Environmental Studies: Overview and Context

David Meiggs

The rescue excavations at Zeugma in 2000 included three detailed investigations into land and environment. These derived from a sampling program supervised by Oxford Archaeology, which also identified personnel to undertake the technical reporting in the following chapters. The purpose of these prefatory remarks is to frame these technical reports within the context of recent research on the land and environment around Zeugma, and to interpret, in broad strokes, the collective impact of this data for analyses of life and culture at Zeugma as presented in chapters on architecture, decoration, and artifacts elsewhere in these volumes of final reports for Zeugma 2000.

Integrating disciplines toward a holistic approach to study of the human past is not new.[1] Indeed, a wide array of specialists now focus on the reconstruction of the environmental context of ancient societies. Information about past environment in the Near East can be roughly categorized into three main *sources* of data, regardless of the researcher's particular focus: 1) historical sources (e.g., ancient authors or later European travelers); 2) archaeological evidence (e.g., macrobotanical remains or fauna); and 3) an extensive variety of proxy measures of ancient environmental conditions (e.g., palynology, geomorphology, isotope measurements). Two problems occur in the effort to reconstruct past environmental conditions around Zeugma. First, each of these approaches has very different limitations, variations, and scales of analysis, and this presents difficulties for integration of data. Second, due to the nature of the available palaeoclimatic and archaeological record, data relating to southeastern Turkey in particular often must be interpolated from sources further afield.

PRESENT ENVIRONMENT

In order to better visualize the environment around Zeugma in the past, a sketch of the present climate and vegetation is helpful. Southeastern Turkey is part of a larger, well-defined geologic and geomorphologic region that extends into Syria to the south and east. Bounded by the Amanus and eastern Taurus (Anti-Taurus) to the west and north, the area around Zeugma is characterized by gently southward-sloping limestone plateaus (500–1000 masl) dissected by the Euphrates and its tributaries. Depressions, such as around Harran, are covered by alluvial soil. The region is bounded on the east by the Karacadağ volcanic massif and the terrain east of it toward Diyarbakir is substantially more rugged than that around Gaziantep and Urfa.[2] Precipitation is generally 400–600 mm per year and occurs mainly during the winter and spring months.[3] These amounts increase substantially toward the piedmont of the anti-Taurus (the "marginal folds") and the mountains themselves. This region of Turkey has likely always been well within the zone for rain-fed agriculture.[4]

The vegetation in southeastern Turkey has been less extensively studied than other areas of the Mediterranean, but some observations about Zeugma are possible. The ancient city was located on a boundary between two vegetation zones: the Mediterranean woodland climax, and the Irano-Turanian steppe.[5] The boundary of forest and steppe areas currently follows a jagged line connecting Nizip-Kızılın-Adiyaman-Siverek (along the right bank of the Euphrates) with forest delimited to the north and west.[6] The Mediterranean zone in southeastern Turkey can be subdivided into a gradient of forest and herbaceous vegetation beginning in the Amanus (Eu-Mediterranean), following the Taurus (Oro-Mediterranean), with the forest becoming increasingly sparse south and eastward (Xero-Euxinian), and grading into the Syrian steppe itself (Mesopotamian steppe).

Turkey has generally the richest flora in the Middle East.[7] Schematically, the main vegetative characteristics from west to east of the main subregions are as follows:

- EU-MEDITERRANEAN: largely evergreen oak (calliprini)–terebinth forest or maquis
- ORO-MEDITERRANEAN: deciduous pine (nigra)–oak (cerris) forest
- XERO-EUXINIAN: "temperate steppe-forest" with oak, pine, and increased herbaceous species (*Aremisietea anatolica*)
- MESOPOTAMIAN STEPPE: dominated by drought and saline-tolerant herbaceous species (*Artemisia herbae-albae*)

Vegetation of course changes with elevation, but along lines within major ecological associations (e.g., Eu- to Oro-Mediterranean). Amount of rainfall is an excellent proxy for the ability of various tree species to grow.[8] Thus the Amanus Mountains also contain species of fir, beech, and most notably cedar.[9] It is not unlikely that the cedar identified from Zeugma (see Gale, this volume) were imported the relatively short distance from these mountains.

