	Cichlidae	Mormyridae	*Labeo* sp.	Cyprinidae
mesethmoid	-	-	1	-	-	-	-	-
frontal	-	1	-	-	-	-	-	-
prootic	-	1	-	-	-	-	-	-
pterotic	-	3	-	-	-	-	-	-
basioccipital	1	-	-	-	-	-	-	-
articular	2	-	1	-	-	-	-	-
dentary	1	-	-	-	-	-	-	-
maxilla	1	-	-	-	-	-	-	-
premaxilla	1	-	-	-	-	-	-	-
quadrate	1	-	-	-	-	-	-	-
basihyal	3	-	-	-	-	-	-	-
branchiostegal	-	2	-	-	-	-	-	-
hyomandibular	-	3	-	-	-	-	-	-
opercular	5	-	-	-	-	-	-	-
subopercular	-	-	-	-	1	-	-	-
ceratobranchial	-	-	-	-	-	-	-	1
pharyngobranchial	3	-	-	-	-	-	-	-
loose pharyngeal teeth	124	-	-	-	-	-	1	8
cleithrum	-	-	-	-	-	1	-	2
postcleithrum	-	1	-	-	-	-	-	-
scapula	-	-	-	-	-	-	-	3
supracleithrum	4	-	-	-	-	-	3	-
basipterygium	1	-	-	-	-	-	-	-
Weberian apparatus	-	-	-	-	-	-	1	1
precaudal vertebra	5	1	1	-	1	5	-	14
processus transversus of precaudal vertebra	-	4	-	-	-	-	-	42
caudal vertebra	-	4	1	1	-	9	-	5
precaudal or caudal vertebra	-	-	-	-	-	2	-	-
rib	-	1	-	-	-	4	-	3
dorsal spine	-	-	-	-	2	-	-	-
anal or dorsal pterygiophore	-	6	-	-	2	-	-	5
asteriscus	-	-	-	-	-	-	-	1
total NISP	152	27	4	1	6	21	5	85
MNI	6	-	2	1	1	1	2	-

Table 2: Skeletal element representation of the fish products from Mons Claudianus. NISP = number of identified specimens; MNI = minimum number of individuals.

	Barbus sp.	*Labeo* sp.	*Lepto cypris*	Cyprinidae indet.	all Cyprinidae	*Hydrocynus* sp.	Alestiidae indet.	all Alestiidae	*Bagrus* sp.	*Synodontis* sp.	siluroids indet.	all siluroids
mesethmoid	-	-	-	3	3	-	1	1	-	-	-	0
orbitosphenoideum	-	-	-	-	0	-	6	6	-	-	-	0
lateral ethmoid	-	-	-	5	5	-	-	0	-	-	-	0
vomer	-	-	-	2	2	-	-	0	-	-	-	0
frontal	-	-	-	22	22	17	-	17	-	-	-	0
alisphenoid	-	-	-	-	0	-	2	2	-	-	-	0
epiotic	-	-	-	6	6	-	4	4	-	-	-	0
exoccipital	-	-	-	5	5	-	6	6	-	-	-	0
parietal	-	-	-	17	17	-	-	0	-	-	-	0
posttemporal	-	-	-	2	2	-	2	2	-	-	-	0
prootic	-	-	-	7	7	-	4	4	-	-	-	0
pterotic	-	-	-	19	19	-	6	6	-	-	-	0
sphenotic	-	-	-	16	16	-	-	0	-	-	-	0
supraoccipital	-	-	-	6	6	-	4	4	-	-	-	0
basioccipital	15	1	-	1	17	-	5	5	-	-	-	0
parasphenoid	-	-	-	13	13	-	1	1	-	-	1	1
articular	-	-	-	7	7	-	3	3	-	-	-	0
dentary	10	-	2	-	12	13	-	13	1	-	-	1
entopterygoid	-	-	-	21	21	-	-	0	-	-	-	0
maxilla	17	-	-	-	17	8	-	8	-	-	-	0
palatine	-	-	-	7	7	-	-	0	-	-	-	0
premaxilla	-	-	-	6	6	4	-	4	-	-	-	0
quadrate	-	-	-	5	5	-	1	1	-	-	-	0
loose jaw teeth	-	-	-	-	0	4	-	4	-	-	-	0
branchiostegal	-	-	-	10	10	-	-	0	-	-	-	0
ceratohyal	-	-	-	13	13	7	1	8	-	-	-	0
epihyal	-	-	-	13	13	-	-	0	-	-	-	0
hyomandibular	-	-	-	17	17	8	1	9	-	-	-	0
interopercular	-	-	-	12	12	-	8	8	-	-	-	0
opercular	-	-	-	33	33	1	2	3	-	-	-	0
preopercular	-	-	-	13	13	13	-	13	-	-	-	0
urohyal	-	-	-	7	7	-	2	2	-	-	-	0
pharyngobranch. IV	19	-	1	-	20	-	-	0	-	-	-	0
cleithrum	-	-	-	24	24	5	1	6	1	-	-	1
coracoid	-	-	-	4	4	-	1	1	-	-	-	0
mesocoracoid	-	-	-	1	1	-	-	0	-	-	-	0
postcleithrum	-	-	-	5	5	-	-	0	-	-	-	0
scapula	-	-	-	2	2	-	-	0	-	-	-	0
supracleithrum	-	-	-	5	5	-	2	2	-	-	-	0
spina pectoralis	-	-	-	-	0	-	-	0	-	1	-	1
basipterygium	-	-	-	10	10	2	1	3	1	-	-	1
1st vertebra	-	-	-	5	5	-	2	2	-	-	-	0
vertebra II+III	12	-	-	-	12	-	-	0	-	-	-	0
2nd vert	-	-	-	-	0	-	1	1	-	-	-	0
3rd vertebra	-	-	-	8	8	-	-	0	-	-	-	0
Weberian apparatus	-	-	-	13	13	-	-	0	-	-	-	0
precaudal vertebra	-	-	-	89	89	-	17	17	-	-	1	1
proc. transv. of precaud. vert.	-	-	-	10	10	-	-	0	-	-	-	0
caudal vertebra	-	-	-	92	92	-	23	23	-	-	1	1
rib	-	-	-	55	55	-	15	15	-	-	-	0
spina dorsalis	-	-	-	-	0	-	-	0	1	-	-	1
anal or dorsal pterygiophore	-	-	-	35	35	-	3	3	-	-	-	0
total NISP	73	1	3	646	723	82	125	207	4	1	3	8
MNI	15	1	1	-	17	10	-	10	1	1	-	2

Table 3: Skeletal element representation of the fish products from Quseir. NISP = number of identified specimens; MNI = minimum number of individuals.

