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Archaeobotany: Macroremains

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Abstract
Palaeoethnobotany (or the shorter term, archaeo- botany) is the study of the "direct interrelationships between humans and plants for whatever purpose as manifested in the archaeological record."50 No matter what the time period or geographical area, plants played an important role in human culture. As primary data about the natural environment, land- use practices, diet, architecture, and trade in exotic plant materials, plant remains also reflect many as- pects of society, including social practices, such as eating, the organization of labor, and status differentiation.

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Archaeobotany: Macroremains

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Palaeoethnobotany (or the shorter term, archaeobotany) is the study of the "*direct* interrelationships between humans and plants for whatever purpose as manifested in the archaeological record."[50] No matter what the time period or geographical area, plants played an important role in human culture. As primary data about the natural environment, land-use practices, diet, architecture, and trade in exotic plant materials, plant remains also reflect many aspects of society, including social practices, such as eating, the organization of labor, and status differentiation.

The three major categories of archaeobotanical materials are macroremains, pollen, and phytoliths.[51] Macroremains are relatively large items that generally comprise the bulk of plant remains recovered from archaeological sites. They include seeds and seed-like plant structures, fruits, wood, leaves, tubers, etc. Typically, macroremains are recovered manually, by screening, and by flotation (fig. 7). Flotation enables the archaeologist to concentrate macroremains dispersed in the site matrix, usually by dissolving a soil sample in water.[52]

Fig. 7. Flotation system used to recover ancient plant remains at Gordion, Turkey, in 1988

No single category of remains provides a full picture of ancient plant use. When one considers the total amount of plant material intentionally brought to a site by ancient people (for food, fuel, fodder, construction, tools, and other artifacts), plus material unintentionally incorporated in the archaeobotanical record, one realizes that it is ordinarily the discards and residues of plant use that get deposited initially, a subset of which is eventually preserved (usually through carbonization, but sometimes under dry or waterlogged conditions).[53] Texts, too, are an important source of information that describe many aspects of the relationships between people and plants (e.g., agricultural treatises, receipts, recipes, and medical prescriptions). Yet such sources are often too limited or too general to provide more than a narrow window onto agricultural practices, the effects of land clearance, fuel-gathering, and irrigation, and all the other ways in which plants were integrated into the daily lives of ancient peoples. Thus, especially for the later periods, the information gleaned from texts complements, but does not supplant, that gained from detailed archaeobotanical studies.

Although archaeologists have been saving plant remains from archaeological sites since the mid-19th century, the systematic sampling of archaeological sediments by means of flotation is a relatively recent development. Prior to the pioneering work of Hans Helbaek[54] at Jarmo in Iraq, and later at Ali Kosh in southwestern Iran, botanists were brought in to identify obvious concentrations of plant remains, usually crops. It was not until the late 1960s that flotation techniques were brought to the attention of archaeologists in the Old and New Worlds, and

[50] R.I. Ford, "Paleoethnobotany in American Archaeology," in M.B. Schiffer ed., *Advances in Archaeological Method and Theory* 2 (New York 1979) 285–336.

[51] Palynology is discussed in the next section of this review.

[52] *Paleoethnobotany: A Handbook of Procedures* (San Diego 1989) by D.M. Pearsall is a comprehensive, practical introduction to palaeoethnobotany.

[53] C.W. Haldane, "Shipwrecked Plant Remains," *BiblArch* 53:1 (1990) 55–60.

[54] H. Helbaek, "The Palaeoethnobotany of the Near East and Europe," in R.J. Braidwood and B. Howe, *Prehistoric Investigations in Iraqi Kurdistan* (Chicago 1960) 99–118; and Helbaek, "Plant-Collecting, Dry-Farming, and Irrigation Agriculture in Prehistoric Deh Luran," in F. Hole et al., *Prehistory and Human Ecology of the Deh Luran Plain* (Ann Arbor 1969) 383–426.

through the 1970s, flotation was not routinely practiced. Most of archaeobotanical work concentrated on the origins of agriculture, the major problem as defined in the United States by anthropologically trained archaeologists and in Europe by prehistorians. Now, in the 1990s, the aceramic Neolithic is increasingly well understood, but comprehensive syntheses of the later Neolithic and beyond have yet to be written. Even the early civilizations of the third millennium B.C., which have been given a fair amount of archaeobotanical attention, are poorly known. Later historical periods have been particularly neglected, probably because of undue reliance on written records.[55]

Several reviews of research in the Near East and Europe summarize decades of work on plant remains from sites dating between Palaeolithic and medieval times.[56] A detailed example from recent work at Gordion, a site that culturally straddled the classical world and the ancient Near East, illustrates the kinds of questions one can ask of archaeobotanical data.