During the Ottoman period, Gaziantep (Ayıntap) and Urfa were both located in the Halep vilayeti. An interesting comparison can be made between modern agricultural productivity in the region with that of the *First Statistical Yearbook of the Ottoman Empire*, published in 1897. The chart below lists the main agricultural products recorded for the Halep vilayeti and the combined totals in 1998 for the Gaziantep and Şanlıurfa İller, according to the Turkish State Institute of Statistics.[10]

The differences in agricultural productivity, where comparable, are not surprising. Wheat production in 1998 was just over six times the 1897 amount of 191,880 metric tons. It is difficult to estimate cotton production in metric units from 1897, but given the massive irrigation program around modern Harran from the reservoir behind the Atatürk Dam, it was undoubtedly relatively tiny. Changes in the movement of foodstuffs must also be reflected in these tallies, as the Ottoman population of the area must have had vegetable gardens and produced locally required necessities not recorded. Most striking, however, are the similarities in the two tallies. Wheat and barley continue to be the leading cereal crops, and while the ratio has inverted, sheep and goats are the main livestock.

Product	1897	1998
Cotton* (*pamuk*)[11]	975 tons[12]	4,924,188 tons
Wheat* (*buğday*)	191,880 tons	1,166,434 tons
Barley* (*arpa*)	79,950 tons	586,362 tons
Millet* (*darı*)	13,325 tons	—
Hemp* (*kenevir*)	5,552 tons	—[13]
Watermelons	n.r.	302,442 tons
Grapes	n.r.	227,404 tons
Red lentils* (*kırmızı mercimek*)	—	117,413 tons
Tomatoes	n.r.	114,715 tons
Melons	n.r.	54,316 tons
Maize* (*mısır*)	6,919 tons	28,674 tons
Olives	n.r.	24,920 tons
Goats* (*keçi*)	650,000	1,904,600
Sheep* (*koyun*)	1,350,000	428,080
Cattle* (*sığır*)	30,000	170,840
Chickens	n.r.	1,060,200
Population*	921,345	2,431,275

PAST ENVIRONMENT

There is evidence of occupation near Zeugma dating from the Upper Paleolithic period,[14] implying that even before the end of the Pleistocene ice age, the regional environment was rich enough to support a hunter-gatherer population. And it is only just east of Urfa that some of the most spectacular pre-pottery Neolithic sites in Turkey have been discovered.[15] This region, then, has been attractive for settlement throughout the human past. But reconstructing the environment around Zeugma from the third century B.C. to the seventh century A.D. requires interpolation of a dispersed set of sources and the result, by necessity, will be somewhat impressionistic. The discussion that follows will assess what can be gleaned from each of the three categories of data mentioned above, followed by a summary of the environment around Zeugma during its occupation in Graeco-Roman times.

Historical Sources

Technological development had reached a critical threshold by the Graeco-Roman period, and ancient testimony about human impact on the landscape around Zeugma reveals witnesses to striking changes. Large tracts of forest were disappearing, rivers and harbors were silting at increasing rates, and a number of animals were reduced to extinction.[16] Unfortunately, accounts of these phenomena do not convey sufficient detail, or appear with enough regularity, to render such observations useful for a systematic reconstruction of ancient climate and processes of human impact on the environment. Shaw points out, for instance, that although Pliny the Elder records the nearly complete deforestation of a particular mountain range in Algeria, later Arab geographers report "vast areas of forested shade for travelers" in North Africa as late as the 13th or 14th centuries.[17] Cuneiform documents, as well as European travelers in the 19th century, mention large forests in the mountains of Anatolia, particularly the Amanus and Anti-Taurus.[18] On the basis of this evidence, Rowton is even able to describe the mountains near Maraş as prime terebinth and oak forest in antiquity comparable to the Amanus, prized for cedar. The evidence from Zeugma confirms this.[19] Rowton observes that mountainous forests and urban settlements coexisted for millennia: "In the Bronze Age therefore the mountainous country of Western Asia was neither the great forest of prehistoric times nor the bare eroded country it is today."[20] Still, an increasing exploitation of lumber in the Graeco-Roman period is attested for building ships, mining, metal smelting, turpentine production, and preparation for grazing land.[21] Other pressures on the forest included lime and pottery production. Since the area around Zeugma straddles a boundary between forest and steppe vegetation, it likely was early affected by this reduction in forest vegetation.

