BOTANICAL ASPECTS OF ENVIRONMENT AND ECONOMY AT GORDION, TURKEY

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Chapter 1
Archaeological Background

The archaeological site of Gordion is most famous as the home of the Phrygian king, Midas, and as the place where Alexander the Great cut the Gordian knot on his way to conquer Asia. Located in central Anatolia near the confluence of the Porsuk and Sakarya rivers, Gordion also lies on historic trade routes between east and west as well as north to the Black Sea. Very favorably situated for long-distance trade, Gordion's setting is marginal for agriculture. It is therefore not surprising that with the exception of a single Chalcolithic site (Kealhofer 2005), the earliest settlements in the region are fairly late—they date to the Early Bronze Age (late 3rd millennium B.C.). The earliest levels of Gordion, too, date to the Early Bronze Age, and occupation of at least some part of the site was nearly continuous through at least Roman times (early 1st millennium B.C.); a small Medieval settlement is also attested (Voigt 2005). Pre-Chalcolithic occupation in this part of the Sakarya valley is evidenced by abraded Paleolithic flint tools that erode out of (Pleistocene) conglomerates and occasionally turn up in flotation samples and other excavated sediments.

Gordion is known through both history and archaeology. The best-known ancient references to Phrygian Gordion and its king Midas are found in Herodotus' Histories. Other ancient references, mostly Greek, occur in the works of Xenophon, Arrian, and Plutarch. Modern archaeological interest in Gordion came through Classicists' knowledge of ancient Greek contact with the Phrygian world. The ancient mound, whose local name is Yassıhöyük, was identified as Gordion and excavated by two railroad engineers, Gustav and Alfred Körte (Körte and Körte 1904). A University of Pennsylvania team led by Rodney S. Young, a professor of Classical Archaeology, began excavations in 1950.

Young's excavations (1950–1974) focussed on the Early Phrygian levels at Gordion and Early Phrygian burial mounds. This work established a rough chronological framework. Analysis and conservation continued after Young's death in 1974. Fieldwork, however, was suspended until 1988, when the University of Pennsylvania Museum reinaugurated excavation under the direction of Mary M. Voigt. Voigt established a stratigraphic sequence for the site based on the excavation of 1988 and 1989. (For the history of the excavations, see Sams 2005; Voigt 2005.) Since the 1990s, extensive excavation of Phrygian and later deposits has been carried out. Analysis of those archaeobotanical remains has just begun (Marston 2003; Miller 2007).

Charrred plant remains from Gordion provide the best evidence for tracing long-term changes in vegetation and plant use that in turn reflect many aspects of ancient economy and society in the Sakarya basin over several millennia. Some of the specific questions that are considered concern the nature of the original vegetation, relationship between agriculture and pastoral production, irrigation, and ethnic markers. Paleoethnobotanical research is an integral part of the renewed program of excavation and surface survey at Gordion that was initiated in 1987 by The University of Pennsylvania Museum in cooperation with the University of North Carolina, Chapel Hill. This report deals with materials from the Late Bronze Age to the Medieval period archaeobotanical assemblage excavated during the 1988 and 1989 seasons at Gordion. The assemblage consists of charcoal hand-picked during excavation and charred seed and wood remains obtained by the flotation of systematically collected soil samples. In subsequent years, the author conducted informal botanical surveys in the region and collected voucher specimens and comparative material housed at the Museum Applied Science Center for Archaeology (MASCA) at the University of Pennsylvania Museum, Philadelphia. This work has informed both the identifications and interpretations presented here.

Stratigraphy and Chronology

The most prominent sites in archaeological region in which Gordion lies are Gordion itself and nearly 100 Phrygian period burial mounds. Archaeological surveys have recorded sites mostly dating between the Early Bronze Age and the modern era (Kealhofer 2005). Gordion is comprised of the 6-ha Yassıhöyük (literally, "flat mound"), also referred to as the the Citadel Mound or City Mound of Gordion, which is surrounded by a lower town and fortification system (Küçük Höyük and Ku{s} Tepe) that together cover an additional [13?] ha. In the mid-first millennium B.C., settlement expanded to an outer town with an area estimated to be about one square kilometer. The plant remains discussed in this report all come from excavations in the eastern part of Yassıhöyük.

