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# BANQUETS AT EPHESOS ARCHAEOZOOLOGICAL EVIDENCE OF WELL STRATIFIED GREEK AND ROMAN KITCHEN WASTE

G. Forstenpointner[1], G. Weissengruber and A. Galik

Abstract

Archaeological excavations at Hanghaus II in Ephesos contained evidence of a residence owned by wealthy Romans that was in use from the AD 1st to the 3rd centuries. Outstandingly well stratified cultural layers provide an opportunity to examine dietary preferences in three successive consumer groups inhabiting this house. Archaeozoological data show constant dominance of pig remains, reaching its strongest expression in the species composition of a faunal assemblage from a Severian (AD 3rd century) kitchen room. Determination of various poultry and a broad range of fish and mollusc species strengthens the *a priori* proposition that there was a gradual transition from the plain dietary customs of the preceding Late Hellenistic settlement phase to rich banquets during the Severian period.

Regarding both the evidence of chronologically increasing percentages of goat remains and the determination of pikeperch (*Sander lucioperca),* additional conclusions may be drawn concerning environmental factors.

Résumé

Les fouilles archéologiques de Hanghaus II à Ephèse ont mis au jour une riche résidence romaine habitée entre les 1er et 3e siècles de notre ère. Des niveaux culturels remarquablement bien stratifiés ont fourni l'occasion d'examiner les tendances de la diète de trois groupes successives de consommateurs. Les données archéozoologiques montrent une prédominance constante des restes du porc, qui atteint sa plus forte expression dans la composition spécifique d'un assemblage faunique d'une cuisine sévérienne (3e siècle de notre ère). La détermination d'une variété de volailles et une large gamme de poissons et de mollusques appuie l'hypothèse d'une transition graduelle de traditions culinaires communes de la précédente phase d'installation à la fin de la période hellénistique, vers de riches banquets pendant l'installation de la période sévérienne.

Au regard des évidences chronologiques de l'augmentation des pourcentages de chèvres et la détermination de la sandre (*Sander lucioperca*), des conclusions supplémentaires au niveau environnemental peuvent être déduites.

Key Words: Kitchen waste, Luxury foods, Ephesos, Roman period

Mots Clés: Rejets culinaires, Nourriture de luxe, Ephèse, période romaine

## Introduction

Domestic waste represents a very common type of find at archaeological sites. However, a monocausal interpretation at least of the "cultural filter" (Reed 1963) – due to one event of human consumption – is rarely possible, considering the broad variety of other factors influencing the taphonomic history of an archaeological record (Bonnichsen 1989).

Recent excavations at Roman "Hanghaus II" at Ephesos yielded well stratified layers containing rich faunal and floral assemblages. One of these stratigraphic units revealed cultural layers lying on top of an ancient kitchen floor. A severe earthquake had destroyed the building. Architectural debris and building structures sealed the underlying layers (Wiplinger 1997; Ladstätter ms.1 and pers. comm.) and therefore, the contents of the cultural layers were preserved undisturbed.

Layers developed in very short periods of time as shown from the coin and ceramic analyses. It can be assumed that only few days of depositional activity produced these layers. These special archaeological records provide an opportunity to examine the cultural and historical tendencies in the diet of the inhabitants of Ephesos. Three distinct consumer groups can be distinguished in the chronological sequences of the layers, doubtlessly all of them characterized by typical features of lifestyle, yet, connected to each other by the "*spiritus loci*" of a continuously inhabited housing area.

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## Physical and chronological setting of the site

Ephesos is situated on the Ionian coast of Asia Minor, 60 km south of Izmir. The Ephesian bay was filled by quantities of silt during the last 2000 years. The coastline gradually moved away from Ephesos, and therefore the town lost its natural port. The archaeological site is situated on the alluvial plains of the Kücük Menderes (the former Kaystros river).

Urban settlement in Ephesos developed in the Middle Bronze Age, probably at the same time as the important town Apasa was mentioned in a Hittite text as the capital of the land of Arzawa (Karwiese 1995).

The old sanctuary of Artemis flourished at least from the 8th century BC onwards, and was surrounded at the time by only a few small villages and the fortified town of Koressos. An enormous new temple was built during and after the reign of the Lydian King Croesos (ca. 560 BC). This temple was known as one of the wonders of the ancient world and urban life concentrated in the surroundings of the sacred place.

As capital of the short-lived Diadochan kingdom under the rule of King Lysimachos (294 - 281 BC) a new town was founded between the ridges of Panayir daği and Bülbül daği based on Hellenistic planning traditions and superseding the old village of Smyrna. Due to lack of acceptance by the local population, the new urban structure did not flourish until the onset of Roman administration (133 BC). From the Augustean period a remarkable construction boom led to the evolution of the wealthy "Metropolis Asiae", with a total population of ca. 200,000 souls, that became the economic center of the Eastern Mediterranean.

The decline of Roman Ephesos began with the disastrous earthquake in the year AD 262/63 followed by a fatal raid by Goth plunderers. The Goths deprived the municipality of its gold reserves and ended the economic leadership of the city.

Hanghaus II is situated on the northern slope of the Bülbül daği, connected by stairways to the noble road of the Curetes, which ran between the two hills of the town. The construction history of the building starts in the early 1st century BC. Obviously, the small Late Hellenistic settlements were replaced by Roman buildings, although only few architectural remains were excavated.

About AD 100, substantial rebuilding led to the construction of the wealthy residence that remained

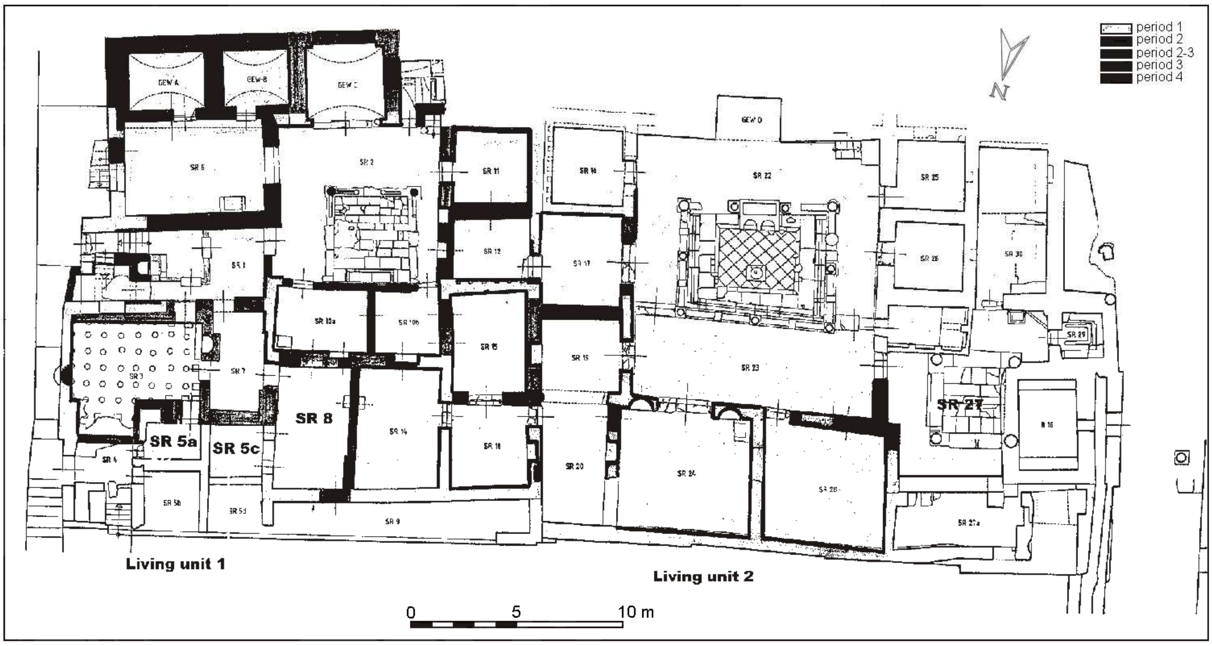


Fig. 1. Layout and building phases of Hanghaus II at Ephesos (Wiplinger 1997).

in use until the Severian period (Fig. 1). The severe earthquake, most probably dated to the years AD 262/63, caused extensive destruction to the building and the ruins were razed to the ground. People used the large quantities of architectural debris to level the site and produced again very characteristic sedimentological layers. The house was rebuilt afterwards.

## Materials and methods

The excavations in living units 1 and 2 in Hanghaus II produced three archaeological and faunal assemblages, which were clearly separated by chronological and sedimentological stratigraphy.

*Sample A (Severian layers):*
Two rooms (SR 5a and SR 5c) at the northeastern corner of living unit/area 1 provided an archaeological record that coincides directly with the event of destruction caused by an earthquake in the middle of the AD 3rd century. During the course of the first rebuilding phase (AD 100), an originally undivided, court-like structure adjacent to the bathrooms SR 3 and SR 6 became bi-partite. Both of the rooms were crossed by an open gutter, which drained sewage into a main sewer (Fig. 2); (Wiplinger, 1998).

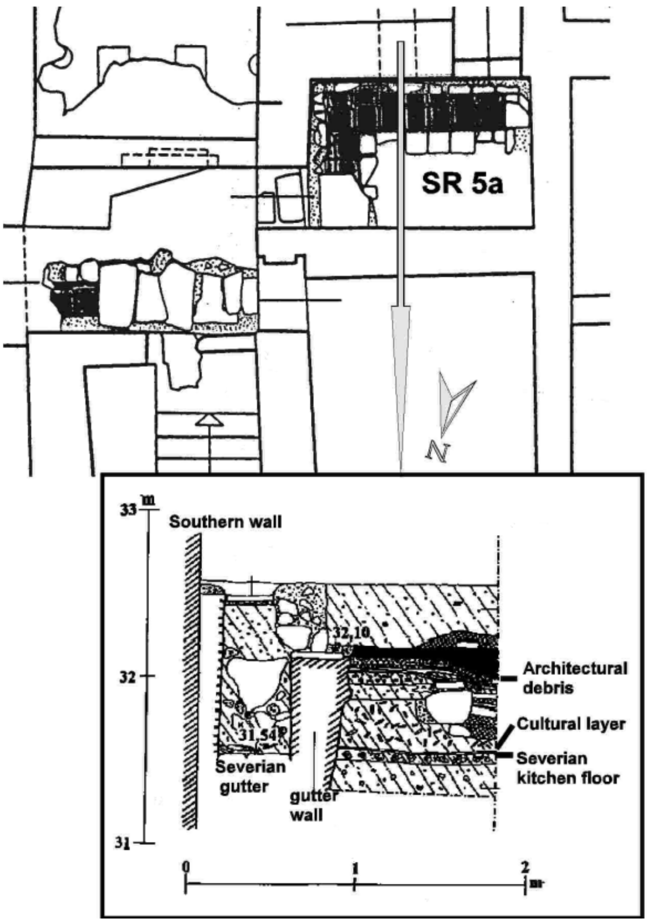


Fig. 2. Mapping and stratigraphic profile of room SR 5a.

Fig. 3. Selection of coarse kitchen vessels from the gutter of room SR 5a.

Under a thick layer of architectural debris, the excavators recovered rich, black and solid cultural layers above the room floors as well as at the bottom of the gutter, which were partly carbonized. Additionally, at least 30 coarse kitchen vessels (Fig. 3) were recovered from the gutter. All of them were complete, although broken by the weight of the layers above them. The archaeological finds indicate that both chambers were used as a kitchen with the gutter representing a kind of a sink.

*Sample B (Flavian layers):*
Excavation in room SR8 (living unit 1, Fig. 1) yielded a densely packed assemblage of Flavian ceramic sherds intermingled with faunal remains. Deposition was obviously related to filling and levelling activities along with the installation of a drainage canal, during the first rebuilding phase at the end of the AD 1st century (Ladstätter ms.2). The composition of the fill displays striking homogeneity.