Archaeological Evidence

Although indicators of past environment from archaeological sites are biased by the cultural proclivities of the former inhabitants and therefore are not necessarily representative, nonetheless they can illuminate patterns through time. Willcox's[22] survey of charcoal studies from a variety of sites and periods in areas surrounding Zeugma indicates that while progressive deforestation occurred throughout the Near East, actual extinction of forest species and development of the present environment was a relatively late phenomenon. The impression of a more diverse vegetation and moister climate in the past are supported by other charcoal studies in Turkey.[23] Willcox observes that sites in southern Syria possessed richer forest cover than at present, through the Islamic period, although human-induced pressure on the environment becomes particularly evident during the Roman period.[24]

Faunal and macrobotanical studies in the Near East echo the charcoal evidence, but the patterns are muted. Currently extinct (or rare) fauna at sites surrounding Zeugma are observed well into the Bronze Age. Among the 23 species represented at Bronze Age Arslantepe, onager, lion, and brown bear are present.[25] The lion is only represented by one bone, as is the case at Kurban Höyük.[26] The lion is reported in Anatolia by ancient authors into the Roman period,[27] but these finds underscore the basically economic nature of faunal remains at ancient sites;[28] the remains of domestic fauna (cattle and sheep/goats) are at least two orders of magnitude larger at both sites. The analysis of microfauna (mice, etc.) is argued to better reflect the environment, rather than cultural choices.[29] Interestingly, some portion of the faunal or macrobotanical collection is derived from wild sources at archaeological sites dating from the Neolithic to the Bronze Age and likely into the ancient period.[30] Despite the economic nature of faunal and macrobotanical assemblages, they still form an important part of any consideration of the interface between cultural decisions and climate variability in the past.[31] The remains from Zeugma are no exception. As Challinor and de Moulins note later in this volume, inhabitants at Zeugma apparently ate wild pistachios in quantity (terebinth) — a fruit apparently associated with Persian diet — even in the context of a typically Roman assemblage of cereals and fruits. Charles, also later in this volume, in discussing potential differences in exploitation of cattle, sheep, goats, and pigs, observes that the assemblage from Zeugma represents what would be expected locally (particularly in terms of fish).

Proxy Measures

One could argue that any of the means at our disposal to reconstruct the environment of the past are in some way by proxy. We choose, however, to group together a set of techniques in this section that utilize data generally not derived from archaeological sites per se: geomorphology, isotopic studies, and palynology. Each exhibits a particular set of interpretive constraints: geoarchaeological studies often have difficulty distinguishing between human and naturally induced events; the sources of variation in isotope values hamper researchers' ability to posit particular climatic changes, particularly with conflicting lines of evidence; and palynological studies often suffer from chronological imprecision, species representation in the sample, and the catchment from which the pollen accumulated.

Geomorphological studies in the Eastern Mediterranean have traced environmental changes through analysis of changes in lake stands,[32] glacial growth and recession,[33] and alluvial regimes.[34] Based on analysis of sedimentary sequences near Kurban Höyük (Keban), Wilkinson suggests the landscape suffered a considerable loss of vegetation based on rapid alluvial-fan aggradation likely beginning in the second millennium B.C., which might also be consistent with a population peak in the late Roman/early Byzantine period.[35] Near Kazane Höyük (Urfa region), study of channel fills suggests an environmental picture in three phases from the fifth millennium B.C. to the first millennium A.D. Importantly, the intermediate period between the Chalcolithic/Early Bronze (fifth–third millennia B.C.) phase and the late Roman phase (first millennium A.D.) is "indicative of either agricultural activity or deforestation of slopes."[36] This intermediate period correlates with Erol's conclusions from lake basins that an unstable climatic period began approximately 5,000–4,000 B.P., with three wet and dry oscillations since.[37] The presence of fluviatile gravels five meters above the present floodplain at Jerablus Tahtani, near the Turkish border in Syria, suggest major increases in flood volume during this period of instability (in this case, the late third millennium B.C.).[38]

There are a few isotopic proxies for climate, but currently the most common climatic indicator is oxygen ($\delta^{18}O$).[39] Analyses have been performed on lacustrine carbonates,[40] cave speleothems,[41] and organic remains.[42] Due to the complexity of the circulation within the Mediterranean Basin and multiple sources of variation in the oxygen isotope ratio ($^{18}O/^{16}O$) itself, interpretations drawn from such analyses should be viewed with a critical eye.[43] Differences in hydrologic conditions (evaporation rates, humidity, source precipitation) between geographic areas can obscure temporal trends in the record.[44] For instance, Yakir et al.[45] posit a more humid environment during the first century A.D., but Bar-Matthews et al.[46] suggest a drier and warmer climate than at present in the same area. The records from Lake Van[47] and Israel[48] would agree, however, with the conclusion that climate in the Eastern Mediterranean for the last 2,000–3,000 years has been unstable.