RECENT RESEARCH AT GORDION

Gordion, located on the Sakarya River in central Turkey, was the capital of ancient Phrygia. Excavations early in this century and more recent research directed by Rodney S. Young between 1950 and 1973 were completed before the systematic search for plant remains became standard practice. Plant remains recovered by Young's team were primarily construction material and food remains from the massive Early Phrygian destruction level, the log structures at the base of the "Midas Mound" (Tumulus MM), other burial mounds, and tomb furniture, also from the Early Phrygian period (ca. 700 B.C.).[57] Renewed excavations in 1988 and 1989 and archaeobotanical study have begun to fill out the picture of ancient plant and land-use practices at Gordion between the Late Bronze Age and medieval times.[58]

Reconstructing Ancient Vegetation and Human Influence

Over the past 3,000 years, human activities have had a more profound influence on the vegetation of the Sakarya valley than climate.[59] Land clearance for fuel and agriculture, the grazing of domesticated animals, and, in the Phrygian period, construction seem to have had the cumulative but gradual effect of reducing whatever natural tree cover there was. Gordion lies at the edge of the central Anatolian steppe, where remnants of oak and juniper woodland and pine forest still exist. Based on the modern distribution of trees, we infer that the impressive juniper and pine timbers found in Phrygian burial mounds and the settlement probably originated in woodland 20–50 km away.

To trace the history of ancient vegetation in more detail, less dramatic evidence from occupation debris must be gathered and analyzed. This plant material, nearly all of which is carbonized, comes primarily from the remains of fuel (wood, brush, and dung) and consists of wood charcoal and charred seeds. Many species are found that are unknown from the tombs or from the constructional and food remains of the burnt buildings. Since fuel is rarely transported from far away, fuel remains enable one to monitor the vegetation growing relatively close to a settlement. At Gordion, the analysis showed a decline in juniper relative to oak. The virtual absence of juniper *fuel* in contemporary Phrygian deposits suggests that juniper timber had already become a fairly rare material, reserved for or limited to use in the royal tombs. Trees that characteristically replace the climax vegetation of oak, juniper, or pine, along with components of riparian forest, show a gradual increase between the Late Bronze Age and the medieval period, though they never surpass 20% by weight of the assemblage.

Brush and dung fuel are potential sources of seeds in the archaeobotanical record, and the charred seed

[55] For a review of recent archaeobotanical research, see N.F. Miller, "The Near East," in W. van Zeist, K.-E. Behre, and K. Wasylikowa eds., *Progress in Old World Palaeoethnobotany* (Rotterdam 1991) 133–60.

[56] For a topically and geographically organized work that includes exhaustive discussions of the European archaeobotanical record, see van Zeist et al. (supra n. 55). *Domestication of Plants in the Old World* (Oxford 1988) by D. Zohary and M. Hopf provides a botanically oriented plant-by-plant discussion, and *Man's Role in the Shaping of the Eastern Mediterranean Landscape* (Rotterdam 1990) by S. Bottema, G. Entjes-Nieborg, and W. van Zeist is particularly informative on developments around the Mediterranean.

[57] E.g., H. Kayacık and B. Aytuğ, "Gordion Kral Mezarı'nın Ağaç Malzemesi üzerinde Ormancılık yönünden Araştırmalar (Recherches au point du vue forestier sur les matériaux en bois du tombeau royal de Gordion)," *İstanbul Üniversitesi Orman Fakültesi Dergisi* 18, series A (1968) 37–54; B. Aytuğ, "Le mobilier funéraire du roi Midas I," *PACT* 22 (1988) 357–68.