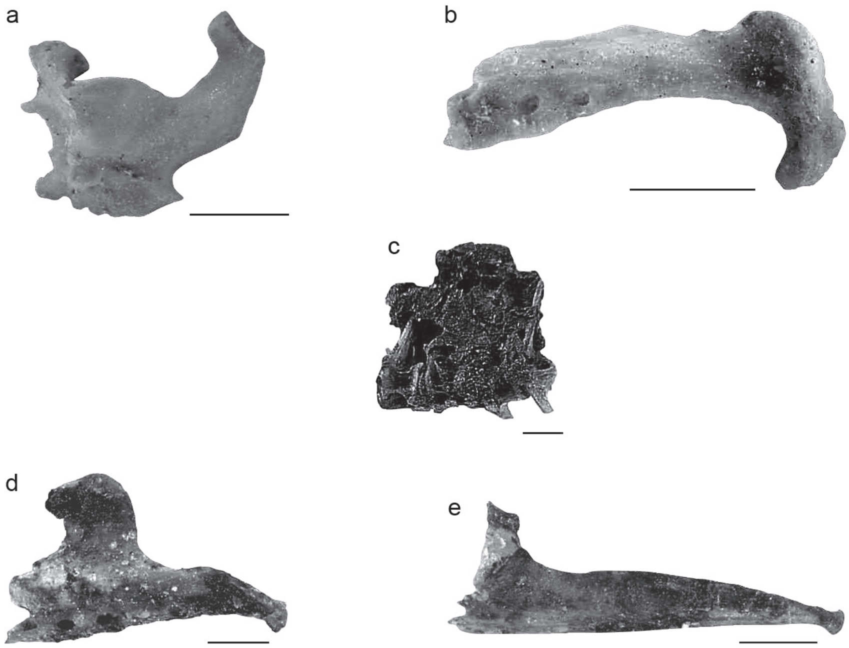

Fig. 3: a) Lateral view of left maxilla of *Labeo niloticus* from Mons Claudianus; b) lateral view of right dentary of *Labeo niloticus* from Mons Claudianus; c) left lateral view of four articulating precaudal vertebra of cyprinid from Quseir. Soft tissue is partially preserved, d) lateral view of a right dentary of *Barbus* cf. *bynni* from Quseir; e) lateral view of a right dentary of *Leptocypris niloticus* from Quseir. Dried soft tissue is sticking to the bone.
These pictures were taken with a Toshiba 3CCD video camera on a Leica MZ12.5 stereomicroscope. The images, taken at different planes, were superimposed and combined in a single focused image using Automontage software (Automontage Pro version 5.01; from Syncroscopy company). The scale bar is 1mm.

individuals are primarily juveniles since tigerfish can attain large sizes (70 to 100 cm depending on the species). On the basis of the frontals, a MNI of 10 was obtained for this subsample.

Finally, catfish remains are poorly represented. Two vertebrae and a skull fragment could not be specifically identified, but the remaining bones belong to two genera. A single pectoral spine indicates the presence of a *Synodontis* measuring about 3 cm SL, whereas *Bagrus* is represented by four bones that may correspond to a single individual of about 5 cm SL.

The insect remains

The insect remains (Table 4) comprise numerous puparia of true flies (Diptera) and thorax and head remains of ants (Formicidae) that could not be identified any further. Besides these remains, six beetle taxa occur that allowed a more detailed identification after comparison with the modern reference collections of the Royal Belgian Institute of Natural Sciences. Relevant information on their biology was found in Arnett (1968) and Hill (2002). One elytrum and a fragment of an abdomen probably belong to a *Dermestes* (skin beetles) species (Fig. 4a), a taxon that typically feeds on dry organic material, mainly from animal origin. Another typical pest of dry food, including fish, is represented by several remains of an Anobiidae (death watch beetles) species, probably attributable to the drugstore or biscuit beetle (*Stegobium paniceum*) (Fig. 4b). One elytrum indicates the presence of a Leptodirid beetle (small carrion beetles) (Fig. 4c), another family of scavengers. Remarkably, the insect remains not only include carrion feeders, but also species that typically feed on botanical matter. A more or less completely preserved individual as well as a head fragment, both belonging to a weevil (Curculionidae, snout beetles or weevils) can be identified with certainty as *Sitophilus granarius* (granary weevil), a cosmopolitan species that is mainly found in cereals and seeds (Fig. 4d). The presence of the Bruchid (bean weevils) family is indicated by an individual of the *Bruchus* genus. This genus comprises several pest species scavenging large seeds, especially beans and peas (Fig. 4e). Finally, a bark beetle (Scolytidae) was identified that compares well with the shot hole borer (cf. *Xyleborus dispar*) (Fig. 4f). This is a polyphagous species living on wood, bark and cork, that is very common in orchards.

The botanical remains

Identifications carried out with the aid of the comparative collections of the Groningen Institute of Archaeology show that four different plant species are represented in the Quseir sample (Table 5). The predominant species is coriander (*Coriandrum sativum*) an aromatic herb that would have improved the taste of the fish prod-

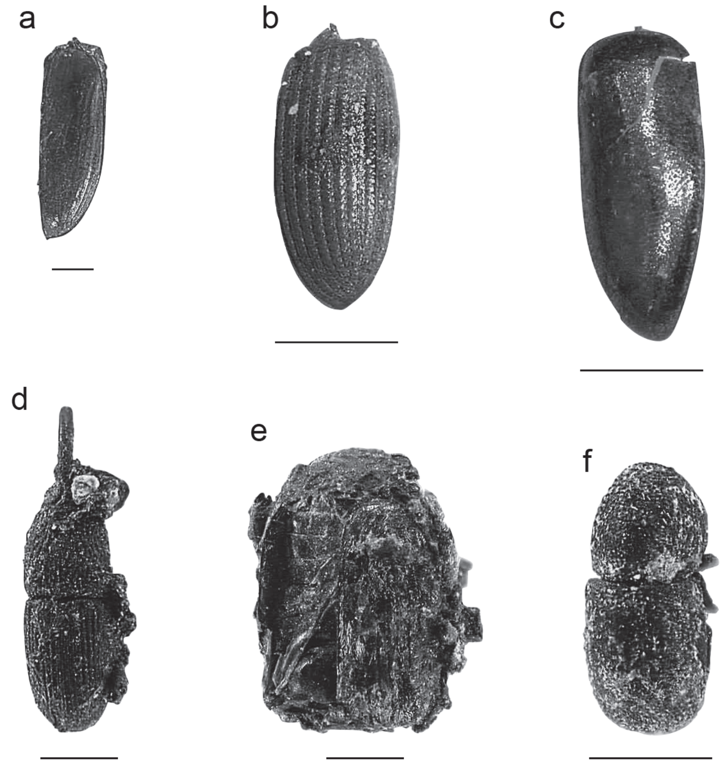

Fig. 4: Insect remains from Quseir. a) dorsal view of elytrum from cf. *Dermestes*; b) dorsal view of an Anobiidae (cf. *Stegobium paniceum*); c) dorsal view of elytrum from a Leptodiridae; d) dorsal view of a *Sitophilus granarius*; e) dorsal view of a Bruchidae; f) dorsal view of a Scolytidae (cf. *Xyleborus dispar*).
These pictures were taken with a Toshiba 3CCD video camera on a Leica MZ12.5 stereomicroscope. The images, taken at different planes were superimposed and combined in a single focused image using Automontage software (Automontage Pro version 5.01; from Syncroscopy company). The scale bar is 1mm.