Of all the measures of past environment thus presented, by far the most abundant is palynology. In two seminal publications, van Zeist et al. and Bottema and Woldring summarize the major pollen records for the Eastern Mediterranean for the late Pleistocene and Holocene.[49] Not all of the available cores cover the same time depth, and Anatolia appears to be somewhat at a disadvantage, with relatively fewer sites conducive to palynological coring. Nonetheless, there are two pollen cores taken near Zeugma, at Gölbaşı, west of Adiyaman, and Bozova, northeast of Birecik.[50] Interpretations of warmer climate in the last two to three millennia is corroborated by the evidence of olive cultivation at elevations where they do not currently grow.[51]

The Gölbaşı core is dated at the bottom to 3,080 B.P. (calculated to ca. 1,460–1,160 B.C.) and is the longer of the two. The vegetative suite near the bottom of the core is dominated by oak, juniper, and pistachio, indicating an upland forest. Some tree/shrub pollen present in the core would have come from river valleys: walnut, plane, ash, alder, and willow. There may also have been hornbeam and hazel present in the vicinity of the lake. The authors consider that humans began to seriously interfere with the upland forest vegetation around the lake and began to intensively grow cereal crops beginning sometime a century or two after 900 B.C. and continuing to approximately A.D. 200, but the interpretation of anthropogenic pollen assemblages in terms of vegetation and agricultural practice remains difficult.[52] Roberts argues that vegetation and land-use histories in southern, and southwestern, Turkey broadly conform to a cyclical model of landscape change.[53] Based on the pollen diagram from Gölbaşı, it might be conjectured that a similar phenomenon occurred around Zeugma in the past. There is a marked decline in oak pollen at 12.5 m in the core, followed by a juniper peak. The oak percentages rise again between 11.5 and 11.0 m only to drop again, perhaps due to renewed clearance efforts. The oak values recover again and slowly decline to the present. For Zeugma, later in this volume Gale discusses vegetation around the city and effects of cultivation, orchards, and grazing.

The core from Bozova is consistent with a picture of this region as a transitional zone between vegetative regimes, although the bottom dates to 2,590 B.P. (ca. ninth–sixth century cal B.C.) and so covers a shorter period. The ratio of arboreal pollen to nonarboreal pollen is significantly different from the Gölbaşı core, showing the dominance of herbaceous species. The arboreal pollen present (perhaps wind-carried from some distance) echoes the trend of decreasing oak woodland seen at Gölbaşı. Here, fluctuations in some plant frequencies suggest changes in grazing pressures, or changes in the level of the lake itself. They observe the impact that recent intensified grazing has on the vegetation presently. These floral associations suggest that grazing was a substantial pressure on the environment around Bozova 2,000 years ago.

SUMMARY

All the evidence reviewed here suggests that, although there have been climatic fluctuations in the last three millennia, changes in the environment in southeastern Turkey are largely attributable to human influence. Ancient Zeugma likely enjoyed a more verdant and diverse environment surrounding the city than at present. Not too distant from the site would have been mountainous forests with oak, pine, and terebinth. River valleys in the north would have contained a diversity of hydrophilous trees. They may have observed higher flood peaks of the Euphrates, particularly as the region was gradually denuded. The average yearly temperature was likely warmer and, depending on the tracking of storms originating near Cyprus, precipitation would have been less extreme than at present (i.e., some summer precipitation). While there has been some (perhaps marked) variability in humidity in the region in the last 3,000 years, overall it was likely moister, with a drying trend towards the present.

During the late first millennium B.C., the environment would have been least like the present. With extensive mountainous forests to the north, onager, lions, and bears would have been present in the landscape (including species present today). Around the city, the landscape would have likely felt the effects of exploitation since the Bronze Age but may not have yet assumed its present state, with greater vegetation stabilizing the land, which would have appeared less eroded and desiccated. Irrigation may have supplemented natural rainfall for agricultural activities, as is well known from sites near Urfa and southward in the Balikh.[54] There would have been extensive grazing of livestock around the site.