*Sample C (Hellenistic layers):*
Excavations in room 5/97 revealed undisturbed Late Hellenistic layers near the stylobate in the atrium SR27 (living unit 2, Fig. 1), which represent a short living occupation of the site during the late second half of the 2nd century BC (Ladstätter 1998). Architectural remains from this settlement phase were not discovered. Several cooking hearths of the Tannur type, which were most probably used in the open-air, demonstrate the coeval nature of this archaeological complex.

*Sample D:*
Sample D was established in order to shed more light on fish and mollusc consumption in Ephesos. This sample includes finds derived from sediment layers, which were poorly separated or even unstratified. The periods of time represented by these finds start in the Late Hellenistic (Sample C) up to the Severian period (sample A).

All samples contain remains which can be generally described as “seafood”, although the assemblages revealed freshwater fishes and terrestrial molluscs, too.

## Osteological description

In keeping with the standards of skeletal analysis, identification up to species level was carried out in addition to determination of skeletal elements and side. Identification and estimation of sex and culling age mainly were determined, using the specific comparative collections at the Department of Anatomy, University of Veterinary Medicine of Vienna, taking into account the published criteria as well (e.g. Habermehl 1975, Grant 1982, Lemppenau 1964).

Alfred Galik's private reference collection was used for the identification of the fish remains. However, the authors would like to thank Dr. Wim Van Neer, Royal Museum of Central Africa, Belgium and Dr. Arturo Morales, Laboratorio de Arqueozoología, Departamento de Biología, Facultad de Ciencias, Universidad Autónoma de Madrid for their support. They kindly provided important assistance by identifying fish species. The molluscs were mainly determined following Kerney *et al.* (1983), Fechter & Falkner (1990), Poppe & Goto (1993), Riedl (1970) and Tornaritis (1987).

Measurements were taken according to von den Driesch (1976). Butchering marks, cuts, and traces of carnivore or rodent activity were recorded in cumulative drawings (following Riedel, 1993). Each identifiable fragment was numbered individually and returned to its original packaging after analysis. Recorded characteristics, including contextual data, were entered into a relational data base (q&a 4.0).

## Hypotheses and issues

Because of their obvious contextual characteristics, all investigated samples were labeled with their *a priori* interpretations before the archaeozoological analysis even began. One assemblage (sample A), in fact, was particularly interpreted to represent remains of cooking, while others (samples B and C) were identified as „plain domestic waste“. The main aim of this study was to test the plausibility of these hypotheses. The second, but no less important goal, was the comparison of three chronologically successive faunal samples from an extraordinary urban site, the economic development of which underwent striking shifts from the 2$^{nd}$ century BC to the AD 3$^{rd}$ century. Comparable as well as biasing factors, related to particular modes of consumption or deposition, had to be worked out in order to strengthen our knowledge of the socio-economic and environmental background of Hellenistic and Roman Ephesos.

## Results

*Sample A*

The Severian layers from rooms SR5a and SR5c yielded a total of 1,320 faunal remains with 1,193 specimens identifiable at least to genus level (mammalia, aves and mollusca) or family level (pisces). Similarly to all other examined samples, the state of bone preservation was excellent, yet with a rather high grade of bone fragmentation (see Table 1 for an overview of the quantitative features of samples A - C).

The faunal composition (Table 2a) displays a remarkably high proportion of domestic pig, comprising more than two thirds of identifiable mammalian and avian specimens. Caprine and bovine remains do not exceed 13 and 9 % respectively, the latter, however, featuring a remarkably high percentage of ribs and vertebrae (Table 2a and Figs. 7a, 8). In caprines, a striking preponderance of goats is obvious. While the number of domestic fowl is more than 6 % (avian and mammalian NISP), evidence of other domestic poultry as well as of game is rather scarce. Few remains mark the presence of goose, duck (maybe mallard), peacock, rock partridge, pheasant, and bustard. Game mammals are represented by four hare bones and, most likely, by three fragments of pig bones that seem to be remains of wild boar. Patterns of age distribution are quantifiable only in pigs, featuring slaughtering at a preferred of 12-24 months. (Fig. 4a). While about 20 % of pig bones form a morphologically rather uniform group, representing younger animals slaughtered at an age of 6-8 months, evidence of very young piglets (0-2 months) is found in a total of 15 specimens. Due to a scarcity of diagnostic skelet-

Table 1. Quantitative features of samples A-C from Hanghaus II/Ephesos.

| SPECIES | Code in Table 2 | Sample A n | Sample A weight | Sample A g/n | Sample B n | Sample B weight | Sample B g/n | Sample C n | Sample C weight | Sample C g/n |
|---|---|---|---|---|---|---|---|---|---|---|
| DOMESTIC MAMMALS | | | | | | | | | | |
| Pig (*Sus scrofa* Linné 1758)) | S | 591 | 2836.0 | 4.8 | 235 | 1409.0 | 6.0 | 60 | 378.5 | 6.3 |
| Caprine | O-C | 81 | 360.0 | 4.4 | 174 | 611.9 | 3.5 | 35 | 184.5 | 5.3 |
| Goat (*Capra hircus* Linné 1758) | C | 24 | 217.0 | 9.0 | 36 | 201.8 | 5.6 | 6 | 16.8 | 2.8 |
| Sheep (*Ovis aries* Linné 1758) | O | 9 | 44.1 | 4.9 | 15 | 93.6 | 6.2 | 6 | 24.6 | 4.1 |
| Cattle (*Bos taurus* Linné 1758) | B | 78 | 807.0 | 10.3 | 102 | 901.9 | 8.8 | 20 | 320.3 | 16.0 |
| Dog (*Canis familiaris* Linné 1758) | Cn | 17 | 61.6 | 3.6 | | | | | | |
| Horse (*Equus caballus* Linné 1758) | E | 1 | 2.6 | 2.6 | | | | 1 | 51.6 | 0.2 |
| DOMESTIC (?) BIRDS | | | | | | | | | | |
| Fowl (*Gallus gallus* Linné 1758) | G | 54 | 58.7 | 1.1 | 8 | 10.3 | 1.3 | 10 | 14.2 | 1.4 |
| Goose (*Anser anser* Linné 1758) | A | | | | 3 | 3.8 | 1.3 | | | |
| Duck (*Anas platyrhynchos* Linné 1758) | An | 2 | 1.3 | 0.7 | 1 | 1.3 | 1.3 | | | |
| Peacock (*Pavo cristatus* Linné 1758) | P | 1 | 1.3 | 1.3 | | | | | | |
| WILD MAMMALS | | | | | | | | | | |
| *Hare (Lepus europaeus* Pallas 1778) | L | 4 | 3.2 | 0.8 | 3 | 10.2 | 3.4 | 2 | 4.0 | 0.9 |
| Fallow deer (*Dama dama* Linné 1758) | D | | | | | | | 1 | 8.1 | 8.1 |
| Red deer (*Cervus elaphus* Linné 1758) | C | | | | | | | 1 | 0.7 | 0.7 |
| Black rat (*Rattus rattus* Linné 1758) | R | 5 | 2.2 | 0.4 | | | | | | |
| WILD (?)BIRDS | | | | | | | | | | |
| Rock partridge (*Alectoris graeca* Meisner 1804) | Al | 3 | 0.9 | 0.3 | 2 | 1.1 | 0.6 | 1 | 0.2 | 0.2 |
| Pheasant (*Phasianus colchicus* Linné 1758) | Ph | 1 | 1.0 | 1.0 | 1 | 0.9 | 0.9 | 1 | 0.9 | 0.9 |
| Bustard (*Otis tarda* Linné 1758) | Ot | 1 | 0.8 | 0.8 | | | | | | |
| Pigeon (*Columba sp.*) | Co | | | | 1 | 0.6 | 0.6 | | | |
| REPTILES | | | | | | | | | | |
| Tortoise (*Testudo graeca* Linné 1758) | Te | | | | 7 | 131.0 | 18.7 | | | |
| Mammalia, Aves, Reptilia total | | 872 | 4397.7 | 5.0 | 588 | 3377.4 | 5.7 | 144 | 1004.4 | 6.9 |
| Pisces | | 14 | | | 67 | | | 2 | | |
| Crustacea | | 1 | | | | | | | | |
| Mollusca | | 110 | | | 95 | | | 27 | | |
| Identified specimens | | 1193 | | | - | | | 277 | | |
| Non-identifiable specimens | | 127 | | | 282 | | | 54 | | |
| Total | | 1348 | | | 1249 | | | 331 | | |

al elements, the culling ages of bovines and caprines could not be estimated extensively. Morphological evidence, however, suggests (including available data on epiphyseal closure) that there seems to be a high percentage of adults. A small assemblage of 8 caprine specimens (MNI: 1) from room SR5a and few other fragments, representing kids or lambs at an age of 0-2 months show butchering marks (Fig. 5) and should be considered parts of the human diet. A coarse estimation of age classes in cattle features an overwhelming number of adults and adolescents in contrast to a minor percentage (approx. 20%) of juvenile individuals (6-18 months).

Almost all bones of domestic animals appear to be not only splintered but also heavily butchered (for example, in the overview of butchering marks on pig bones from room SR5c in Fig. 6). Because of this fact only a few measurements could be taken (all osteometric data from ruminants and pigs are listed in Table 5). Comprehensive comments on estimated body sizes will be given for all examined samples in the discusssion.

Additionally, flotation of soil samples from room SR5a yielded palaeobotanical finds. Identification of well preserved seeds showed that olives, grapes, figs, cucurbitaceous fruits and cereals were eaten (Popovcak, unpubl. ms.).

One hundred and twentyfour fish and mollusc remains were recovered from sample A (Table 3). The greater part of the material consists of molluscs (NISP 110) and only 14 remains are fish bones. Gastropod remains represent marine as well as terrestrial snails. The marine gastropods include whelk (*Buccinulum corneum* Linné, 1758) and five murex (*Murex brandaris* Linné, 1758) shells. Four snail shells (*Helix aspersa/lucorum*) represent the terrestrial gastropods (Fig. 9).

Table 2a. Faunal composition and skeletal representation in sample A from Hanghaus II/Ephesos.