Taxon	NF
Diptera	13
Formicidae	8
Leptodiridae indet.	1
cf. *Dermestes*	2
cf. *Stegobium paniceum*	9
Bruchus sp.	1
Sitophilus granarius	2
cf. *Xyleborus dispar*	1

Table 4: Insect remains found in the sample from Quseir. NF = number of fragments.

uct. Coriander is a member of the carrot family (Umbelliferae; Apiaceae), a plant family characterised by an umbellate inflorescence. The globose fruits of coriander do not separate at maturity and each fruit (mericarp) has five wavy ridges that alternate with six straight ridges (Fig. 5a). The coriander fruits in the fish product, however, fell apart into single fruits, seeds and many fragments of both of these parts (Fig. 5b). The fruits differ considerably in size, the larger ones measuring almost 5 mm, whereas the smaller ones are only 2.5 mm long. Coriander seeds can still be recognised by their shape, the slight curves on the dorsal side and the relatively coarse cell pattern (Fig. 5c). In addition to the fruits, ray stalks (pedicels) of coriander are also present (Fig. 5d). Coriander has compound umbels, which means that each primary ray is terminated by an umbel, whose pedicels are termed secondary rays. The primary rays are straight or slightly curved, depending on the position in the ray, and have several thickenings at the top, being the basal parts of the secondary rays.

From lentil (*Lens culinaris*), a single cotyledon (seed leaf) is present (Fig. 5e). This leguminous species, belonging to the Fabaceae family, has seeds each containing two cotyledons, in which a large quantity of food is stored for the new plant. For this reason, seeds of the lentil and other legume species are attacked by a variety of insects that feed on the seeds, a phenomenon that also affected the Quseir sample, as shown by the beetle remains.

A third crop plant, found in the salted fish product, is safflower (*Carthamus tinctorius*). This plant is a member of the daisy family (Compositae; Asteraceae) that is

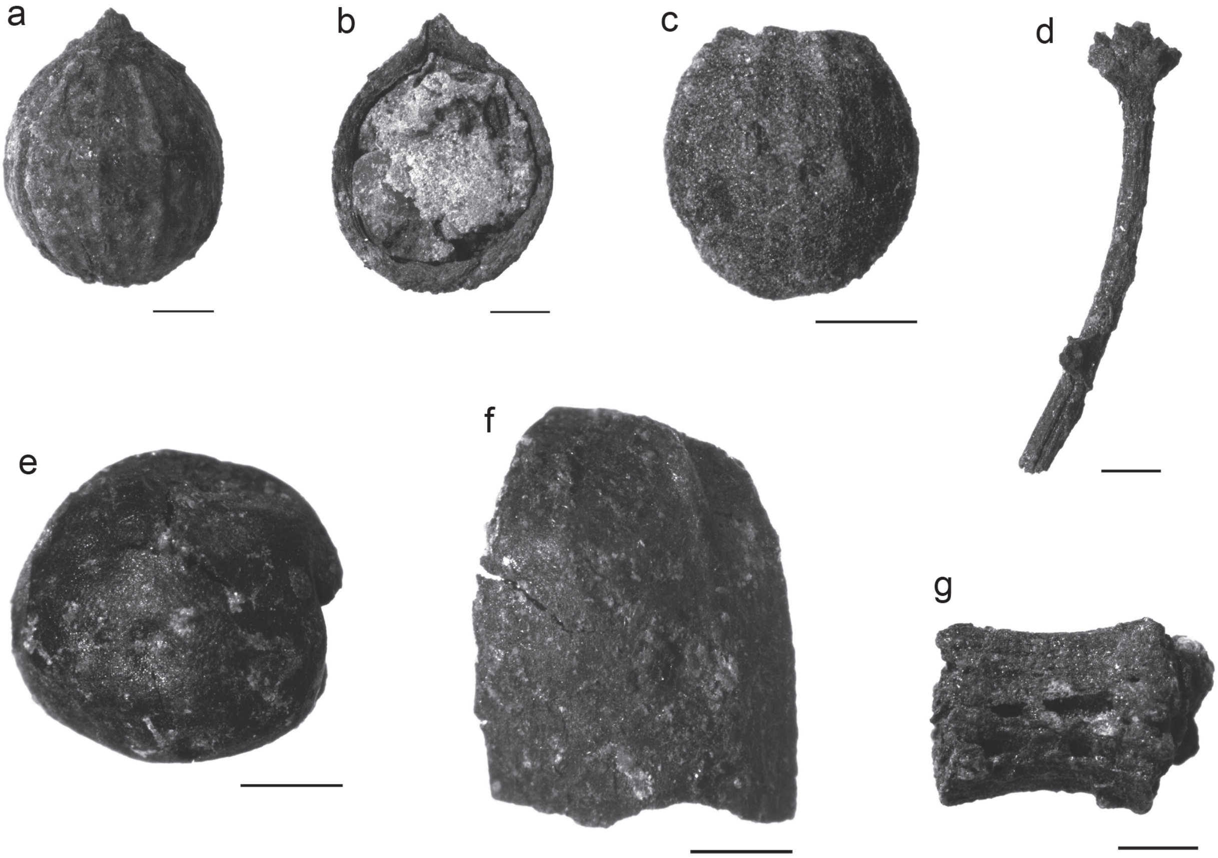

Fig. 5: Plant remains from Quseir. a) Dorsal view of single fruit (mericarp) of coriander. The seed is no longer present and the cavity is refilled with other material; b) same specimen, ventral view; c) seed of coriander (dorsal side, top is missing); d) primary ray (pedicel) of an umbel of coriander; e) cotyledon of lentil; f) fruit fragment of safflower; g) fruit segment of *Enarthrocarpus* cf. *lyratus*.
These pictures were taken with an AxioCam digital camera on a Zeiss Stemi SV11 microscope. The scale bar is 1mm.

Species	preserved part	NF
Coriandrum sativum L. (coriander)	fruit	c. 45
	seed	62
	pedicel	78
Lens culinaris Med. (lentil)	cotyledon	1
Carthamus tinctorius L. (safflower)	fruit	0.25
Enarthrocarpus cf. *lyratus* (Forssk.) DC	fruit segment	1

Table 5: Plant remains found in the sample from Quseir. NF = number of fragments.

cultivated for its flowers and fruits. The flowers are used as a source of water-soluble red and yellow dyes and the fruits have a high oil content. Safflower oil can be used in food preparation but also as technical (industrial) oil, such as the basis of fast drying paints (Langer & Hill 1982). Safflower is well adapted to hot and dry weather and from literary sources it is known that it was cultivated in Ptolemaic and Roman Egypt, although documents from the Roman period partly deal with prohibitory clauses (Sandy 1989). In Egypt, subfossil fruits of safflower dated to the Roman period are frequently found (Wetterstrom 1982, Germer 1988, van der Veen 1996, Cappers 2006). The fragment found in the fish product is small, but still bears diagnostic features such as the typical ridge on the outside (Fig. 5f).

The last plant species found in the assemblage is *Enarthrocarpus* cf. *lyratus*. It is a member of the cabbage family (Cruciferae; Brassicaceae) and has fruits that are typically constricted between the seeds, a feature that is rather uncommon in this plant family. When ripe, such fragments break off and are dispersed. In Egypt, the genus is represented by three species, two of which have unwinged fruits. The fruit segment from the fish product resembles the specimens of *Enarthrocarpus lyratus* from the herbarium of the Groningen Institute of Archaeology, but due to the incompleteness of the reference collection, no positive identification to the species level can be made (Fig. 5g). Similar fruit segments have been found at El Abadiya 2 and Adaïma (both Predynastic), Elkab (2nd Dynasty), Dendara

(Middle Kingdom) and Thebes (New Kingdom) (Newton 2002; Cappers et al. 2004).