By the end of the first millennium B.C., the forests in the north would have decreased substantially, with the climate gradually drying and precipitation regimes becoming more like the present. It is difficult to place the extinction of lions, bears, etc., but in all likelihood by the end of the of the Byzantine period, if not earlier, such animals would have altogether disappeared. Although the climate may not have changed noticeably in the last 3,000–4,000 years, the cycles observed in the vegetation are likely related to changes in the economic and political environment of the region. For instance, based on similar calculations to van Zeist et al. for the Gölbaşı core-date sequences, a reduction of grazing pressure seen in the Bozova core might be dated to ca. 120 B.C.–A.D. 60.[55] How well these changes can be correlated with historical events, though, is problematic, due to the low precision with which the pollen cores are dated.

By the end of the Islamic period, the landscape nearest Zeugma would have begun to assume its present appearance. The dramatic increase in population and the impact of development projects during the 20th century has served to reinforce those patterns.

CONCLUSION

The following contributions on the animal, charred, and charcoal remains at Zeugma document the complex relationships between cultural choices and environmental constraints. They provide an important record of what sorts of plants and animals people actually utilized, whether common in the surrouding landscape (see Gale's discussion of *Juglans*), imported, as was likely the case for *Cedrus*, or cultivated to satisify Roman (pomegranate) or Persian (terebinth) tastes (see Challinor and de Moulins). And particularly when considered in light of other environmental data, a picture of life beyond agricultural economy can emerge. While in general the results conform to general patterns common to Roman cities, these contributions also discern unusual aspects of life at Zeugma. Each chapter, in turn, discusses findings that add to the diversity of life in the Roman world, challenging the perception that complex trade networks and urbanization completely homogenized regional differences.

NOTES

1. Butzer 1982.
2. Erinç 1980.
3. Zohary 1973; UNESCO-FAO 1981.
4. Van Zeist et al. 1970; Wilkinson 1997.
5. Zohary 1973, map 7.
6. Van Zeist et al. 1970.
7. Davis et al. 1965; Zohary 1973, 73–5.
8. Rowton 1967.
9. This is dealt with in detail in Zohary 1973, 156–7 and chapters 15 and 17.
10. Halep vilayeti: Güran 1997. Website for Turkish State Institute of Statistics (T.C. Devlet İstatistik Enstisüsü): www.die.gov.tr. Website for 1998 agricultural information for Şanlıurfa. www.die.gov.tr/TURKISH/ISTATIS/Esg2/f.htm.
11. Asterisks denote categories mentioned both in the Ottoman census and modern Turkish records. Turkish names are included parenthetically to clarify categories tabulated. Other categories are not reported (n.r.).
12. Metric tonnages calculated from Ottoman measures, which were somewhat contextual. 1 *kile* of grain weighed 20.5 *kıyye* and a *kile* of chickpeas weighed 10 *kıyye*. A *kıyye* (*okka*) was equivalent to about 1.3kg.
13. No values are reported by the Turkish State Institute of Statistics, but van Zeist et al. (1970, 27) observed cultivation in the area.
14. Güldali and Deroche 1991.
15. cf. Özdoğan and Başgalen 1999.
16. Brice 1978; Erinç 1978.
17. Shaw 1981, 392.
18. Rowton 1967.
19. Gale, this volume.
20. Rowton 1967, 277.
21. Brice 1978; Wertime 1983.
22. Willcox 1992, 27–8.
23. Follieri and Coccolini 1983; Asouti and Hather 2001; Asouti 2003.
24. Willcox 1999. These sources should be considered alongside the data from Zeugma compiled by Rowena Gale; see Gale, this volume.
25. Bökönyi 1983.
26. Wattenmaker 1986.
27. Brice 1978.
28. Buitenhuis 1990.
29. Waelkens et al. 1999.
30. Neolithic: e.g., van Zeist and de Roller 1995; Fairbairn et al. 2002; Martin et al. 2002. Bronze Age: e.g., Bökönyi 1983; Follieri and Coccolini 1983; Wattenmaker 1986.
31. Esin 1998; Waelkens et al. 1999; Hillman et al. 2001. E.g., Gale's discussion of walnut use, later in this volume.
32. Erol 1978; Erol 1984; Erol 1997; Kuzucuoğlu et al. 1998; Erol 1999; Kashima 2002.
33. Erinç 1978; Farrand 1981, 394–6.
34. Eisma 1978; Kayan 1997; Wilkinson 1999.
35. Wilkinson 1999.
36. Wilkinson 1999, 559.
37. Erol 1997.
38. Wilkinson 1999.
39. cf. Gray 1981.
40. Schoell 1978; Leng et al. 1999; Stevens et al. 2001.
41. Bar-Matthews et al. 1997; Bar-Matthews et al. 1999.
42. Yakir et al. 1994; Goodfriend 1999.
43. For the the Mediterranean Basin, see Wigley and Farmer 1982.
44. Goodfriend 1999.
45. Yakir et al. 1994.
46. Bar-Matthews et al. 1997.
47. Lemcke and Sturm 1997.
48. Bar-Matthews et al. 1999.
49. Van Zeist et al. 1975. Bottema and Woldring 1984.
50. Van Zeist et al. 1970.
51. Roberts 1990, 61.
52. Bottema and Woldring 1990, 34.
53. Roberts 1990.
54. Wilkinson 1999.
55. Van Zeist et al. 1970.