[58] M.M. Voigt, "Excavations at Gordion 1988–89: The Yassihöyük Stratigraphic Sequence," in D. French and A. Çilingiroğlu eds., *Proceedings of the 3rd International Anatolian Iron Age Symposium, 1990* (Oxford, in press); G.K. Sams and M.M. Voigt, "Work at Gordion in 1988," *XI. Kazı Sonuçları Toplantısı* 1 (Ankara 1990) 77–105; and Sams and Voigt, "Work at Gordion in 1989," *XII. Kazı Sonuçları Toplantısı* 1 (Ankara 1990) 455–70.

[59] Cf. S. Bottema and H. Woldring, "Anthropogenic Indicators in the Pollen Record of the Eastern Mediterranean," in Bottema et al. (supra n. 56) 231.

assemblage is a useful indicator of these alternative fuel sources; an increase in the ratio of seeds to charcoal suggests a decline in the use (i.e., availability) of tree wood. At Gordion, there is no dramatic shift in this ratio, which suggests that fuel use practices were relatively stable, despite some long-term disturbance in the tree cover.

Reconstructing Ancient Agricultural Practices

The seeds provide more than just evidence of fuel use. In the absence of cess deposits, seeds from burnt domestic structures provide the strongest evidence that a crop plant was grown for food, though fiber and fodder can usually not be ruled out.

Six-row barley and bread wheat dominate the crop seed assemblage in all periods. Einkorn wheat is a minor cereal, and rice occurs in only one medieval deposit. Lentils and bitter vetch comprise the bulk of the pulses. A burnt early Iron Age house had what appears to be baskets of barley, wheat, and bitter vetch on the floor. A small jar of tiny flax seeds found in the destruction level of Terrace Building 2A might be seed stock for the fiber plant, but the same room yielded small jars of other food crops, wheat, barley, and lentils, so the flax might have been human food. Grapes (a few seeds) were also found as were nutshells, perhaps from wild-growing almonds.

Plant remains may point to changes in irrigation practices, as indicated by crop choice, seed size/shape, and characteristic weeds. At Gordion, despite the unpredictable climate, very little "progress" is visible in the archaeobotanical record. For example, barley is more drought-tolerant than wheat, yet the proportion of these two crop plants remains constant through time. Irrigated grains tend to be plumper than unirrigated ones of the same species; at Gordion, size and shape of both wheat and barley are remarkably stable throughout the occupation. The expansion of a moist habitat—irrigation ditches or riverside vegetation—may be indicated by the apparent increase in the proportion of sedge seeds, which is consistent with the evidence of increased use of riparian vegetation. As trees by the river were cut, a sunny riverbank habitat would have opened up.

Stability characterizes Gordion crop choice. Small shifts in the proportion of einkorn wheat relative to six-row barley and bread wheat are therefore particularly intriguing. Einkorn was one of the earliest domesticated plants, but by 2000 B.C. it had dropped out of favor as an important cereal in the Near East.[60] In southern Europe, the presumed homeland of the Phrygians, it seems to have retained its value well into the Iron Age.[61] Thus, the apparent slight increase in einkorn coincidental with construction and ceramic shifts, suggestive of the Phrygian culture, may be further evidence of the arrival of these newcomers from Europe.[62]

CONCLUSION

Despite several decades of research, the full potential of archaeobotany for the investigation of ancient culture is yet to be realized. For both prehistoric and historical periods, plant remains enable us to assess human impact on the environment. As direct, site-specific evidence of agricultural and culinary activities, they can enrich our understanding of how people lived. Archaeobotanical research at Gordion is meant to show both skeptics and the converted how bits and fragments of charred remains help create a picture of the lives of ancient people and the landscape they shaped and inhabited.

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Ancient Palynology

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The study of micro- and macrofossils (including agricultural products such as carbonized hard grains—see the preceding section on Archaeobotany) in the Near East was stimulated by Robert J. Braidwood of the University of Chicago in the early 1960s. He sought to integrate archaeology and the natural sciences in his work on early prehistoric sites in Iran and Turkey. The botanical investigations of this proj-

[60] Miller (supra n. 55) 146–48.

[61] H. Kroll, "Südosteuropa," in van Zeist et al. (supra n. 55) 167, 174–75.

[62] Voigt (supra n. 58); R.C. Henrickson, "Politics, Economics, and Ceramic Continuity at Gordion in the Late Second and First Millennia B.C.," in W.E. Kingery ed., *Social and Cultural Contexts of New Ceramic Technologies* (Ceramics and Civilization 6, Westerville, Ohio 1993) 89–176.