Discussion and conclusions

Identification of the type of fish product and taphonomic history

The fish bone assemblages described consist of Nilotic fish of small size which, given the large distance of the sites to the Nile valley, cannot have been imported in a fresh state but should be considered as salted fish products. The two samples from Mons Claudianus were associated with vessels (a 'costrel' pot and an amphora) whereas the Quseir assemblage is a subsample of what appeared, during the excavations, to be the discarded contents of a large container. The species composition of the assemblages varies (Table 1), but cyprinids dominate and alestiids are also frequent. As will be discussed below, it is not only fatty marine species that can be used in the manufacture of salted fish products; Nilotic species are also suitable and there is a long tradition in the Nile Valley for such practices. Desse-Berset and Desse (2000) defined criteria for the distinction between fish sauces and *salsamenta*, i.e. skeletal element representation (certain types of *salsamenta* are composed of particular body parts), reconstructed sizes of the fishes (fish sauces tend to contain much smaller specimens) and anatomical position of elements (often still articulated in *salsamenta*). The extremely well preserved Quseir material contains numerous portions of fish still in articulating position, showing that this product was definitely composed of whole, small, fish stored in brine, and thus represents *salsamenta*. It is likely that the Mons Claudianus sample from Fort South-East can be classified as the same product, as shown by the numerous mormyrid vertebrae obviously belonging to a single individual. The sample from Fort West of the same site cannot be attributed to a particular type of salted fish product. All the bones were disarticulated and there is no clear indication for well-defined, single individuals. It remains unclear how this product should be classified. Is it a fish sauce or rather *salsamenta* that continued decomposing to such an extent that it was discarded?

The plant and insect remains preserved in the Quseir assemblage provide insight into the production process and, coincidentally, also illuminate the problems encountered with food storage. The plant remains show that coriander was added as an aromatic species to flavour the *salsamenta*. Coriander predominates in the archaeobotanical sample (Table 4) and this species was also mentioned as being present in the Mons Claudianus Fort South-East *salsamenta* assemblage (Hamilton-Dyer 2001a, 284). Unfortunately, these plant remains were not available for restudy. Coriander was a very frequently used aromatic species in the Roman kitchen, judging from its numerous citations in the texts of Apicius and Vinidarius (Thüry & Walter 1999, 37). Its use in the preparation of salted fish products has been mentioned, along with other herbs, by Martialis (André 1981, 196, Sciallano 1997, 39).

The presence of safflower in the *salsamenta* from Quseir is indicated by a single fragment only. In the aforementioned classical texts, safflower appears only rarely as an additive. Safflower fruits can be added to food as a (bitter) spice, but are most frequently used as a source of oil (Thüry & Walter 1999, 38, 63 & 108). That only a single fruit fragment was found indicates that it probably represents a contamination inside the safflower oil that was added to the *salsamenta*. Still today, the preparation of salted fish products involves the addition of spices and oil, and in antiquity this must also have been the case (Curtis 1991, 165).

Besides spices and oil, crop species were apparently also added to the *salsamenta*. Wheat has been reported from the Mons Claudianus Fort South-East assemblage (Hamilton-Dyer 2001a, 284) and at Quseir this practice is indicated by the single find of a lentil, a species with poor preservation chances. The fruit of the field weed *Enarthrocarpus* cf. *lyratus* in the latter assemblage can be considered to be a contaminant of one of the crops added to the fish sauce. Possibly the amount and variety of legumes added was larger than indicated by the number of preserved remains, as is also suggested by the presence of beetle species specialising exclusively on crop species (see further). The presence of the ray stalks (pedicels) of coriander and of a fruit of *Enarthrocarpus* indicates that the added ingredients were not of high quality. It should be noted, however, that in the area today quality standards for food and spices remain low. At Egyptian markets, coriander is still intermixed with ray stalks and the inferior quality is also shown by the considerable variety in fruit size (Cappers, pers. observation).

A recent overview of insect remains discovered at archaeological sites in Egypt shows that the majority are related to mummified humans and animals, and to stored products in a funerary context (Panagiotakopulu 2001). Exceptions are the finds from New Kingdom and Byzantine Amarna and from Roman Mons Claudianus (Panagiotakopulu & van der Veen 1997, Panagiotakopulu 2001), which were retrieved from settlement contexts. From the latter site bean beetles (Bruchidae) and the granary weevil (*Sitophilus granarius*) have been reported as synanthropic species typically found in stored plant crops. However, they were not associated with a fish product as is the case at Quseir. That both taxa have been reported from New Kingdom Amarna shows that, during the Roman period, these pest species

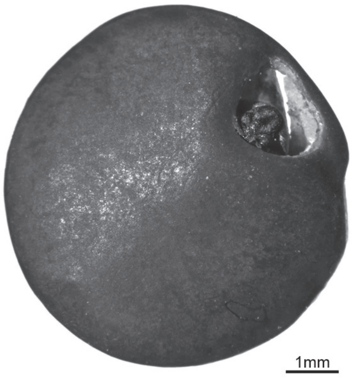

Fig. 6: Recent lentil with a full-grown beetle obtained in 1983 from a shop in Groningen (collection number GIA-20060214).
These pictures were taken with an AxioCam digital camera on a Zeiss Stemi SV11 microscope. The scale bar is 1mm.

must have already been well established in the Nile Valley from where the *salsamenta* found at Quseir was imported. The life cycle of the Bruchidae indicates that the infestation of the salted fish product did not take place during the journey to the coastal site of Quseir, or at the site itself after the product was discarded. Indeed, the female beetles are not capable of laying eggs on dry seeds and the infestations start in the field (Hariri 1979, Kislev 1991). The larval development takes place in the seed and the mature beetle leaves the seed through a hole somewhere at the edge of the seed (Fig. 6). This kind of infiltration may cause serious seed damage and infestations of up to 80% of lentils have been recorded for seeds in Mediterranean countries (Hariri 1979).

Sitophilus granarius, on the contrary, does not breed in the field and infestation starts in storage (Hill 2002). Although the species may theoretically also have colonised the fish product at the site, it seems more logical to assume that it entered the salted fish product when already infested pulses were added during preparation. Explaining the presence of the Scolytidae beetle, possibly the shot hole borer (cf. *Xyleborus dispar*), is less straightforward. Bark beetles are primary invaders in dying plant material and accelerate the breakdown of the host trees. *Xyleborus dispar* utilises all broadleaf tree species and is especially common in orchards. It is therefore likely that the specimen discovered in the Quseir assemblage also originates from the Nile Valley. The shot hole borer has thus far never been reported from archaeological sites in Egypt, but another Scolytidae beetle, *Coccotrypes dactyliperda* (the palm seed beetle), was recovered from a doom palm stone at the Ptolemaic-Roman site of Berenike at the Red Sea coast (Panagiotakopulu 2001). Typical traces of the species were also recognised by the latter author on a date stone from Predynastic Hierakonpolis, illustrated by Fahmy (1998). The putative shot hole borer from Quseir could possibly represent a specimen associated with a plant species in the refuse area that has no connection with the fish product at all, and would then be an intruder that entered the assemblage after deposition. Alternatively, its presence may be related to the material of which an amphora stopper was made, assuming that transport took place in such a vessel and that its stopper was made of wood or bark. Amphora stoppers can be made from various materials, including cork. Although it has been argued that cork stoppers would be more typical of the Roman West and that they are rather rare in Egypt (Cashman 1999, 285-286), the majority of the sealings found at Berenike were made from cork (Bos 2000, 275). Cork stoppers have also been found in the Roman deposits at Quseir.