| Element | S | O-C | C | O | B | G | An | P | Cn | E | L | Al | Ph | Ot | R | NISP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| caput | 86 | 6 | 4 | 4 | 1 | 1 | | | 1 | | | | | | 1 | 104 |
| mandibula | 51 | 7 | | | 2 | 2 | | | | | | | | | 1 | 63 |
| dens | 24 | 2 | | | 1 | | | | | | | | | | | 27 |
| atlas | 7 | | | 1 | | | | | | | | | | | | 8 |
| axis | 6 | | | | | | | | | | | | | | | 6 |
| vertebra C | 13 | 2 | 2 | | 5 | | | 1 | | 1 | | | | | | 24 |
| vertebra T | 34 | 4 | | | 6 | 2 | | | 2 | | 1 | | | | | 49 |
| vertebra L | 42 | 6 | | | 12 | | | | 4 | | 1 | | | | | 65 |
| vertebra S | 5 | | | | 1 | | | | | | | | | | | 6 |
| vertebra Co | | | | | 1 | | | | | | | | | | | 1 |
| costa | 109 | 25 | | | 23 | 1 | | | 1 | | | | | | | 157 |
| sternum | 3 | | | | | 9 | | | | | | 1 | | | | 13 |
| furcula | | | | | | 3 | | | | | | | | | | 3 |
| coracoid | | | | | | 3 | | | | | | | | | | 3 |
| scapula | 28 | 7 | | | 3 | 1 | | | | | 1 | | | | 1 | 41 |
| humerus | 21 | 3 | 1 | 1 | 2 | 5 | | | 1 | | | 1 | | | | 35 |
| radius/ulna | | 2 | 1 | | | | | | | | | | | | | 3 |
| radius | 10 | 2 | | | | 3 | | | 1 | | | | | | | 16 |
| ulna | 8 | 1 | | | | 4 | | | 1 | | | | | | | 14 |
| coxa | 23 | 1 | 2 | | 4 | 5 | | | | | | | | | | 35 |
| femur | 21 | 1 | 1 | | 2 | 7 | | | 1 | | | | | | 1 | 34 |
| patella | | | 1 | | | | | | | | | | | | | 1 |
| tibia | 28 | 8 | 1 | 2 | | | | | | | | | | | 1 | 40 |
| fibula | 7 | | | | | 1 | | | | | | | | | | 8 |
| tibiotarsus | | | | | | 3 | 1 | | | | | | 1 | 1 | | 7 |
| access. carp. | | | | | 1 | | | | | | | | | | | 1 |
| radial carpal | | | | | 1 | | | | | | | | | | | 1 |
| talus | 4 | | | 1 | 1 | | | | | | | | | | | 6 |
| calcaneus | 3 | | 2 | | 1 | | | | | | | | | | | 6 |
| central tarsal | 1 | | | | | | | | | | | | | | | 1 |
| tarsal 4 | 1 | | | | | | | | | | | | | | | 1 |
| metacarpus | 1 | 2 | 1 | | 2 | | | | | | 1 | | | | | 7 |
| mc 2 | 2 | | | | | | | | | | | | | | | 2 |
| mc 3 | 1 | | | | | | | | | | | | | | | 1 |
| mc 4 | 1 | | | | | | | | 1 | | | | | | | 2 |
| mc 5 | 3 | | | | | | | | | | | | | | | 3 |
| metatarsus | 1 | 1 | 5 | | 1 | | | | | | | | | | | 8 |
| mt 2 | 4 | | | | | | | | | | | | | | | 4 |
| mt 3 | 6 | | | | | | | | 2 | | | | | | | 8 |
| mt 4 | 6 | | | | | | | | 1 | | | | | | | 7 |
| mt 5 | 2 | | | | | | | | | | | | | | | 2 |
| metapodium | 10 | | | | | | | | | | | | | | | 10 |
| tarsometatarsus | | | | | | 4 | 1 | | | | | 1 | | | | 6 |
| phalanx 1 | 10 | 1 | | | | | | | 1 | | | | | | | 12 |
| p. 1 anterior | | | 2 | | 1 | | | | | | | | | | | 3 |
| p. 1 posterior | 2 | | | | 1 | | | | | | | | | | | 3 |
| p. 1 para | 1 | | | | | | | | | | | | | | | 1 |
| p. 2 | 3 | | | 1 | | | | | | | | | | | | 4 |
| p. 2 anterior | | | | | 2 | | | | | | | | | | | 2 |
| p. 3 | 3 | | | | | | | | | | | | | | | 3 |
| p. 3 anterior | | | | | 2 | | | | | | | | | | | 2 |
| p. 3 posterior | | | | | 1 | | | | | | | | | | | 1 |
| p. 3 para | 1 | | | | | | | | | | | | | | | 1 |
| sesam prox. | | | | | 1 | | | | | | | | | | | 1 |
| NISP (n) | 591 | 81 | 24 | 9 | 78 | 54 | 2 | 1 | 17 | 1 | 4 | 3 | 1 | 1 | 5 | 872 |
| NISP (%) | 67.8 | 9.29 | 2.75 | 1.03 | 8.94 | 6.19 | 0.23 | 0.11 | 1.95 | 0.11 | 0.46 | 0.34 | 0.11 | 0.1 | 0.57 | 100 |
| weight (g) | 2836 | 360 | 217 | 44.1 | 807 | 58.7 | 1.3 | 1.3 | 61.6 | 2.6 | 3.2 | 0.9 | 1 | 0.8 | 2.2 | 4439 |
| weight (%) | 63.9 | 8.12 | 4.88 | 0.99 | 18.2 | 1.32 | 0.03 | 0.03 | 1.39 | 0.06 | 0.07 | 0.02 | 0.02 | 0.0 | 0.05 | 100 |

Table 2b. Faunal composition and skeletal representation in sample B from Hanghaus II/Ephesos.

| Element | S | O-C | C | O | B | G | A | An | L | Al | Ph | Co | Te | NISP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| caput | 28 | 16 | 3 | 5 | 6 | | | | | | | | | 58 |
| hyoid | 1 | 1 | | | | | | | | | | | | 2 |
| mandibula | 27 | 24 | | | 1 | | | | 1 | | | | | 53 |
| dens | 11 | 13 | | | | | | | | | | | | 24 |
| atlas | 1 | 1 | | | | | | | | | | | | 2 |
| axis | 1 | 1 | | | 1 | | | | | | | | | 3 |
| vertebra C | 1 | 6 | | | 4 | | | | | | | | | 9 |
| vertebra T | 13 | 8 | | | 9 | | | | | | | | | 30 |
| vertebra L | 9 | 2 | | | 16 | | | | | | | | | 26 |
| vertebra Co | 1 | | | | 10 | | | | | | | | | 11 |
| notarium | | | | | | 1 | | | | | | | | 1 |
| costa | 40 | 24 | | | 33 | | | | 1 | | | | | 94 |
| sternum | | 1 | | | | | | | | | | | | 1 |
| coracoid | | | | | | | | | | | | 1 | | 1 |
| scapula | 18 | 2 | 1 | | 5 | | | | | | | | | 26 |
| humerus | 11 | 12 | 5 | | 1 | | | | | 2 | | | | 31 |
| radius/ulna | | 4 | 2 | 1 | | | | | | | | | | 7 |
| radius | 3 | 10 | | | | 1 | 1 | | | | | | | 15 |
| ulna | 10 | 4 | | 2 | | 2 | | | | | | | | 18 |
| coxa | 8 | 2 | 8 | | 4 | 1 | 1 | | 1 | | | | | 25 |
| femur | 14 | 10 | | | | 1 | | | | | | | | 25 |
| tibia | 11 | 14 | 1 | | 2 | | | | | | | | | 28 |
| fibula | 4 | | | | | | | | | | | | | 4 |
| tibiotarsus | | | | | | 2 | | | | | | | | 2 |
| access. carp. | | | | | 2 | | | | | | | | | 2 |
| talus | 5 | 1 | 1 | 2 | | | | | | | | | | 9 |
| calcaneus | 3 | 1 | | 1 | | | | | | | | | | 5 |
| centroquartal | | 1 | | | | | | | | | | | | 1 |
| metacarpus | 1 | 7 | 4 | | 2 | | | | | | | | | 14 |
| mc2 | 2 | | | | | | | | | | | | | 2 |
| mc3 | 5 | | | | | | | | | | | | | 5 |
| mc4 | 2 | | | | | | | | | | | | | 2 |
| carpometacarpus | | | | | | | | | | | 1 | | | 1 |
| metatarsus | 1 | 7 | 1 | 1 | 2 | | | | | | | | | 12 |
| mt2 | 1 | | | | | | | | | | | | | 1 |
| mt4 | 2 | | | | | | | | | | | | | 2 |
| mt5 | 1 | | | | | | | | | | | | | 1 |
| metapodium | | 1 | | | | | | | | | | | | 1 |
| tarsometatarsus | | | | | | | | 1 | | | | | | 1 |
| phalanx 1 | | 1 | | | | | 1 | | | | | | | 2 |
| p. 1 anterior | | | 4 | 2 | | | | | | | | | | 6 |
| p. 1 posterior | | | 3 | | | | | | | | | | | 3 |
| p. 2 anterior | | | 1 | 1 | 1 | | | | | | | | | 3 |
| p. 2 posterior | | | 2 | | | | | | | | | | | 2 |
| p. 3 | | | 1 | | 1 | | | | | | | | | 2 |
| p. 3 anterior | | | | | 1 | | | | | | | | | 1 |
| Carapax | | | | | | | | | | | | | 7 | 7 |
| NISP (n) | 235 | 174 | 36 | 15 | 102 | 8 | 3 | 1 | 3 | 2 | 1 | 1 | 7 | 589 |
| NISP (%) | 39.9 | 29.54 | 6.11 | 2.55 | 17.32 | 1.36 | 0.51 | 0.17 | 0.51 | 0.3 | 0.1 | 0.1 | 1.19 | 100 |
| weight (g) | 1409 | 611.9 | 201.8 | 93.6 | 901.9 | 10.3 | 3.8 | 1.3 | 10.2 | 1.1 | 0.9 | 0.6 | 131. | 3378 |
| weight (%) | 41.71 | 18.11 | 5.97 | 2.77 | 26.7 | 0.3 | 0.11 | 0.04 | 0.3 | 0.0 | 0.0 | 0.0 | 3.9 | 100 |

Table 2c. Faunal composition and skeletal representation in sample C from Hanghaus II / Ephesos.

| Element | S | O-C | C | O | B | G | E | L | D | C | Al | Ph | NISP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| caput | 7 | | | | | | | | | | | | 7 |
| antler | | | | | | | | | | 1 | | | 1 |
| mandibula | 4 | 4 | | | | | | | | | | | 8 |
| dens | 1 | 1 | | | | | 1 | | | | | | 3 |
| vert;C | 1 | 2 | | | | | | | | | | | 2 |
| vert;T | 1 | 2 | | | 1 | | | | | | | | 4 |
| vert;L | | 3 | | | 2 | | | | | | | | 5 |
| vert;co | | | | | 2 | | | | | | | | 2 |
| notarium | | | | | | 1 | | | | | | | 1 |
| synsacrum | | | | | | 1 | | | | | | | 1 |
| costa | 14 | 3 | | | 3 | | | | | | | | 19 |
| sternum | 1 | | | | | | | | | | | | 1 |
| coracoid | | | | | | 2 | | | | | | | 2 |
| scapula | 1 | 2 | | | 1 | | | | | | 1 | | 5 |
| humerus | 3 | 4 | | | | 1 | | | | | | | 8 |
| radius/ulna | | 1 | | | | | | | | | | | 1 |
| radius | 3 | 4 | 2 | 1 | 1 | 1 | | | | | | | 12 |
| ulna | 2 | 1 | | | | | | | | | | | 3 |
| coxa | 4 | | | 2 | 3 | | | | | | | | 9 |
| femur | 4 | 1 | | | 1 | | | 1 | | | | | 7 |
| patella | | | | | 1 | | | | | | | | 1 |
| tibia | 6 | 6 | | | 2 | | | | | | | | 14 |
| tibiotarsus | | | | | | 4 | | | | | | | 4 |
| talus | | | | 1 | | | | | | | | | 1 |
| centroquart. | | | 1 | | | | | | | | | | 1 |
| tarsometat. | | | | | | | | | | | | 1 | 1 |
| metacarpus | | | 1 | | 2 | | | | | | | | 3 |
| mc2 | 1 | | | | | | | | | | | | 1 |
| mc3 | 1 | | | | | | | | | | | | 1 |
| mc4 | 2 | | | | | | | | | | | | 2 |
| metatarsus | | 1 | | | | | | | 1 | | | | 2 |
| mt5 | | | | | | | | 1 | | | | | 1 |
| metapod. | 1 | | | | | | | | | | | | 1 |
| phalanx1 | 2 | | | | | | | | | | | | 2 |
| p.1anterior | | | | | 1 | | | | | | | | 1 |
| p.1 posterior | | | 1 | 1 | | | | | | | | | 2 |
| p.2 posterior | | | 1 | 1 | | | | | | | | | 2 |
| p.3 | 1 | | | | | | | | | | | | 1 |
| NISP(n) | 60 | 35 | 6 | 6 | 20 | 10 | 1 | 2 | 1 | 1 | 1 | 1 | 144 |
| NISP(%) | 41.7 | 24.3 | 4.2 | 4.2 | 13.9 | 6.9 | 0.7 | 1.4 | 0.7 | 0.7 | 0.7 | 0.7 | 100 |
| weight(g) | 378.5 | 184.5 | 16.8 | 24.6 | 320.3 | 14.2 | 51.6 | 4 | 8.1 | 0.7 | 0.2 | 0.9 | 1005.8 |
| weight(%) | 37.63 | 18.34 | 1.67 | 2.45 | 31.85 | 1.41 | 5.13 | 0.4 | 0.8 | 0.07 | 0.02 | 0.09 | 100 |

Closer identification of these two species was not possible, because of the preservation of the shells. Although, the shells were quite completely preserved, their surface became covered by calcium carbonate. The better part of the bivalves are mussels (*Mytilus galloprovincialis* Lamarck, 1819) and oysters (*Ostrea edulis* Linné, 1758). Cockles (*Cerastoderma edule glaucum* Brugiere, 1789), scallops (Pectinidae), wedge clams (*Donax semistriatus* Poli, 1795) and grooved carpet shells (*Tapes decussatus* Linné, 1758) are numerous but less common. Another characteristic seafood resource, cuttlefish (Cephalopoda, *Sepia* sp.), appeared among the remains. Numerous cuttlefish shells were recovered in this sample (Table 3).