BIBLIOGRAPHY

Asouti, E. 2003. "Woodland Vegetation and Fuel Exploitation at the Prehistoric Campsite of Pinarbasi, South-Central Anatolia, Turkey: The Evidence from the Wood Charcoal Remains." *JSA* 30:1185–201.

Asouti, E., and J. Hather. 2001. "Charcoal Analysis and the Reconstruction of Ancient Woodland Vegetation in the Konya Basin, South-Central Anatolia, Turkey: Results from the Neolithic Site of Çatalhöyük East." *Vegetation History and Archaeobotany* 10:23–32.

Bar-Matthews, M., A. Ayalon, et al. 1997. "Late Quaternary Paleoclimate in the Eastern Mediterranean Region from Stable Isotope Analysis of Speleothems at Soreq Cave, Israel." *Quaternary Research* 47:155–68.

———. 1999. "The Eastern Mediterranean Paleoclimate as a Reflection of Regional Events: Soreq Cave, Israel." *Earth and Planetary Science Letters* 166:85–95.

Bökönyi, S. 1983. "Late Chalcolithic and Early Bronze I Animal Remains from Arslantepe (Malatya), Turkey: A Preliminary Report." *Origini* 12:581–98.

Bottema, S., and H. Woldring. 1984. "Late Quaternary Vegetation and Climate of Southwestern Turkey, Part II." *Palaeohistoria* 26:123–49.

———. 1990. "Anthropogenic Indicators in the Pollen Record of the Eastern Mediterranean." In *Man's Role in the Shaping of the Eastern Mediterranean Landscape*, edited by S. Bottema, G. Entjes-Nieborg, and W. van Zeist, 231–64. Rotterdam: A.A. Balkema.

Brice, W.C. 1978. "The Desiccation of Anatolia." In *The Environmental History of the Near and Middle East since the Last Ice Age*, edited by W.C. Brice, 141–6. London: Academic Press.

Buitenhuis, H. 1990. "Archaeozoological Aspects of Late Holocene Economy and Environment in the Near East." In *Man's Role in the Shaping of the Eastern Mediterranean Landscape*, edited by S. Bottema, G. Entjes-Nieborg, and W. van Zeist, 195–205. Rotterdam: A.A. Balkema.

Butzer, K.W. 1982. *Archaeology as Human Ecology: Method and Theory for a Contextual Approach*. Cambridge: Cambridge University Press.

Davis, P.H., J. Cullen, et al. 1965. *Flora of Turkey and the East Aegean Islands*. 11 vols. Edinburgh: University Press.

Eisma, D. 1978. "Stream Deposition and Erosion by the Eastern Shore of the Aegean." In *The Environmental History of the Near and Middle East since the Last Ice Age*, edited by W.C. Brice, 67–81. London: Academic Press.

Erinç, Ş. 1978. "Changes in the Physical Environment in Turkey Since the End of the Last Glacial." In *The Environmental History of the Near and Middle East since the Last Ice Age*, edited by W.C. Brice, 87–108. London: Academic Press.

———. 1980. "Kültürel Çevrebilim Açisindan Güneydoğu Anadolu." In *The Joint Istanbul-Chicago Universities' Prehistoric Research in Southeastern Anatolia*, edited by H. Çambel and R.J. Braidwood, 65–81. Istanbul: Edebiyat Fakültesi Basimevi.

Erol, O. 1978. "The Quaternary History of the Lake Basins of Central and Southern Anatolia." In *The Environmental History of the Near and Middle East since the Last Ice Age*, edited by W.C. Brice, 111–36. London: Academic Press.