Besides the aforementioned species, that probably all entered the fish product in the Nile valley, there are five taxa that are most likely to have infested the fish product at Quseir itself. These species can be classified as carrion feeders and probably colonised the assemblage when it was discarded. The flies may have been attracted by the fish product immediately after it was discarded, when there was still enough moisture necessary for the development of the larvae. Leptodirid beetles are also carrion feeders and both adults and larvae seem to prefer decaying organic products, usually in moist habitats. Dermestid beetles, on the other hand, lay their eggs on drying animal products and the larvae can continue feeding on such totally desiccated matter. Anobiid beetles, in the case of the Mons Claudianus sample probably the drugstore beetle (*Stegobium paniceum*), may also have been attracted by the spoilt *salsamenta* once it was dry. The species is known to infest materials such as wool, hair, leather, horn, and museum specimens. However, *Stegobium paniceum* also feeds on a wide variety of plant foods and, therefore, could have been included unconsciously into the fish product while adding spices, pulses or other plant ingredients. The ants, finally, can probably be considered as general scavengers attracted by the discarded product.

Salted fish products in the Roman world and beyond

As far as fish commerce is concerned, previous archaeozoological analyses of assemblages from Eastern Desert sites have already demonstrated the importation of Red Sea fish to Mons Claudianus (Hamilton-Dyer 1994, 2001) and Mons Porphyrites (Hamilton-Dyer in press), both located at about 50 km from the Red Sea. Marine species have also been found at Al-Zarqa, a desert station situated 65 km from the Red Sea, and occupied between the 1st century AD and the beginning of the 3rd century (Leguilloux 1997). Nilotic fish were also regularly traded within Roman Egypt as shown by the presence of catfish, some of large size (*Clarias* sp., *Bagrus* sp. and *Synodontis* sp.), at both Mons Claudianus (Hamilton-Dyer 1994, 2001) and Mons Porphyrites (Hamilton-Dyer in press). Besides these siluroids, Mons Porphyrites also yielded occasional remains of Nile perch (*Lates niloticus*) while at Mons Claudianus a few tilapia were found. Nilotic fish have also been found at Berenike, located on the Red Sea coast about 260 km from the Nile, where four catfish taxa (*Clarias*, *Bagrus*, *Synodontis* and *Schilbe*) were attested in Roman occupation levels (Van Neer & Ervynck 1998, 1999). The numerous finds of Nilotic fish in various, more distant parts of the Eastern Mediterranean, show that their trade has a long tradition already starting in the Late Chalcolithic and Early Bronze Age (Van Neer et al. 2004). Given the large distances covered, fish needed to be preserved to prevent spoilage. Sun-drying and smoking were the most commonly practiced preservation methods, which even go back to at least Late Palaeolithic times (Van Neer et al. 2000). Once dried, the fish could easily be stored for future consumption and transportion over long distances, probably in baskets (Curtis 1991, 137). When fish are salted or pickled in brine (*salsamenta* or fish sauces such as a*llec*) even longer periods of storage are possible.

Long distance trade of large specimens, probably transported in baskets in dried or smoked form, should thus be distinguished from pickled fish stored in vessels. Up to date, no archaeological evidence is available from Roman Egypt for the storage of chunks of large fish in amphora. Such salted fish products have thus far only been found in early Byzantine contexts at the Coptic monastery of Baouit (Maspero & Drioton 1931-1943, 44, Van Neer, pers. observation 2005).

The fish products described in the present article are the first assemblages dating to the Roman period that consist of small Nilotic fish and that are believed to represent a local variant of the famous ‘genuine’ fish sauces and *salsamenta* produced on an industrial scale in the Roman Mediterranean. That the fish bone assemblages were found at a great distance from the Nile implies that the fish must have been salted to prevent spoilage during transport, and ascertains their identification as fish sauce or *salsamenta*. Additional arguments that support this assumption are the fact that the two products from Mons Claudianus were found in vessels, and that one of them, as well as the sample from Quseir, contained herbs and other additives. As argued above, the Quseir sample and the Mons Claudianus Fort South East assemblage clearly represent *salsamenta*, i.e. whole fish prepared in brine, in this case small specimens. The small assemblage from Mons Claudianus Fort West II gives no clue as to whether it was a fish sauce or *salsamenta*. In any case, it consisted of small Nilotic fish that were either preserved whole or fermented to a higher degree, which then resulted in a more decomposed product that can be classified as fish sauce. If a fish sauce, it then contained bones and should therefore be considered as *allec*, as opposed to *garum*. Within the fish sauce manufacturing chain, *garum* is the higher quality product, obtained by decanting the volume of brine and fermented fish. *Garum* is a liquid that contains no, or almost no, fish bones, and is thus usually impossible to detect archaeozoologically.

In the industrial installations along the Mediterranean, *salsamenta* was made from a large variety of marine species, the most common being the Spanish mackerel (*Scomber japonicus*) and the sardine (*Sardina pilchardus*). Larger species, such as tunnids, were prepared in chunks and various names were given to those products depending on the body parts used (Curtis 1991, 6-8, Etienne & Mayet 2002, 38). From large fishes, only the blood, gills and intestines were used for the production of *garum*, but small fish were used in their entirety to make fish sauce (*garum*, *allec*, etc.). The species most frequently used for fish sauces were sardines and anchovies (*Engraulis encrasicolus*). The export and consumption of both *salsamenta* and fish sauces can be documented within the Roman world using amphora, *tituli picti* (inscriptions on ceramic containers), texts, iconography and also fish bones. Most archaeozoological evidence of Mediterranean fish products is found in southern Europe (e.g., Desse-Berset 1993, Williams 1978, von den Driesch 1980, Wheeler and Locker 1985, Morales and Roselló 1989, Delussu & Wilkens 2000, Desse-Berset & Desse 2000), although finds are also known from the interior of the Empire. Several findings of *salsamenta*, mainly *Scomber japonicus*, have been reported from north-western Europe (Van Neer & Ervynck 2004), but Mediterranean fish sauces have thus far not been securely documented archaeozoologically, although amphora studies show that the typical containers reached that part of the Empire (Martin-Kilcher 1990). To date, the only certain archaeozoological evidence of a Mediterranean fish sauce found outside the Mediterranean basin comes from Austria (Lepiksaar 1986). Two contexts from England could represent a similar product but they have not been studied in detail (Kenward et al. 1986, O’Connor 1988). Ceramic studies in the Northern provinces also demonstrate that the amount of fish amphorae declines after the 1st century. It is striking that in this period local variants of fish sauce appear, as shown by archaeozoological examples from Great Britain (Bateman and Locker 1982, Jones 1988, Jaques & Van Neer, in prep.) and Belgium (Van Neer & Lentacker 1994, Lentacker et al. 2004, Van Neer et al. 2005). Clupeids (small herring and sprat), and sometimes small flatfish, were the main ingredients of this ‘North Sea fish sauce’. It is not clear whether this local product was a replacement for the ‘genuine’ product from the Mediterranean, which may have been more difficult to obtain once import slowed down due to logistic difficulties, or whether it was a cheaper alternative, and thus a competitive product, for the Mediterranean sauce. It is even unknown whether the consumer was able to tell the difference between both varieties. In the south-eastern part of the Empire another local variant of the 'typical' Mediterranean fish sauce has been found in the Roman port of Berenike (Van Neer & Ervynck, 1998, 1999). For this 'Red Sea fish sauce' local clupeiforms were used. Similar assemblages may be present at Quseir (Hamilton-Dyer, pers. observation) but have not yet been studied. At Petra, Jordan, a similar sauce has been found, in a late 4th – early 5th century AD pilgrim's flask (Studer 1994). A possible additional indication for a salted fish product from the Red Sea has been reported from a Byzantine monastery at Jabal Hārūn, about 5 km southwest of Petra, where isolated small clupeiform bones were found in sieved sediment dated to the Late Byzantine – Early Umayyad periods (late 6th – 7th centuries AD) (Frösén et al. 2002).