Eight specimens are indeterminable fish remains and the rest can be divided into two groups containing freshwater and marine fishes (Table 3, Table 4). Marine fish is represented by wrasse (*Labrus* sp.) and by a fragmented anal bone from a flatfish (Pleuronectiformes). The group of freshwater fishes contains a cyprinid bone, a carp (*Cyprinus carpio*) bone and a specimen of pikeperch (*Sander lucioperca*, Fig. 10). Finally, crustacean remains from a *Balanus* sp. appeared among the material.

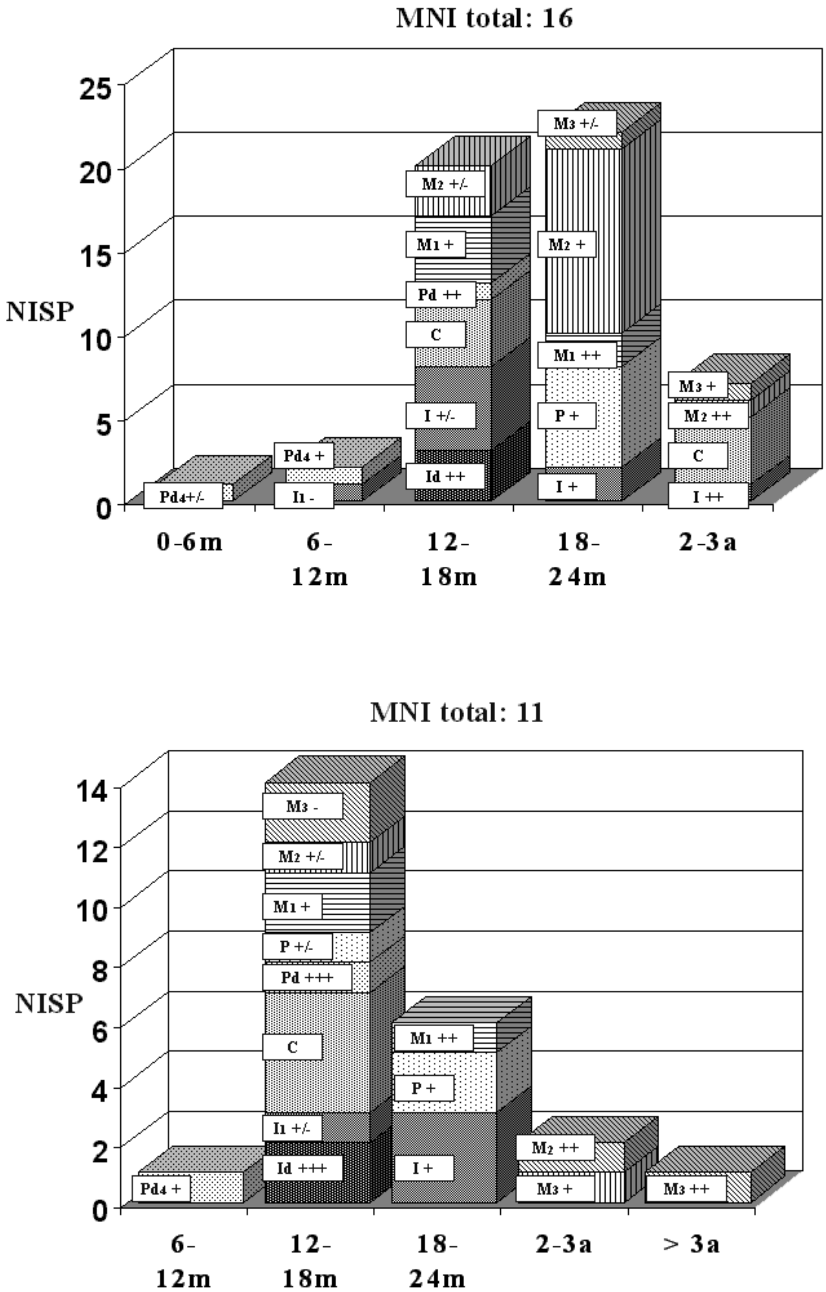


Fig. 4. Age classes in pigs based on dentition, above: Severian layers, below: Flavian layers.

*Sample B*

The Flavian fill stratum in room SR8 produced a total of 1,249 faunal remains (see Table 1 for an overview on broad quantitative results). A comparison with finds from Severian layers shows substantial differences but also similarities, in various features of the sample. While species composition (Table 2b) still displays a slight predominance of pig remains, caprine bones, however, cover almost the same percentage of identifiable specimens. Similarly to the Severian sample, a preference for goats is obvious, but the proportion of cattle bones and of domestic fowls differs sharply, the first doubling in number, the latter decreasing to less than a quarter of the comparative values. Scarcity and composition of game remains resembles that of the Severian faunal remains.

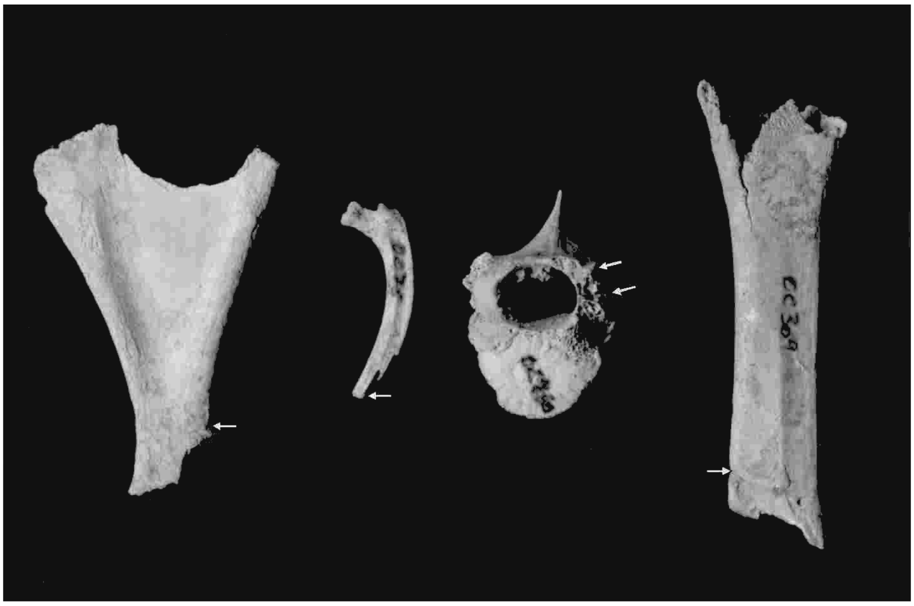

Fig. 5. Butchering marks on infantile (left specimens) and juvenile (right specimens) bones from kids or lambs (room SR 5a).

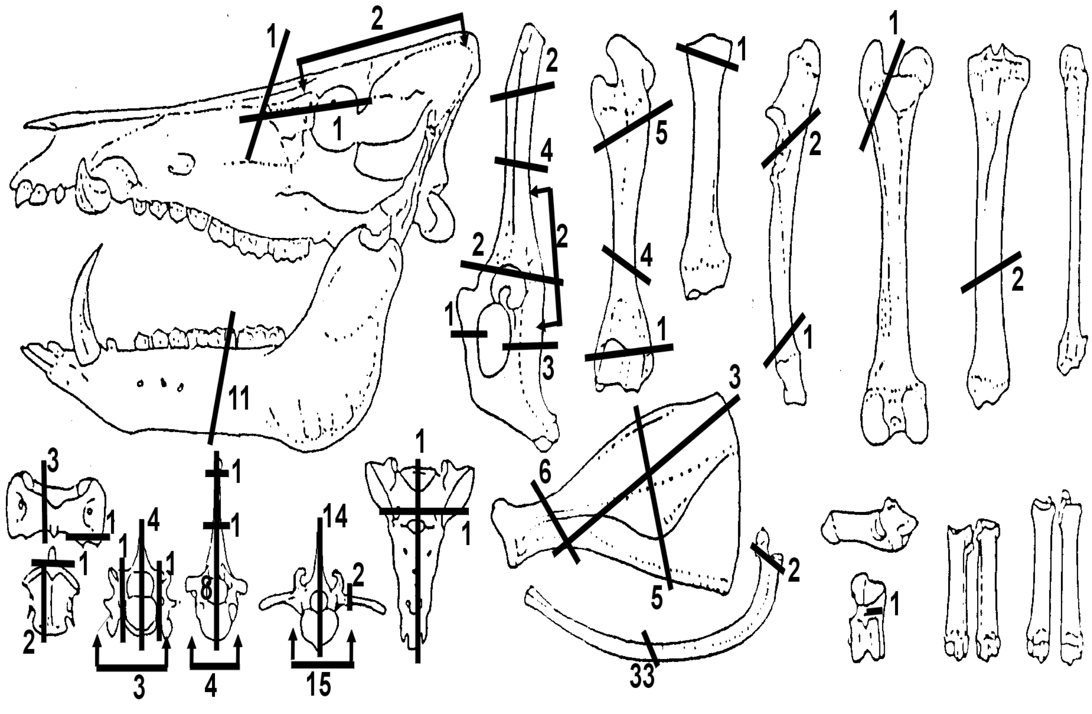

Fig. 6. Occurrence of butchering marks in pig bones from room SR 5c (drawings by courtesy of E. Pucher).