The excavation of 1988/89 was limited to the Yassıhöyük City Mound. Young's work had exposed the royal precinct, or at least elite quarter, of the Early Phrygian period, about 5 m below the modern surface; the excavated area covers about 2.5 ha (Voigt and Henrickson 2000a:39). To minimize the amount of area that would have to be excavated, Voigt set the upper excavation units (Operations 1, 2, and 7) at the edge of the main excavation. Physically but not stratigraphically discontinous, the lower units (Operations 3–6; 8–11; 14 [below 3–6]) were placed in an Early Phrygian courtyard area, to avoid extant building remains; the wall stubs from that level are preserved for touristic purposes (Figure1.1). The project used a lot and locus system for excavation, recording and analyis. In particular, a lot represents a contiguous unit of excavated earth, ideally from a single depositional stratum; it is the basic unit of excavation. A locus is comprised of one or more contiguous lots that ideally represent a "significant stratigraphic unit." Lots and loci may also be arbitrarily defined (for example, exploratory trenches). A shorthand representation of the stratigraphic analysis, Voigt developed the YHSS numbering system to aid in the recording and sorting of the various data classes generated by the project.

The Yassıhöyük Stratigraphic Sequence and characteristics of deposits sampled for botanical remains

The Yassıhöyük Stratigraphic Sequence (YHSS) assigns the strata to broad chronostratigraphic units that roughly correspond to more traditional archaeological periods. Numbered one to ten from top to bottom (Table 1.1), each of these large units is divided into a series of stratigraphic contexts defined with a minimum three-digit code (thus, deposits within YHSS 7 are assigned a number between 700 and 799). Decimal places are added as the complexity and understanding of the deposits warrant (thus, 725 is a floor deposit of a burned building in YHSS 7, and 725.04 is an oven within that building). The Early Phrygian Destruction level (YHSS 6A) is at the base of the upper trenches and top of the lower ones. Voigt has discussed the stratigraphy and the cultural and historical associations in detail (Voigt 1994). The discussion here emphasizes the time periods for which there is substantial archaeobotanical data.

Middle Bronze Age (YHSS 10). These deposits pre-date 1500 B.C. A single deposit was sampled; two samples from an erosion surface were analyzed.

Late Bronze Age (YHSS 8–9), c. 1500–12th century B.C. Initially YHSS 9 was assigned to the Early Hittite Empire period; the excavated area (and flotation samples taken) consisted primarily of lensed trash and some exterior surfaces; there were no structures. YHSS 8 was assigned to the Late Hittite Empire. The only structure was single-room CBH [cellar], lined with stone, with no internal features. Samples analyzed from this phase are mainly from pits, a hearth, and floor deposits. According to Voigt, samples from YHSS 8 and 9 can be grouped for comparisons with the Early Iron Age and later deposits, since there is no break in the cultural sequence at this time (Voigt 1996).

Early Iron Age (YHSS 7), c. 12th century–950 B.C. The Early Iron Age deposits are analyzed in three stratigraphic groups. Samples from the earliest, YHSS 7B (stratum numbers 730 and higher), come from various features (ovens, pits) associated with domestic structures and activities. A burnt reed structure (GBR/BRH, stratum number 725) is the earliest group of deposits assigned to YHSS 7A. Due to the in situ charring, the floated material is not comparable to ordinary occupation debris and so is listed and treated separately in this report. The rest of the samples from YHSS 7A are mostly from wash and later Early Iron Age pits (705).

Early Phrygian Period Courtyards (YHSS 6B), 950–900 B.C., redated (DeVries et al. 2003). The distinct stratigraphic break between YHSS 7 and 6 signals a change in function, from ordinary domestic to elite quarters. YHSS 6B yielded very few botanical remains.

Early Phrygian Destruction Level (YHSS 6A), c. 900–800 B.C., redated (DeVries et al. 2003). On a grander scale, the buildings of the Destruction Level suffered the fate of the burnt reed house 725. Similarly, the charred construction debris and in situ room contents are not comparable to ordinary occupation debris and are treated separately in this analysis. The deposits analyzed here come from the antechamber of Terrace Building 2. Note further that the YHSS 6B deposits excavated in 1988/1989 are in the center of the old excavations, and the YHSS 6A deposits are at the edge.

Middle Phrygian (YHSS 5), c. 800-540 B.C., redated (DeVries et al. 2003). Soon after the fire, the site was leveled and covered with a thick (4 to 6 m) layer of clay (Voigt and Henrickson 2000a:51). In the stratigraphic sounding, only a few samples from this phase were taken, mostly from post-occupation deposits within the cellar of Middle Phrygian building I and a few later pits. This makes generalizations difficult.

Late Phrygian (YHSS 4), c. 540–330 B.C. Thanks to a large number of trash-filled pits in excavated area, many flotation samples yielding quite a bit of material were taken. There are also a few samples from hearths. Remains of structures were fragmentary, however, as the fairly small exposure seems to have become an "industrial" area (Voigt 1996).