The importance of the fish assemblages from Quseir and Mons Claudianus, lies in the fact that they contradict the impression that fish sauces and *salsamenta* were only made from marine fish that have a high fat content. The examples from the Roman settlements in Egypt show that salted fish production also occurred along the Nile using local freshwater species. It is now known that production continued into Byzantine times as shown by bone finds from the Coptic monastery of Baouit, located in the Nile Valley. At this site a 7th century AD amphora was found with thousands of fish bones, mainly from cyprinids (among which *Labeo* seems to be more frequent than *Barbus*) and some *Synodontis* catfish (Van Neer, unpublished data). The distinction between fish sauce and *salsamenta* on the basis of archaeozoological material is not straightforward: with the exception of a few small portions of vertebral column all of the bones were disarticulated, suggesting fish sauce. Documentary information from ostraca from the same site confirms the importance of Nilotic fish in the preparation of salted fish products (Clackson 1999, 2002). Remarkably, the species mentioned in these texts (the cyprinid *Labeo* and the catfish *Synodontis*) are exactly those that were identified in the archaeozoological sample. Other archaeozoological evidence from the Nile Valley for pickled fish or fish sauce is available from a late 6th-early 7th century AD context at Shanhûr (Van Neer & Depraetere, 2005). In that assemblage the predominating taxon is tilapia, followed by *Synodontis* and cyprinids. Preparation of pickled fish still goes on at the present day in Egypt where '*faseekh*' is traditionally eaten during the yearly spring festival, '*sham an-naseem*'. The product is also known, under the same name, in northern Sudan (Chaix 1984). Archaeological finds from Kerma show that pickled fish were already being prepared in Sudanese Nubia about 2500 years ago. The contents of a jar found in a residential Napatan building consisted of numerous fish bones analysed by Jean Desse (CNRS, Valbonne), who identified cyprinids (probably mainly *Barbus*), *Hydrocynus* and possibly small Nile perch (*Lates niloticus*) in what was defined as *salsamenta* (Chaix 1984). No firm pre-Roman archaeozoological evidence is available for the production of salted fish in Egypt and claims in the popular press that the tradition of *faseekh* goes back to Pharaonic times cannot be substantiated by the scanty archaeological information available thus far. In the 'worker's' houses at Giza, concentrations of fish bones have been found suggesting processing on the spot, but the material has not yet been analysed in detail and it is still unclear whether it represents smoked, dried or salted fish (Lehner 1996). One of the concentrations does comprise small fish, ranging from less than 5 to 10 cm (Lehner 2000), and it needs to be verified if these might indicate the presence of a salted fish product. Papyrological evidence on pickled fish and its production and commerce in Egypt exists, but it does not predate Ptolemaic times (Drexhage 1993). Literary evidence shows that salteries already existed during the Hellenistic period (Curtis 2001, 321), but because of their location it is likely that mainly marine fish, including anadromous species entering the Nile, were processed.

As has been explained, in north-western Europe, Roman influence in the provinces and acquisition of a 'Roman taste' may have triggered the local manufacture of an alternative, once the provisioning with salted fish products from the south was hampered. The archaeozoological evidence available from Egypt suggests a similar process, including the local production of both Red Sea and Nilotic fish sauces. Strangely enough, this observation does not seem to be supported by the study of Drexhage (1993) of Ptolemaic, Roman and Byzantine papyri. Using the number of references related to fish sauce as a measure, the demand seems to have been low until the 2nd century AD, and only from the 3rd century onwards do the papyrological data increase in number. Because of the numerous descriptions of taste and quality the same author believes that the demand could be mainly covered by local or domestic production. He also excludes large-scale production in the Nile Valley on the basis of the low number of references to specialised trade. As it stands, more clarity on these issues will only be obtained once more data from amphora, ostraca, papyri and fish bones become available.

Acknowledgements

The contribution of Wim Van Neer to this text presents research results of the Interuniversity Attraction Poles Programme - Belgian Science Policy.

Bibliography

André, J., 1981.
L'alimentation et la Cuisine à Rome. Paris: Les Belles Lettres.

Arnett R.H., 1968.
The Beetles of the United States. Ann Arbor, Michigan: American Entomological Institute.

Bagnall R.S., 1986.
Papyri and ostraka from Quseir al-Qadim. *Bulletin of the American Society of Papyrologists* **23**: 1-60.

Bateman N & Locker A., 1982.
The sauce of the Thames. *The London Archaeologist* **4**: 204-207.

Bingen J., Bülow-Jacobsen A., Cockle W.E.H., Cuvigny H., Rubinstein L. & Van Rengen W., 1992.
Mons Claudianus Ostraca Graeca et Latina I., O. Claud. 1 à 190. Institut Français d'Archéologie Orientale, Documents de Fouilles 29. Cairo : IFAO.

Bishai H.M. & Khalil M.T., 1997.
Freshwater Fishes of Egypt. Cairo: Publication of National Biodiversity Unit 9.

Bos J.E.M.F., 2000.
Jar stoppers and seals. In: Sidebotham, S.E. & Wendrich, W.Z. (eds). *Report of the 1998 Excavations at Berenike and the Survey of the Egyptian Eastern Desert, including Excavations in Wadi Kalalat*. CNWS Publications, Special Series 5: 275-303. Leiden: CNWS.

Boulos L., 1999.
Flora of Egypt: volume 1. Cairo: Al Hadara.

Boulenger G.A., 1907.
The Fishes of the Nile. London: Hugh Rees.

Bülow-Jacobsen A., Cuvigny H., & Fournet J.-L., 1994.
The identification of Myos Hormos. New papyrological evidence. *Bulletin de l'Institut Français d' Archéologie Orientale* **95**: 103-124

Cappers R.T.J., Van Thuyne T. & Sikking L., 2004.
Plant remains from Predynastic El Abadiya-2 (Naqada area, Upper Egypt). In: Hendrickx, S., Friedman, R.F., Cialowicz, K.M. & Chlodnicki M. (eds). *Egypt at its Origins. Studies in Memory of Barbara Adams. Proceedings of the International Conference "Origin of the State. Predynastic and Early Dynastic Egypt", Krakow, 28th August - 1st September 2002*. Orientalia Lovaniensia Analecta 138: 297-293. Leuven: Peeters Publishers.

Cappers R.T.J., 2006.
Roman Foodprints at Berenike. Archaeobotanical Evidence of Trade and Subsistence in the Eastern Desert of Egypt. Monograph 51. Los Angeles: Cotsen Institute of Archaeology, UCLA.