Table 3. Quantification of crustacean, mollusc and fish remains from Hanghaus II/Ephesos.

| Identified specimens | NISP sample A | NISP sample B | NISP sample C | NISP sample D |
|---|---|---|---|---|
| *Balanus* sp. | 1 | | | |
| Decapoda | | | | 1 |
| *Buccinulum corneum* Linné, 1785 | 1 | | | |
| *Charonia sequenzia* Aradas & Benoit, 1876 | | 2 | | 1 |
| *Murex brandaris* Linné, 1758 | 5 | 2 | 1 | 8 |
| *Patella* sp. | | | | 1 |
| *Helix aspersa/lucorum* | 4 | 11 | | 7 |
| Bivalvia | | 1 | | |
| *Mytilus galloprovincialis* Lamarck, 1819 | 31 | 17 | 1 | 30 |
| *Ostrea edulis* Linné, 1758 | 43 | 10 | 17 | 29 |
| *Cerastoderma edule glaucum* Brugiere, 1789 | 3 | 43 | 5 | 19 |
| *Acanthocardia tubercolata* Linne, 1758 | | 1 | | 2 |
| Glycimeridae | | 1 | 1 | |
| *Donax semistriatus* Poli, 1795 | 3 | 5 | | 3 |
| *Tapes decussatus* Linné, 1758 | 4 | | | 1 |
| Pectinidae | 2 | | | 1 |
| *Pecten jacobaeus* Linné, 1758 | 4 | 2 | | |
| *Chlamys* sp. | | | | 1 |
| *Chlamys glabra proteus* Linné, 1758 | 1 | | | |
| *Sepia* sp. | 9 | | | |
| Pisces ind. | 8 | 42 | 1 | 25 |
| Chondrichthyes/shark | | 1 | | |
| *Squalus acanthias* Linné, 1758 | | | 1 | |
| *Muraena helena* Linné, 1758 | | 4 | | |
| Pleuronectiformes | 1 | | | |
| Mugilidae | | | | 1 |
| Serranidae | | | | 1 |
| *Epinephelus* sp. | | | | 1 |
| Sparidae | | 1 | | 1 |
| Labridae | | | | 1 |
| Labrus sp. | 2 | | | 1 |
| Cyprinidae | 1 | | | 2 |
| *Cyprinus carpio* Linné, 1758 | 1 | 5 | 2 | |
| *Abramis brama* Linné, 1758 | | 8 | | |
| *Rutilus frisii* Nordmann 1840 | | 1 | | 1 |
| ***Sander** lucioperca* Linné, 1758 | 1 | 4 | | 2 |
| *Clarias* sp. | | 1 | | |
| total | 125 | 162 | 29 | 140 |

Table 4. Faunal composition and skeletal representation of fish remains from Hanghaus II/Ephesos.

| | Pisces indet. | | | | Chondrichthyes | | | | *Squalus acanthias* | | | | Pleuronectiform | | | | *Muraena helena* | | | | Mugilidae | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| dentale | | | | | | | | | | | | | | | | | | 4 | | | | | | |
| cleithrum | | | | 2 | | | | | | | | | | | | | | | | | | | | 1 |
| vertebra | | | | | | 1 | | | | | | | | | | | | | | | | | | |
| fin ray/rib | 7 | 30 | | 7 | | | | | | | 1 | | | | | | | | | | | | | |
| total | 8 | 42 | 1 | 25 | | 1 | | | | | 1 | | 1 | | | | | 4 | | | | | | 1 |

| | Serranidae | | | | Epinephelidae | | | | *Labrus* sp. | | | | Labridae | | | | Sparidae | | | | Cyprinidae | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| parasphenoid | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| mesethmoid | | | | | | | | | 1 | | | | | | | | | | | | | | | |
| premaxilla | | | | | | | | | | | | | | | | 1 | | | | 1 | | | | |
| dentale | | | | | | | | 1 | | | | | | | | | | | | | | | | |
| operculum | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| hyomandibula | | | | | | | | | | | | | | | | | | 1 | | | | | | |
| pharyngeal bone | | | | | | | | | | | | 1 | | | | | | | | | | | | |
| vertebra | | | | 1 | | | | | | | | | | | | | | | | | 1 | | | |
| fin ray/rib | | | | | | | | | | | | | | | | | | | | | | | | 1 |
| total | | | | 1 | | | | 1 | 2 | | | 1 | | | | 1 | | 1 | | 1 | 1 | | | 2 |

| | *Cyprinus carpio* | | | | *Abramis brama* | | | | *Rutilus frisii* | | | | *Sander lucioperca* | | | | *Clarias* sp | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Element | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D | A | B | C | D |
| parasphenoid | 1 | | | | | | | | | | | | | | | | | | | |
| premaxilla | | | | | | | | | | | | | | 1 | | | | | | |
| palatinum | | | | | | | | | | | | | | 1 | | | | | | |
| operculum | | 1 | | | | 1 | | | | | | | | | | | | | | |
| preoperculum | | 1 | | | | 3 | | | | | | | | | | | | | | |
| suboperculum | | | | | | 1 | | | | | | | | | | | | | | |
| epihyale | | | | | | | | | | | | | | 1 | | | | | | |
| urohyale | | | | | | 1 | | | | | | | | | | | | | | |
| pharyngeal bone | | 1 | | | | | | | | 1 | | 1 | | | | | | | | |
| cleithrum | | | | | | 2 | | | | | | | | | | | | | | |
| vertebra | | 1 | | | | | | | | | | | 1 | 1 | | 2 | | | | |
| fin ray/rib | | 1 | 2 | | | | | | | | | | | | | | | 1 | | |
| total | 1 | 5 | 2 | | | 8 | | | | 1 | | 1 | 1 | 4 | | 2 | | 1 | | |

Table 5. Measurements in domestic mammals from Hanghaus II/Ephesos.

| Element/sp. | a/p | Dating | Measurements | | | | |
|---|---|---|---|---|---|---|---|
| **BOS** | | | | | | | |
| Metatarsus | | | Bd | | | | |
| | | Flavian | 67.3 | | | | |
| Talus | | | GLl | GLm | Tl | Tm | Bd |
| | | Severian | 7 1.5 | 66.7 | 40.2 | 41.7 | 43.5 |
| Phalanx 1 | a/p | | GL(l) | Bp | KD | Bd | |
| | a. | Hellenistic | 63.9 | 30.2 | 25.3 | | |
| | a. | Severian | 63.2 | 30.4 | 25.4 | 27.2 | |
| | p. | Severian | 58.4 | 27 | 21.6 | 24.6 | |
| Phalanx 2 | | | | | | | |
| | a. | Flavian | 40.6 | 29.9 | 25.3 | 24.6 | |
| | a. | Severian | 40.8 | 33.3 | 25.3 | 27.4 | |
| | a. | Severian | 41 | 29 | 22.6 | 24.5 | |
| Phalanx 3 | | | GLS | Ld | MBS | | |
| | a. | Flavian | 82.5 | 64.2 | 29.8 | | |
| **CAPRA** | | | | | | | |
| Humerus | | | Bd | BT | | | |
| | | Flavian | 33.4 | 32.2 | | | |
| | | Severian | 30.3 | | | | |
| Radius | | | Bp | BFp | | | |
| | | Flavian | 31 | 28.7 | | | |
| Coxa (male, castr.) | | | KH | KB | | | |
| | | Flavian | 16.8 | 9.3 | | | |
| Talus | | | GLl | GLm | Tl | Tm | Bd |
| | | Flavian | 29.8 | 27.9 | 14.4 | 16.8 | 17.2 |
| Calcaneus | | | GL | GB | | | |
| | | Severian | 58.5 | 20.8 | | | |
| Metatarsus | | | Bp | KD | Bd | | |
| | | Severian | 22 | 13.1 | 27.2 | | |
| Phalanx 1 | a/p | | GL(l) | Bp | KD | Bd | |
| | p. | Hellenistic | 39.3 | 13 | 10.2 | 11.3 | |
| | a. | Flavian | 46.8 | 17.8 | 13.8 | 12.5 | |
| | a. | Flavian | | 16.1 | 11.9 | 14.3 | |
| | a. | Flavian | 38.2 | 14.2 | 11.6 | 13.1 | |
| | a. | Flavian | 36.1 | 12.6 | 10.5 | 12.6 | |
| | p. | Flavian | 43.2 | 12.7 | 10.6 | 13.1 | |
| | p. | Flavian | 41.3 | 13.2 | 11.5 | 12.9 | |
| | a. | Severian | 39.9 | 13.8 | 11 | 12.7 | |
| | a. | Severian | 38.2 | 13.2 | 10.9 | 14 | |
| Phalanx 2 | | | | | | | |
| | p. | Flavian | 32 | 15.3 | 10.3 | 11.7 | |
| | p. | Flavian | 26.9 | 12.9 | 9.2 | 10.2 | |
| | p. | Flavian | 24.1 | 10.6 | 7.9 | 8.7 | |

| Element/sp. | a/p | Dating | Measurements | | | | |
|---|---|---|---|---|---|---|---|
| **OVIS** | | | | | | | |
| Humerus | | | Bd | BT | | | |
| | | Severian | 36.6 | 34.5 | | | |
| Radius | | | Bp | BFp | | | |
| | | Hellenistic | 31.4 | 26.5 | | | |
| Ulna | | | TPA | KTO | BPC | | |
| | | Flavian | 25.8 | | | | |
| | | Flavian | 24.2 | 21.7 | 21.4 | | |
| Talus | | | GLl | GLm | Tl | Tm | Bd |
| | | Hellenistic | | 28.2 | 16.7 | | 17.8 |
| | | Flavian | | 27.3 | | | 19.8 |
| | | Severian | 28.6 | 27.1 | 16 | 17.2 | |
| Phalanx 1 | a/p | | GL(l) | Bp | KD | Bd | |
| | p. | Hellenistic | | | 10.1 | 11.8 | |
| | a. | Flavian | 41.8 | 15.0 | | | |
| | a. | Flavian | 36.9 | 12.8 | 9.8 | 11.7 | |
| Phalanx 2 | | | | | | | |
| | a. | Flavian | 28.6 | | 12.0 | 14.4 | |
| | ? | Severian | 26.9 | 12.1 | 8.9 | 10.6 | |
| **SUS** | | | | | | | |
| Atlas | | | GL | BFcr | BFcd | LAd | H |
| | | Flavian | 35.3 | 42.1 | 44.5 | 15.7 | 39.4 |
| Scapula | | | KLC | BG | | | |
| | | Flavian | 24.5 | 23.7 | | | |
| Humerus | | | Bd | | | | |
| | | Flavian | 36.8 | | | | |
| | | Flavian | 36.3 | | | | |
| Radius | | | Bd | | | | |
| | | Severian | 25.7 | | | | |
| Ulna | | | TPA | KTO | BPC | | |
| | | Flavian | 33.4 | 24.6 | 15.3 | | |
| Coxa | | | LA | LAR | LFo | | |
| | | Flavian | 33.2 | 29.4 | | | |
| | | Severian | 33.7 | | 40 | | |
| Talus | | | GLl | GLm | Tl | Tm | Bd |
| | | Flavian | 43.3 | 40.5 | | | |
| | | Flavian | 43.2 | 37.8 | | | |
| | | | | | 22.3 | | 22.6 |
| Metacarpus II | | | GL | LoP | Bp | KD | Bd |
| | | Hellenistic | 53.6 | | 6.1 | 5.4 | 9.6 |
| Metatarsus II | | Severian | | 49.4 | 4.2 | | 8 |
| Metatarsus V | | Severian | 57.7 | 56.5 | 5 | 8.9 | 8.8 |
| Phalanx 1 | | | GL(l) | Bp | KD | Bd | |
| | | Severian | 43.1 | 16.1 | 12.5 | 15.4 | |
| | | Severian | 32.2 | 15.3 | 12.1 | 13.5 | |
| Phalanx 2 | | Severian | 26.6 | 17.1 | 14.4 | 14.3 | |
| | | Severian | 22.5 | 16.4 | 14.3 | 15.4 | |
| Phalanx 3 | | | GLS | Ld | MBS | | |
| | | Severian | 26.5 | 25.8 | 9.5 | | |
| | | Severian | 26 | 24.8 | 9.5 | | |

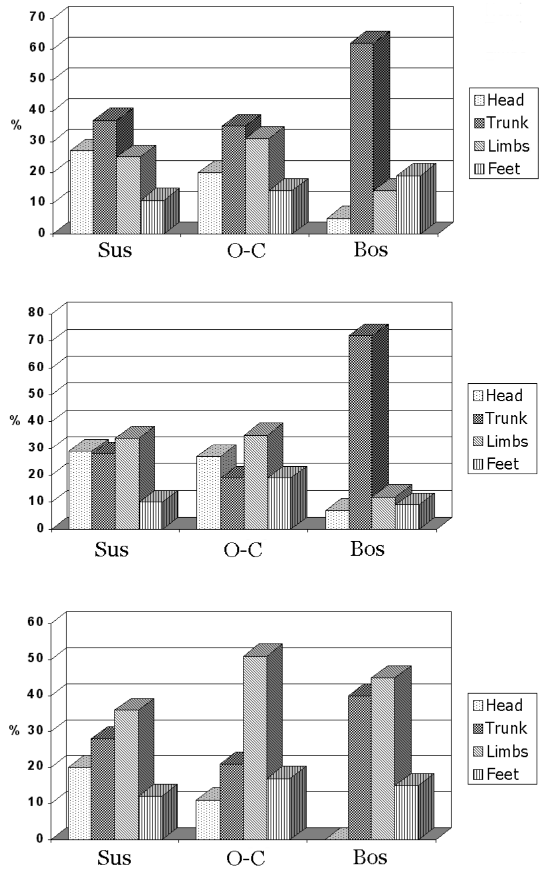


Fig. 7. Upper: Representation of skeletal elements (%), Severian layers (Sample A); Middle: Representation of skeletal elements (%), Flavian layers (Sample B); Lower: Representation of skeletal elements (%), Late Hellenistic layers (Sample C).