———. 1984. "Geomorphology and Neotectonics of the Pluvial Lake Basins in the Taurus Belt and South Central Anatolia." In *Geology of the Taurus Belt, Proceedings*, edited by O. Tekeli and M.C. Göncüoglu, 119–23. Ankara: Maden Tetkik ve Arama Enstitüsü.

———. 1997. "Geomorphologic Arguments for Mid- to Late Holocene Environmental Change in Central Anatolian (Pluvial) Lake Basins." In *Third Millennium BC Climate Change and Old World Collapse*, edited by H.N. Dalfes, G. Kukla, and H. Weiss, 321–50. Berlin: Springer-Verlag.

———. 1999. "A Geomorphological Study of the Sultansazligi Lake, Central Anatolia." *Quaternary Science Reviews* 18:647–57.

Esin, U. 1998. "The Aceramic Site of Aşıklı and Its Ecological Conditions Based on Its Floral and Faunal Remains." *TÜBA-Ar* 1:95–103.

Fairbairn, A., E. Asouti, et al. 2002. "Macrobotanical Evidence for Plant Use at Çatalhöyük, South-Central Anatolia, Turkey." *Vegetation History and Archaeobotany* 11:41–54.

Farrand, W.C. 1981. "Pluvial Climates and Frost Action during the Last Glacial Cycle in the Eastern Mediterranean: Evidence from Archaeological Sites." In *Quaternary Paleoclimate*, edited by W.C. Mahaney, 393–410. Norwich: Geo Abstracts.

Follieri, M., and G.B.L. Coccolini. 1983. "Palaeoethnobotanical Study of the VI A and VI B Periods of Arslantepe (Malatya, Turkey): Preliminary Report." *Origini* 12:599–617.

Goodfriend, G.A. 1999. "Terrestrial Stable Isotope Records of Late Quaternary Paleoclimates in the Eastern Mediterranean Region." *Quaternary Science Reviews* 18:501–13.

Gray, J. 1981. "The Use of Stable-Isotope Data in Climate Reconstruction." In *Climate and History: Studies in Past Climates and Their Impact on Man*, edited by T.M.L. Wigley, M.J. Ingram, and G. Farmer, 53–81. Cambridge: Cambridge University Press.

Güldali, N., and A.M. Deroche 1991. "Güneydoğu Anadolu'da Tarih Öncesi İnsanlarının Yaşam Ortamları: Özellikle Doğal Mağaralar." *Jeomorfoloji Dergisi* 19:131–8.

Güran, T. 1997. *Osmanli Devleti'nin ilk istatistik yıllığı, 1897*. Ankara: T.C. Başbakanlık Devlet İstatistik Enstitüsü.

Hillman, G., R. Hedges, et al. 2001. "New Evidence of Late Glacial Cereal Cultivation at Abu Hureyra on the Euphrates." *The Holocene* 11:383–93.

Kashima, K. 2002. "Environmental and Climatic Changes during the Last 20,000 Years at Lake Tuz, Central Turkey." *Catena* 48:3–20.

Kayan, I. 1997. "Bronze Age Regression and Change of Sedimentation on the Aegean Coastal Plains of Anatolia (Turkey)." In *Third Millennium BC Climate Change and Old World Collapse*, edited by H.N. Dalfes, G. Kukla, and H. Weiss, 431–50. Berlin: Springer-Verlag.

Kuzucuoğlu, C., R. Parish, et al. 1998. "The Dune Systems of the Konya Plain (Turkey): Their Relation to Environmental Changes in Central Anatolia during the Late Pleistocene and Holocene." *Geomorphology* 23:257–71.

Lemcke, G., and M. Sturm 1997. "d^{18}O and Trace Element Measurements as Proxy for the Reconstruction of Climate Changes at Lake Van (Turkey): Preliminary Results." In *Third Millennium BC Climate Change and Old World Collapse*, edited by H.N. Dalfes, G. Kukla, and H. Weiss, 656–78. Berlin: Springer-Verlag.

Leng, M.J., N. Roberts, et al. 1999. "Late Quaternary Palaeohydrology of the Konya Basin, Turkey, Based on Isotope Studies of Modern Hydrology and Lacustrine Carbonates." *Journal of Paleolimnology* 22:187–204.

Martin, L., N. Russell, et al. 2002. "Animal Remains from the Central Anatolian Neolithic." In *The Neolithic of Central Anatolia: Internal Developments and External Relations in the 9th–6th Millennia cal BC*, edited by F. Gérard and L. Thissen, 193–206. Istanbul: Ege Yayinlari.