Cashman V.L. (with contributions by Bos J.E.M.F. & Pintozzi L.A.), 1999.
Jar stoppers. In: Sidebotham, S. & Wendrich, W. (eds) *Berenike '97. Report of the 1997 Excavations at Berenike and the Survey of the Egyptian Eastern Desert, including Excavations at Shenshef.* CNWS Publications, Special Series 4: 285-297. Leiden: CNWS.

Casson L., 1989.
The Periplus Maris Erythraei: Text, Translation and Commentary. Princeton: Princeton University Press.

Chaix L., 1984.
Third note on the fauna of Kerma (Sudan). Seasons 1983 and 1984. *Genava* **32**: xiv-xvi.

Clackson S., 1999.
Something fishy in CPR XX. *Archiv für Papyrusforschung und verwandte Gebiete* **45**: 94-95.

Clackson S., 2002.
Fish and chits: the *Synodontis schall*. *Zeitschrift für Ägyptische Sprache und Altertumskunde* **129**: 6-11.

Curtis R.I., 1991.
Garum and Salsamenta. Production and Commerce in Materia Medica. Studies in Ancient Medicine 3. Leiden: Brill.

Curtis R.I., 2001.
Ancient Food Technology. Leiden: Brill.

Delussu F. and Wilkens B., 2000.
Le conserve di pesce. Alcuni dati da contesti italiani. *Mélanges de l'Ecole Française de Rome* **112** : 53-65.

Desse-Berset N., 1993.
Contenus d'amphores et surpêche: l'exemple de Sud-Perduto. In : Desse, J. &Audoin-Rouzeau, F. (eds). *Exploitation des Animaux Sauvages à travers le Temps*: 341-346. Juan-les-Pins: APDCA.

Desse-Berset N. and Desse J., 2000.
Salsamenta, garum et autres préparations de poisson. Ce qu'en disent les os. *Mélanges de l'Ecole Française de Rome, Antiquité* **112** : 73-97.

Drexhage H.-J., 1993.
Garum und Garumhandel im römischen und spätantiken Ägypten. *Münstersche Beiträge zur antieken Handelsgeschichte* **12**: 27-55.

Etienne R. & Mayet F., 2002.
Salaisons et Sauces de Poisson Hispaniques. Paris: E. de Boccard.

Fahmy A., 1998.
Artifical pollination: archaeobotanical studies at HK43. *Nekhen News* **10**: 11.

Froese R. & Pauly D. (eds), 2005.
FishBase. World Wide Web electronic publication. www.fishbase.org, version (05/2005).

Frösén J., Fiema Z.T., Koistinen K., Studer J., Danielli C., Holmgren R., Gerber Y., Heiska N. & Lahelma A., 2002.
The 2001 Finnish Jabal Hārūn project: preliminary report. *Annual of the Department of Antiquities of Jordan* 46: 391-407.

Germer R., 1988.
Katalog der altägyptischen Pflanzenreste der Berliner Museen. *Ägyptische Abhandlungen* **47**: 1-90.

Hamilton-Dyer S., 1994.
Preliminary report on the fish remains from Mons Claudianus, Egypt. *Offa* **51**: 275-278.

Hamilton-Dyer S., 2001a.
Chapter 9. The faunal remains. In: Maxfield, V.A. & Peacock, D.P.S. (eds). *Mons Claudianus, Survey and Excavation: Vol II Excavations, Part 1*. Institut Français d'Archéologie Orientale Documents de Fouilles 43: 251-301. Cairo: IFAO.

Hamilton-Dyer S, 2001b.
Faunal Remains. In: Peacock, D.P.S. & Blue, L. (eds). *Myos Hormos - Quseir al Qadim: A Roman and Islamic Port Site on the Red Sea Coast of Egypt*. Interim Report, 2001: 57. University of Southampton

Hamilton-Dyer S., in press.
Faunal remains. In: Peacock, D.P.S. & Maxfield, V.A. (eds). *Mons Porphyrites, Survey and Excavation: Vol 2 Finds*. Exeter.

Hamilton-Dyer S., in prep.
Faunal Remains. In: Peacock, D.P.S. and Blue L. (eds). *Myos Hormos - Quseir al-Qadim, Roman and Islamic Ports on the Red Sea, Volume 2: The Finds*. Oxford: Oxbow Books.

Hariri G., 1979.
Insect pests of chick-pea and lentil in the countries of the eastern Mediterranean: a review. In: Hawtin, G.C. & Chancellor, G.J. (eds). *Food Legume Improvement and Development. Proceedings of a Workshop held at the University of Aleppo, Aleppo, Syria, 2-7 May 1978*: 120-123. Ottawa: International Development Research Center.

Hill. D.S., 2002.
Pests of Stored Foodstuffs and their Control. Dordrecht: Kluwer.

Jones A.K.G., 1988.
Fish bones from the excavations in the cemetery of St Mary Bishophill Junior. *The Archaeology of York* **15**: 126-130.

Kenward H.K., Hall A.R. & Jones A.K.G., 1986.
Environmental evidence from a Roman well and Anglian pits in the legionary fortress. *The Archaeology of York* **14(5)**: 41-288.

Kislev M.E., 1991.
Archaeobotany and storage archaeoentomology. In: Renfrew, J.M. (ed.). *New Light on ancient Farming: Recent Developments in Palaeoethnobotany*: 121 - 136. Edinburgh: University Press.

Langer R.H.M. & Hill G.D., 1982.
Agricultural Plants. Cambridge, New York: Cambridge University Press.

Leguilloux M., 1997.
Quelques aspects de l'approvisionnement en viande des *praesidia* du désert oriental égyptien. *Archaeozoologia* **9** : 73-82.

Lehner M., 1996.
The Giza Plateau Mapping Project 1995-96 Annual Report. http://oi.uchicago.edu/OI/AR/95-96/95-96_Giza.html

Lehner M., 2000.
The Giza Plateau Mapping Project 1999-2000 Annual Report. http://oi.uchicago.edu/OI/AR/99-00/99-00_Giza.html

Lentacker A., Ervynck A. & Van Neer W., 2004.
The symbolic meaning of the cock. The animal remains from the Mithraeum at Tienen (Belgium). In: Martens, M. & De Boe, G. (eds). *Roman Mithraism: the Evidence of the Small Finds*. Archeologie in Vlaanderen Monografie 5: 57-80. Zellik & Tienen: Institute for the Archaeological Heritage of the Flemish Community.

Lepiksaar J., 1986.
Tierreste in einer römischen Amphore aus Salzburg (Mozartplatz 4). *Bayerische Vorgeschichtsblätter* **51**: 163-185.

Martin-Kilcher S., 1990.
Fischsauces und Fischkonserven aus dem römischen Gallien. *Archäologie der Schweiz* **13**: 37-44.

Maspero J. & Drioton E., 1931-1943.
Fouilles exécutées a Baouît. Mémoires de l'Institut Français d'Archéologie Orientale, 59. Cairo : IFAO.

Maxfield V.A., 2001.
Stone quarrying in the Eastern Desert with particular reference to Mons Claudianus and Mons Porphyrites. In: Mattingly, D.J. & Salmon, J. (eds). *Economies beyond Agriculture in the Classical World*: 143-170. London-New York: Routledge.

Maxfield V.A. & Peacock D.P.S., 2001a.
Mons Claudianus, Survey and Excavation: Vol II Excavations, Part 1. Institut Français d'Archéologie Orientale Documents de Fouilles 43. Cairo: IFAO.