Skeletal remains from the main domestic species (Table 2b and Fig. 7b) display strikingly similar patterns to the Severian assemblages, especially concerning the remarkably high percentage of axial elements or the underrepresentation of head bones in bovine remains. Three specimens of worked cattle bone represent waste material from industrial bone working (following von den Driesch & Boessneck 1982).

Regarding the results of dental analysis, patterns of age distribution in pigs do not differ much from the Severian period (Fig. 4b). A main culling age during the second year of life is clear, indicating a probable preference for animals not older than 18 months. The proportion of animals slaughtered as juveniles at an age of 6-8 months amounts to 8% only, and three specimens indicate very young piglets. A rather high percentage of cranial remains (30%, Table 2b) allowed us to estimate preferential patterns of culling ages in caprines. While analysis of dental features (Fig. 4c) shows a dominance of adults slaughtered at an age of 3-5 years, morphological examination of the whole assemblage reveals a substantial amount (10%) of infantile specimens, indicating – similarly to the Severian finds – consumption of very young kids or lambs. Bovine remains represent mostly adult or adolescent individuals (>1.5 year). Juveniles (6-18 months) and younger calves (6m>) do not exceed 7 to 10 %.

Sediment sample B revealed the highest frequency of fish remains (67) and numerous mollusc remains (95) (Table 3; Table 4). Marine gastropods consist of two murex and triton shells (*Charonia sequenzia* Aradas & Benoit, 1876) (Fig. 9). Numerous shells of terrestrial snails appeared in sample B, too. Cockles are predominant among bivalves but mussels and oysters are numerous as well. Other bivalves such as wedge clam, dog cockles (Glycimeridae) and scallops are clearly less common. Forty-two specimens are indeterminable fish remains, consisting mainly of fragmented ribs and fin rays.

However, a fragmented hyomandibula is identified as "sea bream" (Sparidae) and a vertebra comes from a cartilaginous fish (Chondrichthyes). The size of this bone suggests it comes from a shark about 1.5 meter long. Four distinctively elongated and slender dentals (Fig. 10) provide evidence of moray eel (*Muraena helenea*). The freshwater fish fauna from sample B is very special because it contains an "exotic" catfish (*Clarias* sp.), which is represented by a pectoral fin ray (Fig. 10). Another raptor fish found here is pikeperch with two vertebrae. The remaining fish bones belong to cyprinids including eight specimens of bream (*Abramis brama*). Most of the bream remains are skull bones (Table: 4). A suboperculare and its corresponding preoperculare indicate the same individual. Further five remains represent carp and a single fragmented pharyngeal bone is from a roach (*Rutilus frisii*). The carp bones include a typical first fin spine of the dorsal or anal fin, a vertebra, a fragmented pharyngeal bone (Fig. 10), a preoperculum and finally an operculum.

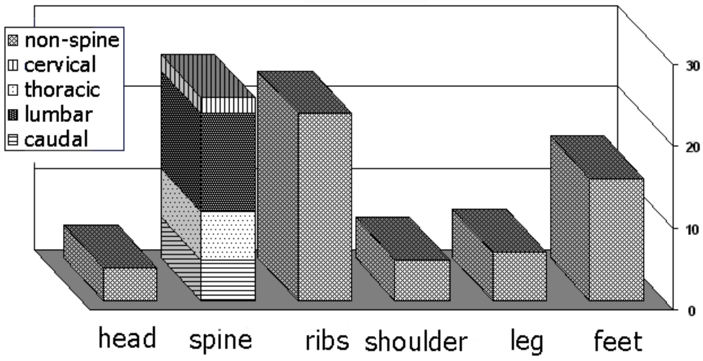


Fig. 8. Skeletal distribution (NISP) of bovine remains in Severian layers (Sample A).

*Sample C*

Hellenistic layers from room SR27 produced a rather small assemblage of faunal remains (total: 331 specimens, quantitative features in Table 1). However, distinct pecularities are detected in caparing samples A and B. Pig bones are clearly dominant in the faunal assemblage (Table 2c), while percentages of identifiable sheep and goats now are almost identical. The proportion of domestic fowl is rather high (almost 7%) and the spectrum of game remains is augmented by one metatarsal from fallow deer (*Dama dama* L. 1756). A buck coxa from room SR30 provides additional evidence for fallow deer. The Hellenistic date must remain provisional until stratigraphic analysis of these layers has been completed. Skeletal representation (Table 2c and Fig. 7c) differs clearly from what was found in the Severian and Flavian periods. The meat-bearing limbs are preferred, not only in caprines and pigs but also in cattle.

Due to scarcity of dental data, estimation of age distribution in all main domestic species had to depend on morphological evidence. A high degree of similarity to Severian and Flavian assemblages seems most likely although the percentage of juveniles and very young individuals is remarkably low.

Sample C contains the lowest frequencies of molluscs (27 specimens) and only four fish remains (Table 3, Table 4). Oysters are dominant, whereas cockles, mussels and dog cockles appear in lower frequencies. The four fish remains comprise an unidentifiable fish bone and two characteristic first indented fin spines from carp. Another spine shows the presence of spurdog (*Squalus acanthias*, Fig. 10). This calcified spine was situated in front of the second dorsal fin of the shark.

*Sample D*

Sample D contains 103 molluscs, 36 fish remains and a single crustacean remain (Table 3; Table 4). The crustacean is represented by a fragmented prawn claw. Murex is the most common species among the marine gastropods. Further, a triton shell and a limpet (*Patella* sp.) occurred in the sample. Terrestrial snails are represented by at least seven specimens of *Helix aspersa/lucorum*. Cockles, mussels and oysters are most common whereas all the other bivalves are significantly less common.

Twenty-four fragmented remains could only be identified as fish bones. The marine fishes included several species such as mullet (Mugilidae) represented by a cleithrum. Two remains came from groupers (Serranidae), a vertebra represents a big fish, probably a meter in length. The other bone is a fragmented dentale of a smaller specimen (*Epinephelus* sp.). Two of the remaining fish bones are premaxillae coming from sea bream and wrasse (Table 4, Fig. 10). The wrasse (*Labrus* sp.) is represented again by another element, a pharyngeal bone. The fresh water fishes consist of cyprinids and two pikeperch vertebrae. The cyprinid remains include a fragmented fin ray and an incompletely preserved operculum. The presence of a pharyngeal bone shows that roach (*Rutilus frisii*) may be found in this sample as well (Table 4).

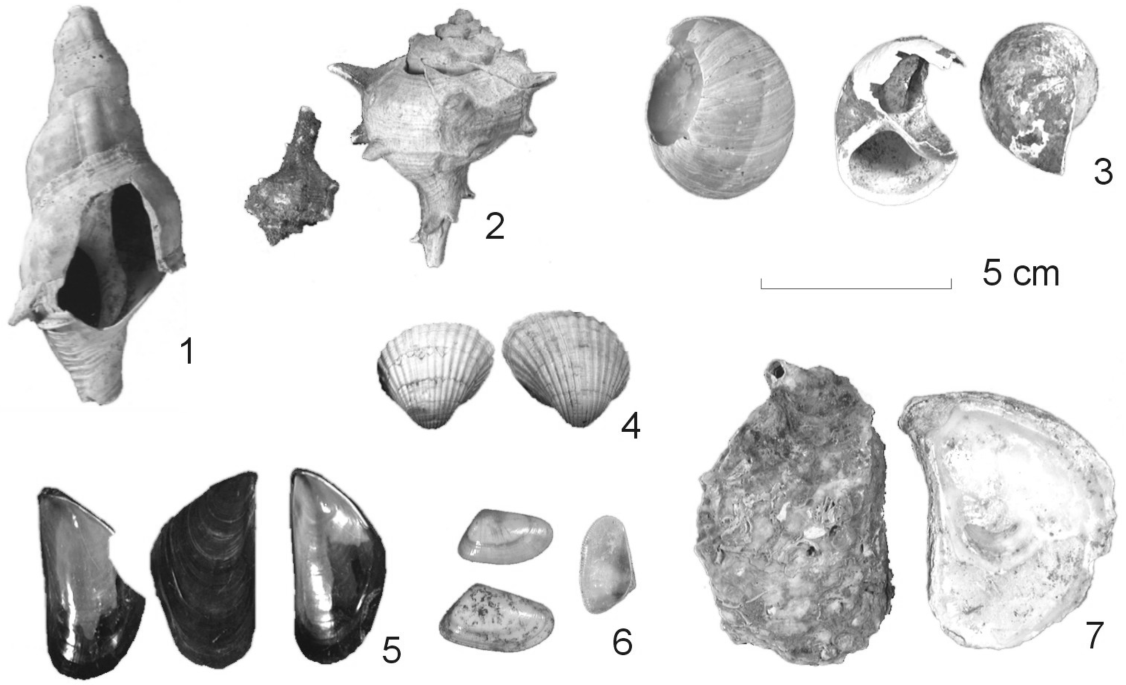


Fig. 9. Examples of molluscs consumed at Ephesos: 1. *Charonia sequenzia* Aradas & Benoit, 1876; 2. *Murex brandaris* Linne, 1758; 3. Helix sp.; 4. *Cerastoderma edule g*. Brugiere, 1789; 5. *Mytilus galloprovincialis* Lamarck, 1819; 6. *Donax semistriatus* Poli, 1795; 7. *Ostrea edulis* Linne, 1758.


Fig. 10. Examples of fishes consumed at Ephesos: 1a. urohyale &1b. preoperculum *Abramis brama*; 2. inf. pharyngeal bone *Cyprinus carpio*; 3a. dentale & 3b. palatinum *Stizostedion lucioperca*; 4. pectoral spine *Clarias* sp.; 5. premaxilla *Dentex*; 6. dentale *Muraena helena*; 7. second dorsal fin spine *Squalus acanthias*.

**Discussion and conclusions**

1. Testing hypotheses

The main goal of the present study was to test the plausibility of *a priori* hypotheses about the way these "spaces" were used, detected by, more or less, characteristic archaeological finds. Classifying animal remains according to a range of specified waste categories is a widely used procedure in order to determine origins and functional peculiarities of dumped food refuse (e.g. Barker 1982; Lyman 1994: 300). Three main categories are discernible:

1. Offal: waste produced by primary butchering of slaughtered animals. It usually comprises bovine heads and phalanges as well as caprine horn-cores, depending on traditions of meat division and sale. Sometimes bovine and caprine feet and other large elements of the bovine carcass are also present.
2. Kitchen waste: is produced by processing of meat, particularly boning of the carcass prior to preparation in a kitchen. This kind of waste contains mainly bovine limbs and often trunk parts of calves, pigs and caprines.
3. Table waste: The served meal consisted usually of already boned meat. However, animals such as poultry, small game, fish and molluscs can be recognized as table waste. Occasionally piglets and sometimes porcine heads and feet are typical table waste, too.