Özdoğan, M., and N. Başgalen, eds. 1999. *Neolithic in Turkey: The Cradle of Civilization, New Discoveries*. Istanbul: Arkeoloji ve Sanat Yayınları.

Roberts, N. 1990. "Human-Induced Landscape Change in South and Southwest Turkey during the Later Holocene." In *Man's Role in the Shaping of the Eastern Mediterranean Landscape*, edited by S. Bottema, G. Entjes-Nieborg, and W. van Zeist, 53–67. Rotterdam: A.A. Balkema.

Rowton, M.B. 1967. "The Woodlands of Ancient Western Asia." *JNES* 26:261–77.

Schoell, M. 1978. "Oxygen Isotope Analyses on Authigenic Carbonates from Lake Van Sediments and Their Possible Bearing on the Climate of the Past 10,000 Years." In *The Geology of Lake Van*, edited by E.T. Degens and F. Kurtman, 92–7. Ankara: The Mineral Research and Exploration Institute of Turkey.

Shaw, B.D. 1981. "Climate, Environment, and History: The Case of Roman Africa." In *Climate and History: Studies in Past Climates and Their Impact on Man*, edited by T.M.L. Wigley, M.J. Ingram, and G. Farmer, 379–403. Cambridge: Cambridge University Press.

Stevens, L.R., H.E. Wright, Jr., et al. 2001. "Proposed Changes in Seasonality of Climate during the Lateglacial and Holocene at Lake Zeribar, Iran." *The Holocene* 11:747–55.

UNESCO-FAO. 1981. *Soil Map of the World*. Vol. 5, *Europe*. Paris: UNESCO.

Waelkens, M., E. Paulissen, et al. 1999. "Man and Environment in the Territory of Sagalassos, a Classical City in SW Turkey." *Quaternary Science Reviews* 18:697–709.

Wattenmaker, P. 1986. "The Organization of Production and Consumption in a Complex Society: A Study of a Village Site in Southeast Turkey." *MASCAJ* 4:191–203.

Wertime, T.A. 1983. "The Furnace versus the Goat: The Pyrotechnologic Industries and Mediterranean Deforestation in Antiquity." *JFA* 10:445–52.

Wigley, T.M.L., and G. Farmer. 1982. "Climate of the Eastern Mediterranean and the Near East." In *Palaeoclimates, Palaeoenvironments and Human Communities in the Eastern Mediterranean Region in Later Prehistory*, edited by J.L. Bintliff and W. van Zeist, 3–37. BAR-IS 133. Oxford: British Archaeological Reports.

Wilkinson, T.J. 1997. "Environmental Flucutations, Agricultural Production and Collapse: A View from Bronze Age Upper Mesopotamia." In *Third Millennium BC Climate Change and Old World Collapse*, edited by H.N. Dalfes, G. Kukla, and H. Weiss, 67–106. Berlin: Springer-Verlag.

———. 1999. "Holocene Valley Fills of Southern Turkey and Northwestern Syria: Recent Geoarchaeological Contributions." *Quaternary Science Reviews* 18:555–71.

Willcox, G. 1992. "Timber and Trees: Ancient Exploitation in the Middle East: Evidence from Plant Remains." *Bulletin on Sumerian Agriculture* 6:1–31.

———. 1999. "Charcoal Analysis and Holocene Vegetation History in Southern Syria." *Quaternary Science Reviews* 18:711–6.

Yakir, D., A. Issar, et al. 1994. "C-13 and O-18 of Wood from the Roman Siege Rampart in Masada, Israel (AD 70–73): Evidence for a Less Arid Climate for the Region." *Geochimica et Cosmochimica Acta* 58:3535–9.

van Zeist, W., and G.J. de Roller. 1995. "Plant Remains from Asikli Höyük, a Pre-pottery Neolithic Site in Central Anatolia." *Vegetation History and Archaeobotany* 4:179–85.

van Zeist, W., R.W. Timmers, et al. 1970. "Studies of Modern and Holocene Pollen Precipitation in Southeastern Turkey." *Palaeohistoria* 14:19–39.

van Zeist, W., H. Woldring, et al. 1975. "Late Quaternary Vegetation and Climate of Southwestern Turkey." *Palaeohistoria* 17:53–143.

Zohary, M. 1973. *Geobotanical Foundations of the Middle East*. Stuttgart: G. Fischer.