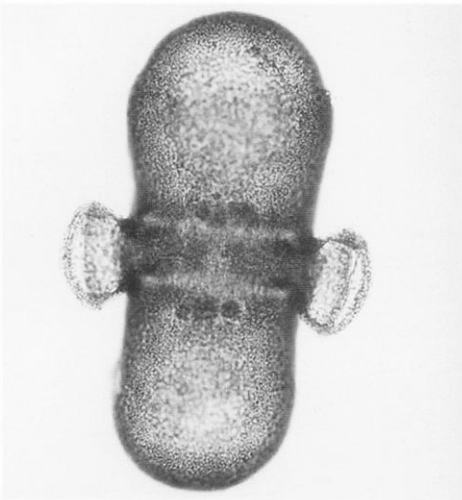

Fig. 8. Pollen grain of *Morina persica* of the teasel family, measuring ca. 100 μ in length (90 × magnification), with prominent protuberances on the sides from which the pollen tubes grow. From a Bronze Age tin mine in Kestel, Turkey, excavated under the direction of Aslıhan Yener, this *Morina* grain is the only one recovered by the author in 30 years of palynological investigation.

ect were carried out by a Groningen University team led by Willem van Zeist, and were subsequently extended to many other regions of the Near East.[63]

An important aim of ancient palynological research is to reconstruct the palaeoenvironment of early humans, which includes the human impact on the environment. To obtain the optimal information from pollen samples, the nature of typical microfossils needs to be understood. Thousands of pollen grains (fig. 8) are precipitated on each square inch of ground per year. Unless they are preserved under anaerobic conditions (e.g., under water), pollen will very rapidly disappear. The various pollen types are not equally sensitive to degradation, some being far more resistant than others. The identifiability of different pollen types also varies; while some pollen retain their characteristic features even after degradation, other pollen are impossible to identify even under weakly oxidative conditions.

Other factors also need to be considered in any palynological investigation. For example, the gradually accumulating sediments of lakes, peatbogs, and swamps incorporate enormous numbers of pollen, which can be well preserved if kept constantly wet. Yet, these pollen need not correlate with the activities of ancient peoples, whose settlements and encampments can be located away from such bodies of water. Samples from the archaeological site itself, on the other hand, have the disadvantage that they are dominated by Liguliflorae, mostly yellow flowering composites, which comprise a relatively small percentage of the total pollen rain. Furthermore, the accumulation of debris in a Near Eastern tell is often the result of the disintegration and leveling of mudbrick houses. Such mudbrick is made from clay that has its own history, i.e., it may contain pollen that derives from a time preceding the structure in which it was used and which therefore cannot be used to reconstruct the contemporaneous palaeoenvironment.

Pollen samples from water sediments usually enable the general vegetational development of a region to be reconstructed. The best sequences occur where rainfall exceeds 300 mm per year. This isohyet appears to be the minimum for the formation of pollen-bearing sediments. An exception is a pollen core from the salt flats of Bouara on the Syrian-Iraqi border,[64] where precipitation amounts to only about 150 mm. The Bouara salt flats form part of the Khabur valley, a region that was densely inhabited during Assyrian times.[65] The Assyrians, who dry-farmed and irrigated the fields elsewhere in the Khabur, evidently used the Bouara exclusively for salt-winning.

The collection of pollen samples is done by manually coring the sediments. The samples are identified in the laboratory, using a light microscope, generally under 400 × magnification.

PALAEOENVIRONMENTS IN PRE- AND POSTGLACIAL TIMES

Near Eastern pollen sequences or profiles (e.g., fig. 9) show a marked contrast in palaeoenvironmental development from the glacial period (Pleistocene) to postglacial (Holocene) times, i.e., pre- and post-10,000 B.P. (uncalibrated radiocarbon years). As dated by radiocarbon or by correlation with other

[63] See W. van Zeist and S. Bottema, *Late Quaternary Vegetation History of the Near East* (Beihefte zum Tübinger Atlas des Vorderen Orients A18, Tübingen 1991).

[64] W.H.E. Gremmen and S. Bottema, "Palynological Investigations in the Syrian Gazira," in H. Kühne ed., *Die rezente Umwelt von Tall Seh Hamad und Daten zur Umweltrekonstruction der assyrischen Stadt Dur-katlimmu* (Berlin 1991) 105–16.