Skeletal representation of the main domestic species provides the first hint of how the samples studied from Hanghaus II (Figs. 7a-c) were processed. The remains of caprines and pigs coming from Severian and Flavian layers display rather "usual" patterns. A clear dominance of cattle bones from axial elements is obvious, while cranial parts are underrepresented. In Hellenistic layers limb bones dominate in all species, while bovine head bones are missing. With regard to waste categories, all three samples seem to be kitchen-refuse, although domestic butchering and probably slaughtering of pigs and caprines can be assumed. Beef might have been supplied in the form of cut meat quarters, obviously also including autopodials. When analyzing the quantitative representation of bovine remains from Flavian and Severian layers, there is a clear preponderance of axial elements, in particular fragments of lumbar vertebrae (Fig. 8). The overrepresentation of these elements indicates preferential consumption of meat cuts from the loin, which represented probably the best beef quality even in Roman times. In spite of careful recovery methods, table waste appears to be rather scarce. Remains of game and poultry are represented by only a few specimens. A taphonomic loss might be caused not only by commensal (i. e. rodent or carnivore) activity, but also by disposing this kind of garbage somewhere else.

A single left (lower) and 27 right (upper) oyster valves (*Ostrea edulis*) from room SR5c (Fig 11) also support this suggestion. Even nowadays, the flat upper valve of oysters will be discarded during meal preparation, while the mollusc body is served in its deeper lower shell. The ratio of upper and lower oyster shells from room SR5a is similarly distributed, containing fourteen upper and only a single lower valve. The Flavian sample B contained two basal and 8 very fragmented valves, whereas the ratio of upper and lower valves is quite balanced in sample C (9 upper, 7 lower and a very fragmented valve). However, it is remarkable that none of the three stratified samples contained complete oysters including both valves.

The majority of fish remains from Hanghaus II comprise cranial bones, whereas other bones like vertebrae are clearly underrepresented. An interpretation of this result is quite problematic because the fish remains were mainly handcollected. The fish bones show almost no butchering marks. Only a cyprinid vertebra has a cut mark. The cuttlefish might provide another hint for the interpretation of waste production. The shells will be usually removed from the cuttlefish before it becomes prepared. Additional results from fish and mollusc remains led to the interpretation of these samples as kitchen waste.

While analysis of skeletal representation seems to corroborate the *a priori* interpretations of the functional identification of samples A – C, the species composition and patterns of age distribution shed some light upon the social rank of the people producing this waste.

All samples from Hanghaus II show clear dominance of pig remains. This find is unique in Hellenistic and Roman sites in Asia Minor. Contemporary faunal assemblages from Troy (Uerpmann *et al*. 1992, Fabis 1996), Pergamon (Boessneck and von den Driesch 1985), Sagalassos (De Cupere and Waelkens 1998) and Pessinus (De Cupere 1994) yielded almost constantly more (by NISP only, due to partial lack of features needed to calculate MNI features) caprine remains, usually followed by cattle. The latter, thus, played a major role in meat supply. Only in Roman Pergamon, higher numbers of pig bones (few samples exceeding 35%) have been recovered. A clear preference for pig, on the other hand, is a characteristic feature of faunal assemblages from Roman Italy (Albarella *et al*. 1993).

Sample A produced the highest percentage of pig bones (67,7%), at the same time featuring a substantial number (20%) of young animals and a few skeletal remains of suckling pigs. A comparison of the animal remains with the detailed Diocletianic edict on prices (Lauffer 1971) reveals pork to be the most expensive meat. The image of a wealthy household emerges and it seems that the inhabitants of Severian Hanghaus II tried to maintain a metropolitan Roman lifestyle.

A male peacock cost 300 denarii, whereas one pound of beef cost 8 denarii. Pheasant or goose each had a value of 100-200 denarii per piece while a hare cost about 150 denarii. The high costs of these animals are consistent with a luxurious lifestyle, even more so if it proves true that most of the table waste was deposited outside the excavation areas of Hanghaus II. Considering that suckling piglets, kids or lambs like poultry were served with their bony carcasses (according to recipes by Apicius [Edwards 1984]), the scarce representation of the most expensive sort of pork (16 denarii/pound of live weight) is also not surprising.

Finds in sample B display clear similarities to the remains from Severian layers, although a slightly more humble life-style seems to be emphasized with regards to the economic background of waste production. Faunal remains from sample C obviously reflect different traditions of household activi-

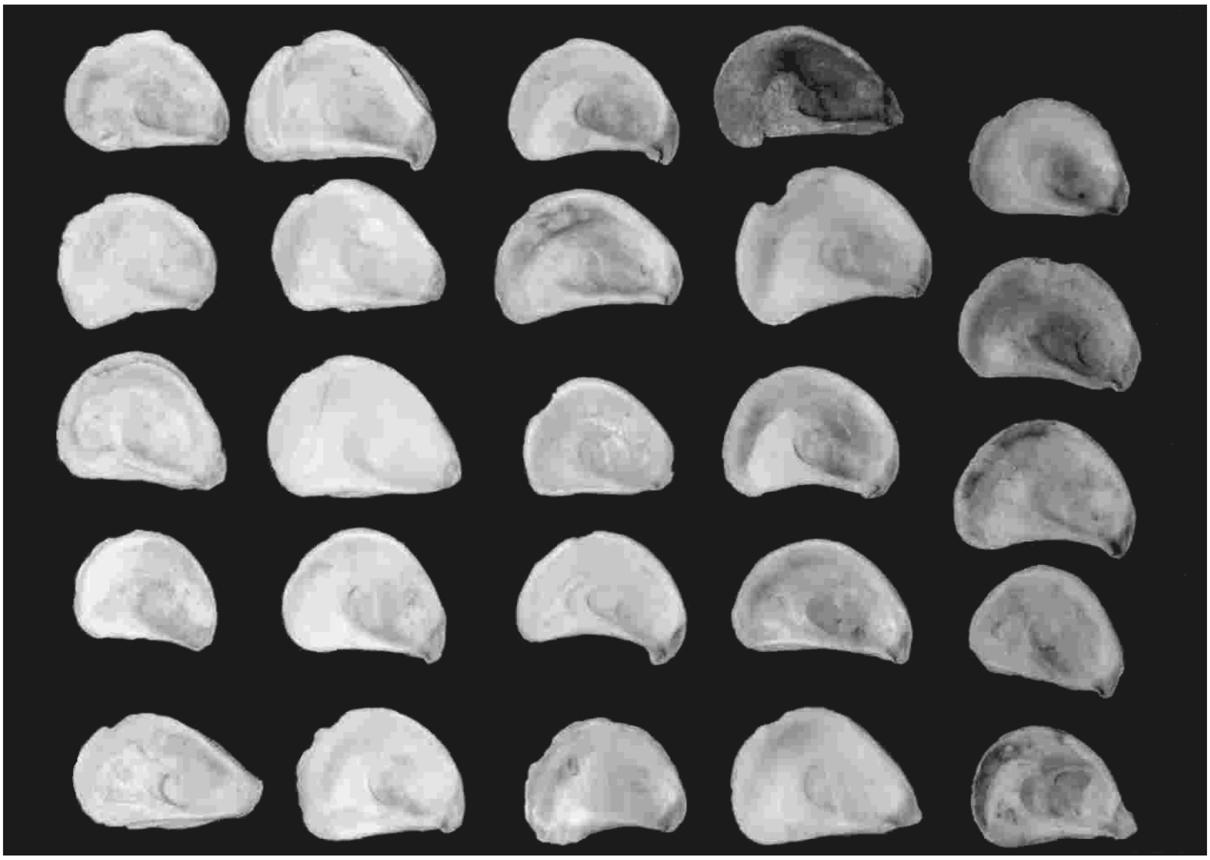

Fig. 11. Assemblage of right valves from *Ostrea edulis* Linne, 1758; from room SR 5c.

ties, characterized mainly by the particularities in the meat supply.

Nevertheless, the dominance of pig bones shows, that the first settlement phase on the northern slope of Bülbül daği was influenced by or even held to Italic Roman household customs. Certainly this interpretation still has to be tested with additional archaeological analysis. However, it is not the result of chronological differences, bearing in mind that Roman administration in Ephesos began in 133 BC, thus, demonstrating that these layers were coeval.

As far as mollusc and fish remains are concerned, the three stratified as well as the fourth non-stratified sample display, more or less, the same tendencies in their faunal assemblages. The differences are probably related to the frequencies of specimens. The samples with the highest frequencies of shellfish and fishes contain the highest species diversity of all the faunal assemblages. Worth noting, nevertheless, is the scarcity of fish bones and the absence of terrestrial snail shells in the Hellenistic assemblage. This find may be due to taphonomic loss as well as to gradual changes in the meals of the inhabitants from plain meals to rich banquets. Helicidae were greatly valued in Roman times. These snails were not only kept for "fattening" but also traded over long distances (Frank 1988) which possibly supports this idea though prices of terrestrial snails prove moderate (4 denarii per 20 first-class or 40 second-class pieces). Additionally, assemblages of domestic waste from Roman Pergamon (Boessneck and von den Driesch 1985) and from Late Hellenistic Kassope (Friedl 1984) yielded remarkable numbers of Helix shells.

## 2. Further conclusions

Some additional questions related to the main domestic species should also be discussed. Although osteometric data on cattle, caprines, and pigs are scarce, comparison with roughly contemporary data enables us to make rough estimations of average body sizes in Ephesian livestock.

The morphology of cattle as derived from autopodial dimensions (Table 3) is similar to ancient stocks from Hellenistic Kassope (Epirus [Friedl 1984]) and Roman Pergamon (Boessneck and von den Driesch 1985). The cattle represented rather large breeds with shoulder heights of 120 to 140 cm). These animals obviously differ from the small and slender cattle (heights not exceeding 125 cm), slaughtered at the Archaic Ephesian Artemision (Riezler 1993). The dimensions of sheep, goat and pigs lie within the size range of species from Kassope and Pergamon. Finally, special attention should be paid to the identifiable sheep-goat ratio. Though sample sizes are small, there seems to be an increasing significance of goat remains from Late Hellenistic through the Severian periods. This find does not coincide with contemporary evidence from western Asia Minor, where caprine remains from Troy (Fabiš 1996; Uerpmann *et al*. 1992), Pergamon (Boessneck and von den Driesch 1985), and Pessinus (De Cupere 1994) always display a greater abundance of ovine bones.

However, ratios of sheep and goat from Hellenistic and Roman Sagalassos (De Cupere & Waelkens 1998) and Limyra (Weissengruber and Forstenpointner, in study) are similar to those from Hanghaus II. Both sites are situated near the south coast of Asia Minor. Further investigations will be necessary to shed light on this important aspect of animal husbandry, especially concerning possible environmental degradations, deriving from excessive goat herding (Eastwood *et al*. 1998).

The shellfish assemblage contains typical edible bivalves and snails from the Mediterranean. Mussels, cockles and oysters were obviously the most important species. Other species such as scallops or wedge clam for example, were also consumed but their importance was similar to that of the terrestrial snails. Marine fishes such as sea bream, wrasse, grouper, mullets or moray eel indicate that there was inshore costal fishing, whereas sharks were probably caught in deeper waters. The rich assemblage of seashells, and especially the remains from cuttlefish usually demonstrate proximity to the sea. Long distance trade in such animals is only possible if they were specially preserved. In this case, Ephesos was situated close to the sea, although the bay became gradually silted up and the shoreline moved seawards. Troy, which is not far away from Ephesos, displayed similar hydrographic development. Freshwater fish species increased as the seashore moved northwards (Van Neer and Uerpmann 1998). Although fish bones from Ephesos are quite rare, it seems that the freshwater fishes became more important. This impression is undoubtedly strengthened by the highest frequency of fish remains in sample B.