Maxfield V.A. & Peacock D.P.S., 2001b.
The Roman Imperial Quarries: Survey and Excavation at Mons Porphyrites 1994-1998. Volume 1: Topography and Quarries. Egypt Exploration Society, Excavation Memoirs 67. London.

Miller A.G. & Cope T.A., 1996.
Flora of the Arabian Peninsula and Socotra. Volume 1. Edinburgh: Edinburgh University Press.

Morales Muñiz A. & Roselló E., 1989.
Informe sobre la fauna ictiològica recuperada en una àmfora tardo-romana del Tipus Keay XXVI (Spatheion). In : Ted, A. (ed.). *Un Abocador del Segle V D.C. en el Fòrum provincial de Tàrraco*. Memòries d'Excavació 2: 324-328. Tarragona: Ajuntament de Tarragona.

Newton C., 2002.
Environnement végétal et Economie en Haute-Égypte à Adaïma au Prédynastique. Approches archéobotaniques comparatives de la II^e Dynastie à l'Epoque Romaine. Montpellier: Unpublished PhD-thesis.

O'Connor T.P., 1988.
Bones from the General Accident site, Tanner Row. *The Archaeology of York* **15(2)**: 61-136.

Panagiotakopulu E. & van der Veen M., 1997.
Synanthropic insect faunas from Mons Claudianus, a Roman quarry site in the Eastern Desert, Egypt. In: Ashworth, A.C., Buckland, P.C. & Sadler, J.P. (eds). *Studies in Quaternary Entomology - An Inordinate Fondness for Insects*. Quaternary Proceedings 5: 199-205. Chichester: John Wiley.

Panagiotakopulu E., 2001.
New records for ancient pests: Archaeoentomology in Egypt. *Journal of Archaeological Science* **28**: 1235-1246.

Peacock D.P.S., 1993.
The site of Myos Hormos: a view from space. *Journal of Roman Archaeology* **6**: 226-232.

Peacock D.P.S. & Blue L., 2006.
Myos Hormos - Quseir al-Qadim, Roman and Islamic Ports on the Red Sea, Volume 1: The Survey and Report on the Excavations. Oxford: Oxbow Books.

Sandy D.B., 1989.
The production and use of vegetable oils in Ptolemaic Egypt. *Bulletin of the American Society of Papyrologists*. Suppl. no. 6: 1-136.

Sciallano M., 1997.
Poissons de l'Antiquité. Istres: Musée d'Istres.

Studer J., 1994.
Roman fish sauce in Petra, Jordan. In: Van Neer, W. (ed.). *Fish Exploitation in the Past. Proceedings of the 7th Meeting of the ICAZ Fish Remains Working Group*. Annales du Musée Royal de l'Afrique Centrale 274: 191-196. Tervuren.

Thüry G. & Walter J., 1999.
Condimenta. Gewürzpflanzen in Koch- und Backrezepten aus der römischen Antike. Herrsching: Institut für Botanik und Botanischer Garten der Universität Wien.

van der Veen M., 1996.
The plant remains from Mons Claudianus, a Roman quarry settlement in the Eastern Desert, Egypt. An interim report. *Vegetation History and Archaeobotany* **5**: 137-141.

Van Neer W., 1997.
Archaeozoological data on the food provisioning of Roman settlements in the Eastern Desert of Egypt. *ArchaeoZoologia* **9**: 137-154.

Van Neer W. & Ervynck A., 1998.
The faunal remains. In: Sidebotham, S. & Wendrich, W. (eds). *Berenike '96. Report of the Excavations at Berenike (Egyptian Red Sea Coast) and the Survey of the Eastern Desert*. CNWS Publications, Special Series 3: 349-388. Leiden: CNWS.

Van Neer W. & Ervynck A., 1999.
The faunal remains. In: Sidebotham, S. & Wendrich, W. (eds) *Berenike '97. Report of the 1997 Excavations at Berenike and the Survey of the Egyptian Eastern Desert, including Excavations at Shenshef*. CNWS Publications, Special Series 4: 325-348. Leiden: CNWS.

Van Neer W. & Ervynck A., 2004.
Remains of traded fish in archaeological sites: indicators of status or bulk food? In: O'Day, S.J., Van Neer, W. & Ervynck, A. (eds.). *Behaviour Behind Bones. The Zooarchaeology of Ritual, Religion, Status and Identity:* 203-214. Oxford: Oxbow Books.

Van Neer W. & Lentacker A., 1994.
New archaeozoological evidence for the consumption of locally-produced fish sauce in the northern provinces of the Roman Empire. *Archaeofauna* **3**: 53-62.

Van Neer W., Paulissen E. & Vermeersch P.M., 2000.
Chronology, subsistence and environment of the Late Palaeolithic fishing sites of Makhadma-2 and 4. In: Vermeersch, P.M. (ed.). *Palaeolithic Living Sites in Upper and Middle Egypt*: 271-287. Leuven: Leuven University Press.

Van Neer W., Lernau O., Friedman R., Mumford G., Poblome J. & Waelkens M., 2004.
Fish remains from archaeological sites as indicators of former trade connections in the Eastern Mediterranean. *Paléorient* **30(1)**: 101-148.

Van Neer W., Wouters W., Ervynck A. & Maes J., 2005.
New evidence from a Roman context in Belgium for fish sauce locally produced in northern Gaul. *Archaeofauna* **14**: 171-182.

Van Neer W. & Depraetere D., 2005.
Pickled fish from the Egyptian Nile: osteological evidence from a Byzantine (Coptic) context at Shanhûr. *Revue de Paléobiologie, Genéve. Vol. Spéc.* **10:** 159-170.

Van Rengen W., 2000.
The written material. In: Peacock, D.P.S. et al. *Myos Hormos - Quseir al Qadim: A Roman and Islamic Port Site on the Red Sea Coast of Egypt.* Interim Report 2000: 51-52. University of Southampton.

von den Driesch A., 1980.
Osteoarchäologische Auswertung von Garum-Resten des Cerro del Mar. *Madrider Mitteilungen* **21**: 151-154.

Wattenmaker P., 1979.
Flora and fauna. In: Whitcomb,D.S. & Johnson, J.H. (eds). *Quseir al-Qadim 1978. Preliminary Report*: 250-252. Princeton: American Research Center in Egypt.

Wattenmaker P., 1982.
Fauna. In: Whitcomb,D.S. & Johnson, J.H. (eds). *Quseir al-Qadim 1980. Preliminary Report*. American Research Center in Egypt Reports 7: 347-353. Cairo.

Wetterstrom W., 1982.
Plant remains. In: Whitcomb,D.S. & Johnson, J.H. (eds). *Quseir al-Qadim 1980. Preliminary Report*. American Research Center in Egypt Reports 7: 355-377. Cairo.

Wheeler A. & Locker A., 1985.
The estimation of size in sardines (*Sardina pilchardus*) from amphorae in a wreck at Randello, Sicily. *Journal of Archaeological Science* **12**: 97-100.

Williams Ch. K., 1978.
Corinth, 1978: Forum Southwest. *Hesperia* **48**: 104-144.

Young G.K., 2001.
Rome's Eastern Trade. International Commerce and Imperial Policy, 31 BC - AD 305. London: Routledge.

Zitterkopf R.E. & Sidebotham S.E., 1989.
Stations and towers on the Quseir-Nile road. *Journal of Egyptian Archaeology* **75**: 155-189.