[65] See Kühne (supra n. 64).

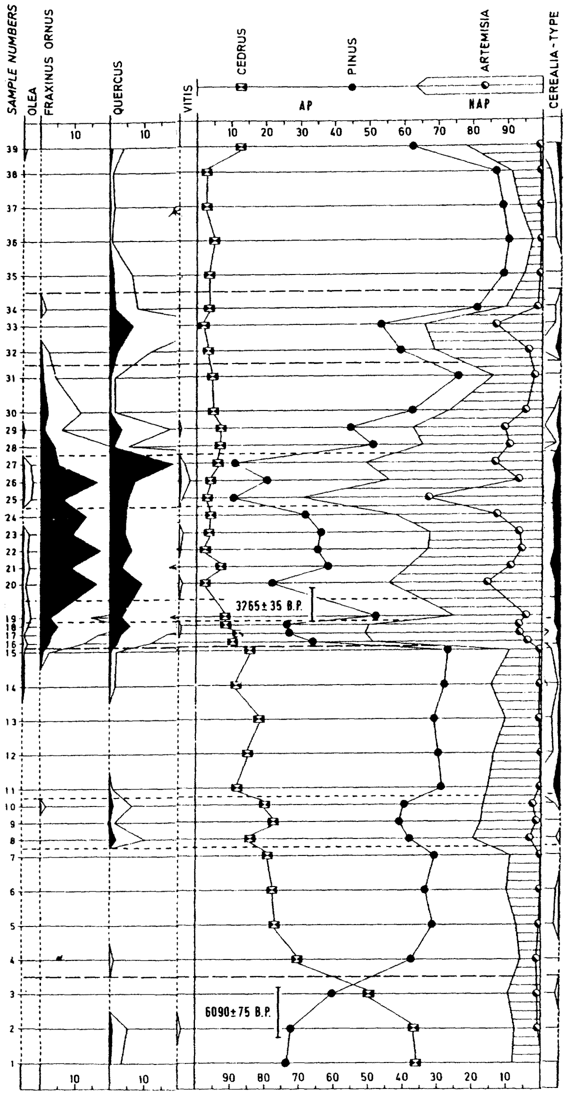

Fig. 9. Percentages of a selection of pollen types from a 5.5-m long core from Lake Beyşehir, Turkey, beginning about 6000 B.P. (bottom of the graph) and indicating an occupation phase, with greater amounts of edible fruits and nuts available, ca. 3200 B.P. (middle). The cumulative percentages of the most frequent arboreal types (AP) in each sample, *Cedrus* (cedar) and *Pinus* (pine), can be read along the top scale from left to right. On the left side of the diagram are shown less frequent arboreal types, including *Olea* (olive), *Fraxinus ornus* (manna-ash), *Quercus* (oak), *Vitis* (grape); individual percentage scales read from left to right. Non-arboreal types (NAP), including *Artemesia* (composite herbs and shrubs) and *Cerealia*-type (cereals), are shown to the right; their percentages are read along the bottom scale from right to left. The sum of the less frequent arboreal types is the difference between the cumulative percentages of AP and NAP. Dashed horizontal lines separate periods having similar vegetation and subject to similar environmental constraints, as inferred by the palynologist.

dated pollen profiles, the general picture for lower elevations (e.g., the Ghab valley of northwest Syria or Yenişehir in the Bursa area of western Turkey), as well as the higher Anatolian plateau of Turkey and the Zagros Mountains of western Iran, is that of a steppe landscape giving way to forest. This climatically induced change is locally influenced by developing farming communities, but the general trend of steppe herb pollen gradually being replaced by tree pollen has been demonstrated.

The process starts as early as 15,000 B.P. in northern Israel where relatively dense Tabor oak forests established themselves, only to decrease abruptly around 11,500 B.P. A climatic belt of rain that encouraged tree growth apparently moved farther north and east, leaving Israel much drier after this time.[66] The moist zone arrived in the Pisidian Lake district of southwestern Anatolia around 9000 B.P. In eastern Turkey, the Van district shows some increase in deciduous oaks at about 7000 B.P. In northwestern Iran, optimal conditions for tree growth were established around 5500 B.P. The forest development of the Pontic part of Turkey is very similar to that of northern Greece and large areas of Europe. If such vegetational patterns are translated into climatic terms, two main systems can be observed: a general European pattern that is uniform over a large area, and a shifting system that moves from the southern part of the Near East to the north and northeast. The latter moisture belt might have been caused by the gradual retreat of the large ice cap in northern Europe. This retreat, which started in the west and south, is likely to have caused a shift in the polar front that contributed to a moving moisture belt in the Near East.