However, cyprinids are well known from other archaeological sites in Turkey. Carp, for example, appeared in several sites in Minor Asia from the Bronze Age onwards. Carp bones are known from Demirçihüyük (Boessneck and von den Driesch 1987), Pergamon (Boessneck and von den Driesch 1985) and Pessinus in Central Anatolia (De Cupere 1994). Numerous evidences of carp came from the town Sagalassos. These specimens revealed the presence of wild carp (Van Neer *et al*. 1997). The distribution of carp or bream was assumed to be limited to the north of Turkey, to the Sea of Marmara and the rivers running into the east part of the Black Sea today (Ladiges 1960; Maitland 1978). However, recent investigations showed that these cyprinids have a wider distribution than expected (Van Neer 2000).

Evidence of pikeperch close to Ephesos is known in the river Meriç (river between Greece and Turkey), in the Küçükçekmece lagoon (W-Istanbul), and in the northern part of Turkey in the area of Temre-Samsun-Bafra (Berg 1965; Ladiges 1964; Sterba 1990). Archaeological remains of pikeperch are demonstrated from the neolithic settlement Fikirtepe near Kadiköy at the Marmara Sea (Boessneck and von den Driesch 1979) and from a well fill from Pergamon (Boessneck and von den Driesch 1985). Pikeperch was already identified in Hellenistic Ephesos (Forstenpointner *et al.* 1993) and the authors offered two explanations concerning possible origins for the piscivorous pikeperch.

The first interpretation was that pikeperch lived and was caught somewhere in the Kaystros or in other inland water near Ephesos. This solution was supposed to be improbable because the climate seemed to be unfriendly for pikeperch. However, forty years ago, pikeperch was successfully released into Anatolian lakes such as lake Egirdir and it may still be found there (Van Neer *et al*. 2000). The problem of the recent and ancient distribution of pikeperch has to be carefully studied in the future. In connection with other reasons for and signs of environmental degradation (Eastwood *et al*. 1998), it is worth investigating within a multidisciplinary research project. One way to solve such problems is to gather all available information about recent and ancient ecological developments using many branches of science. The second suggestion, the favored one (Forstenpointner *et al*. 1993), was that pikeperch was imported dried or salted from somewhere in the north of Turkey. Anyway, the presence of freshwater catfish *Clarias* sp. touches upon the same question of fish trade. This genus is usually thought to be a Nilotic fish and it appears to be a good example of long distance trade (Van Neer *et al*. 1997). However, recent studies showed that the westernmost distribution of *Clarias gariepinus* in present day Turkey is the Acisu and even the lower Aksu river (Van Neer *et al*. 2000). In any case, the fish remains of *Clarias* sp. demonstrates that there was a trade in these catfish because Ephesos is certainly situated too far west in Turkey, outside the natural range of this fish.

## References


Albarella U., V. Ceglia and P. Roberts, 1993. S. Giacomo degli Schiavoni (Molise): An early fifth century AD deposit of pottery and animal bones from Central Adriatic Italy. *Papers of the British School at Rome* 61: 157-230.

Barker G., 1982. The animal bones. In: D. Whitehouse, G. Barker, R. Reece and D. Reese (eds), *The Schola Praeconum I: The coins, pottery, lamps and fauna*. *Papers of the British School at Rome* 50: 81-91.

Berg L. S., 1965. *Freshwater fishes of the USSR and adjacent countries. Vol. 3*. Jerusalem, Israel Program for Scientific Translations.

Boessneck J. and A. von den Driesch, 1979. *Die Tierknochenfunde aus der neolithischen Siedlung auf dem Fikirtepe bei Kadiköy am Marmarameer*. Institutsschrift, Inst. Für Paläoanatomie, Domestikationsforschung und Geschichte der Tiermedizin, Univ. München.

Boessneck, J. and A. von den Driesch, 1985. *Knochenfunde aus Zisternen in Pergamon.* München, Uni Druck.

Boessneck J. and A. von den Driesch, 1987. Analyse der Reptilien-, Amphibien- und Fischknochen. In: Korfmann, M. (ed), *Demircihüyük. Die Ergbnisse der Ausgrabungen 1975 – 1978. Band II*. Naturwissenschaftliche Untersuchungen, Mainz am Rhein, Philipp von Zabern: 47-52.

Bonnichsen R., 1989. Constructing Taphonomic Models. In: R. Bonnichsen and M.H. Sorg (eds), *Bone modification.* Maine, Center for the Study of the First Americans: 515-526.

De Cupere B., 1994. Report on the faunal remains from trench K (Roman Pessinus, Central Anatolia). *Archaeofauna* 3: 63-75.

De Cupere B. and M. Waelkens, 1998. The antique site of Sagalassos (Turkey): Faunal results from the 1990-1994 excavation seasons. In: H. Buitenhuis, L. Bartosiewicz and A. M. Choyke (eds), *Archaeozoology of the Near East III. Proceedings of the third international symposium on the archaeozoology of Southwestern Asia and adjacent areas.* Groningen, ARC Publicatie 18: 276-284

Eastwood W.G., N. Roberts and H.F. Lamb 1998. Palaoecological and arcaheological evidence from himan occupance in southwest Turkey: The Beyşehir occupation phase. *Anatolian Studies* 48: 69-86.

Edwards J. (ed), 1984. *The Roman cookery of Apicius.* London, Century Publ.

Fabiš M., 1996. Archaeofaunal remains from the Lower Sanctuary. A preliminary report on the 1994 excavations. *Studia Troica* 6: 217-227.

Fechter R. & G. Falkner, 1990. *Weichtiere*. München, Mosaik Verlag.

Forstenpointner G., Scherrer, P., Schultz, O. & H. Sattmann, 1993. Archäologisch-paläoanatomische Untersuchungen an einer hellenistischen Brunnenanlage in Ephesos, Türkei. *Wiener Tierärztliche Monatsschrift* 80:216-224.

Frank Ch., 1988. Molluskenfunde aus Carnuntum. In: Jobst, W. *Amt der Niederösterreichischen Landesregierung, Neue Folge, 221*:15-54.

Friedl H., 1984. *Tierknochenfunde aus Kassope/Griechenland*. Unpublished DVM Dissertation, Veterinärmedizinische Fakultät München, Institut für Paläoanatomie, Domestikationsforschung und Geschichte der Veterinärmedizin.

Grant A., 1982. The use of tooth wear as a guide to the age of domestic ungulates. In: B. Wilson, C. Grigson, and S. Payne (eds.), *Ageing and sexing animal bones from archaeological sites.* Oxford, BAR British Series 109: 91-108.

Habermehl K.-H., 1975. *Die Altersbestimmung bei Haus- und Labortieren.* 2nd. ed., Hamburg & Berlin, P. Parey Verlag.

Karwiese S., 1995. *Groß ist die Artemis von Ephesos*. Wien, Phoibos Verlag.

Kerney M.P., Camoerin, R.A.D. & J.H. Jungbluth. *Die Landschnecken Nord- und Mittel-europas*. Hamburg & Berlin, P. Parey Verlag.

Ladiges W., 1960. Süsswasserfische in der Türkey. 1. Teil Cyprinidae. *Mitt. Hamburg. Zool. Mus. Inst*. 58:105-150.

Ladiges W., 1964. Süßwasserfische der Türkei. 3. Teil, restliche Gruppen. *Mitt. Hamburg. Zool. Mus. Inst.*, 61:203-220.

Ladstätter S., 1998. Die Grabungen in der Wohneinheit 2 des Hanghauses 2 in Ephesos. In: S. Karwiese *et al*., Ephesos. Grabungsbericht 1997. *Jahreshefte Österr. Archäolog. Inst.* 67 *Grab.*: 46-50.

Ladstätter S., unpubl. ms.1. *Die Grabungen 1996 in der Wohneinheit 1 im Hanghaus 2: Ein Beitrag zur Chronologie.*

Ladstätter S., unpubl. ms.2. *Ein flavischer Fundkomplex aus dem Hanghaus 2 in Ephesos.*

Lauffer, S. (ed.), 1971. *Diocletians Preisedikt.* Berlin, Walter de Gruyter.

Lemppenau U., 1964. *Geschlechts- und Gattungsunterschiede am Becken mitteleuropäischer Wiederkäuer.* Unpublished DVM Dissertation, Veterinärmedizinische Fakultät München, Institut für Paläoanatomie, Domestikationsforschung und Geschichte der Veterinärmedizin.

Lyman R.L., 1994. *Vertebrate taphonomy*. Cambridge Manuals in Archaeology, Cambridge, University Press.

Maitland P.S., 1978. *Elseviers gids van de zoetwatervissen*. Brussel, Elseviers.

Meadow R.H., 1980. Animal Bones: Problems for the Archaeologist together with some possible solutions. *Paleorient* 6:65-77.

Popovcak M., unpubl. ms. *Arbeitsbericht Ephesos I: Hanghaus 2, Raum SR 5a.*

Poppe G. and Y. Goto, 1993. *European Seashells*. Wiesbaden, Christa Hemmen.
Reed C.A., 1963. Osteo-archaeology. In: D. Brothwell and E. Higgs (eds), *Science in Archaeology.* New York, Basic Books: 204-216.
Riedel A., 1993. Die Tierknochenfunde des römerzeitlichen Lagervicus von Traismauer/Augustiana in Niederösterreich. *Annalen des Naturhistorischen Museums in Wien* 95: 179-294.
Riedl P., 1970. *Fauna und Flora der Adria*. Hamburg & Berlin, P. Parey Verlag.
Riezler B., 1993. *Tierknochenfunde aus dem Artemision von Ephesos. Die Wiederkäuer.* Unpublished DVM Dissertation, Veterinärmedizinische Universität Wien, Institut für Anatomie.
Skelton P.H. & G.G. Teugels, 1992. Neotype description for the African Catfish *Clarias gariepinus* (Burchell, 1822) (Pisces: Silurodiei: Clariidae). *Ichthyological Bulletin of the J.LB. Smith Institute of Ichthyology* 56:1-8.
Sterba G., 1990. *Süßwasserfische der Welt.* Leipzig, Urania Verlag.
Tornaritis, G., 1987. *Mediterranean sea shells (Cyprus).* Nicosia, Proodos.
Uerpmann H.-P., K. Köhler, E. Stephan, 1992. Tierreste aus den neuen Grabungen in Troia. Erster Bericht. *Studia Troica* 2: 105-121.
Van Neer W., B. De Cuepere, and M. Waelkens, 1997. Remains of local and imported fish at the ancient site of Sagalassos (Burdur Prov., Turkey). Waelkens, M. & J. Poblome (eds). Sagalassos IV. *Acta Archaeol. Lovansiensia Monographiea*, 9:571-586.
Van Neer W. and M. Uerpmann 1998. Fish remains from the new excavations at Troy. In: H. Buitenhuis, L. Bartosiewicz and A. M. Choyke (eds), *Archaeozoology of the Near East III. Proceedings of the third international symposium on the archaeozoology of Southwestern Asia and adjacent areas.* Groningen, ARC Publicatie 18: 243-254.
Van Neer W., R. Wildekamp, M. Waelkens, A. Arndt and F. Volckaert, 2000. Fish as indicators of trade relationship in roman times: the example of Sagalassos, Turkey. In: Mashkour, M., Choyke, A. M., Buitenhuis, H. & F. Poplin (eds). *Archaeozoology of the Near East IV B.* Groningen, ARC – Publicatie 32: 206-215.
Von den Driesch A. and J. Boessneck, 1982. Tierknochenabfall in einer spätrömischen Werkstatt in Pergamon. *Archäologischer Anzeiger* 1982: 563-574.
Wiplinger G., 1997. Die Wohneinheiten 1 und 2 im Hanghaus 2 von Ephesos. *Jahreshefte Österr. Archäolog. Inst.* 66 HB: 75-86.
Wiplinger G., 1998. Hanghaus 2, Wohneinheit 1 + 2. In: S. Karwiese *et al*., Ephesos. Grabungsbericht 1997. *Jahreshefte Österr. Archäolog. Inst.* 67 *Grab.*: 44-46.