EARLY AGRICULTURE

The pollen record also informs us about the impact of ancient man on the vegetation of a region, as well as the kinds of agriculture that were initiated during the Holocene period. In what kind of landscape did ancient agriculture develop, and what were the consequences for the environment? Pollen analysis provides answers to such questions if so-called indicator types (pollen that can be ascribed to human activity), which derive either from crops (pri-

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[66] U. Baruch and S. Bottema, "Palynological Evidence for Climatic Changes in the Levant ca. 17,000–9,000 B.P.," in O. Bar-Yosef and F.R. Valla eds., *The Natufian Culture in the Levant* (International Monographs in Prehistory, Archaeological Series 1, Ann Arbor 1991) 11–20.

mary types) or from weeds (secondary types), are present. The available pollen profiles generally show that these types increase slowly during Neolithic times (near the beginning of the Holocene period). Sometimes agriculture is known to have been practiced, as evidenced especially by carbonized cereal grains of wheat and/or barley that are known to have been early domesticates, but indicator pollen are lacking. This circumstance often arises when pollen types of the wild ancestors of our domestic cereals cannot be distinguished from those of a group of wild grasses. In addition, wheat and barley often disseminate little pollen into the air, because the pollen of these self-fertilizers remain in their glumes. Bread made from these cereals actually contains far more pollen than what is recovered from an ancient context exposed to pollen rain.

In sediment pollen profiles with no plants of economic importance represented, types related to the grazing of animals are often found. Weedy pollen types, which occur in the Near East and Europe (e.g., *Plantago lanceolata*, *Sanguisorba minor*, and *Rumex*) are good indicators.

Another noticeable change in pollen profiles that can be attributed to human impact on the environment is a decrease in forest pollen species. Around 4000 B.P., the first effects of the degradation of forests, which were burned for pasture and grazing land, are evident over large areas of the Near East. This development intensifies around 3200 B.P. Along the Mediterranean coast, the typical xerophytic vegetation replaces the former deciduous oak forest. In western Anatolia, arboriculture based on walnut, sweet chestnut, manna-ash, grape, and olive appears. At the same time, the plane tree spreads all over central and western Anatolia.[67]

CONCLUSIONS

An important focus of future palynological research in the Near East will be to define the specific constraints for human settlement, especially in the forest-steppe regions. In general, the pollen evidence needs to be integrated with and interpreted in light of the results from other disciplines (e.g., archaeobotany) and the available archaeological data to draw well-based conclusions.

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Faunal Analysis with a Focus on Anatolia

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INTRODUCTION

Analysis of animal bones (faunal analysis) has become increasingly common in Near Eastern archaeology.[68] Much of the first research focused on identifying animals exploited by Palaeolithic hunters and on the beginnings of animal domestication during the Neolithic. Recently, however, increasing numbers of faunal studies have been carried out on sites later than the Neolithic. Because analysis of animal bones began as early as the 1930s in Anatolia, that area provides a useful source of examples to underline some of the possibilities and problems of research that have changed over time.

GOALS

Perception of what faunal analysts do and should do varies among archaeologists and even among faunal specialists themselves. At one end of a continuum is faunal analysis as a set of procedures to identify and record animal bone remains with a view toward documenting the history of human impact on animals. People who work in this way often call themselves "archaeozoologists." At the other end is analysis and interpretation of faunal remains in the context of particular archaeological problems with a focus on interactions between humans and animals within specific social and cultural contexts. In-

[67] Bottema and Woldring (supra n. 59) 231–64.

[68] This essay is respectfully dedicated to the memory of Berrin Kuşatman (Doğan), whose tragic death at the age of 36 in May 1993 robbed Turkey of a dedicated faunal analyst with a bright future. Her Ph.D. dissertation titled "The Origin of Pig Domestication with Particular Reference to the Near East" (Institute of Archaeology, University College London, 1991) represents a remarkable piece of research on a difficult topic.