Hellenistic (YHSS 3), c. 330–mid-2nd century B.C. Two phases have been distinguished, YHSS 3B, c. 330–mid 3rd century B.C., and YHSS 3A, mid- 3rd–mid 2nd century B.C. The industrial nature of the excavated area continues in the lower part of this stratum (YHSS 3B), and most of the samples come from a series of hearths. A burned structure, part of the Galatian "Abandoned Village" lies above. The flotation samples are most usefully compared to those of the YHSS 7 BRH structure and Terrace Building 2A of the YHSS 6 Early Phrygian destruction level. A few late Hellenistic pits and wall fragments lie above.

Medieval (YHSS 1), 13th–14th century A.D. Voigt (1994) reserved YHSS 2 for Roman period deposits; in the 1988/1989 excavation area, however, there is a stratigraphic gap. Roman material has been excavated recently elsewhere on the site (see Goldman 2005; Miller 2007a, 2007b). The few Medieval samples come primarily from a few pits.

Yassıhöyük Stratigraphic Sequence in cultural context

All archaeological periods were important for the people living in them, but some stand out thanks to the breadth and depth of present-day knowledge of the time. Texts—those that were never lost as well as those known only from excavation—are an independent source of information against which one can compare the archaeological materials. Also, members of the Gordion team, working with excavation, survey, archival, and other data continue to refine our understanding of the sequence.

Bronze Age settlement. In addition to Gordion, there are a few Early Bronze Age sites within a 10-km radius of the site. During the Middle, and especially Late Bronze in the region Gordion was in the orbit of the Hittite empire (Voigt 1994:276). Despite the uncertain environment the area had numerous settlements (Kealhofer 2005). Perhaps integration into the Hittite economy allowed people simply to move, or trade in foodstuffs covered dietary needs in bad years, or some combination of local adaptation, migration, and trade saw people through.

The Phrygian question. In line with Herodotus' and Strabo's writings, the Phrygians are thought to have originated in southeastern Europe (Sams 1988; Voigt and Henrickson 2000). Keith Devries (2000:18) has mapped the plausible extent of Phrygia (at least seventh to fourth centuries B.C.) in west central Anatolia through rock inscriptions in the Phrygian language and other epigraphic finds. Sometime after Hittite domination of the Sakarya valley (YHSS 9–8) and before the establishment of the royal precinct (YHSS 6), Phrygians had settled at Gordion. Voigt (1994:277) sees a stratigraphic break between YHSS 9–8 and 7, along with a suite of cultural changes, which reflect the arrival of the Phrygians. For example, a possible ceramic marker is the Early Iron Age handmade pottery characteristic of YHSS 7B, which replaced the wheel-made Hittite ceramics; among other possibilities, at the very least this would indicate a change in ceramic production and distribution (Henrickson 1993). Despite the apparent continuity in settlement between YHSS 7B and 7A, the pottery is once again wheel-made, and indeed, is indistinguishable from that of Early Phrygian YHSS 6B.

The Early Phrygian Destruction Level. Rodney Young's major investigation of the Yassıhöyük mound stopped at the Early Phrygian royal precinct. The area exposed by his excavation included presumed royal residences in the center and at the edge a series of attached megarons (Terrace Buildings 1-10?) the back walls of which presented a single face to the central area. These buildings appear to have functioned as service buildings for the elite quarter. The buildings had been destroyed in a catastrophic fire, now dated to about 800 B.C. Though no skeletons were found, the fire was so intense it vitrified the silica[tes] in some of the wood and seeds. Young and others associated the fire with the Kimmerian invasion mentioned by Strabo, but even before the current re-dating to 800 B.C., that view was not tenable.

The outstanding feature of the Phrygian and subsequent landscapes was the burial tumuli that dot the countryside, especially Tumulus MM ("Midas Mound") and the cluster nearby. Tumuli were erected throught the Phrygian period; about a hundred have been mapped [(ref.)]; they are distributed within about [xx] km^2. Tumulus-building ended during the Hellenistic period (ref).

Middle Phrygian rebuilding. One of the most mysterious aspects of Gordion is the clay layer that seals the Destruction level. Over much of the excavated area, the buildings built into the clay layer are smaller, but follow the general lines of the earlier, now buried, structures. It is therefore not surprising that "The YHSS 5 (Middle Phrygian) assemblage is clearly derived from that of YHSS 6 (Early Phrygian) both typologically and technologically" (Henrickson 1993:132). Henrickson remarks that this assemblage is restricted to local types. It is during this period, however, that the settlement expanded considerably. Excavation and surface materials suggest relatively dense occupation across the river over an area of approximately one square kilometer (Voigt and Henrickson 2000a). This, the massive earth-moving and reconstruction of the palace quarter, continued tumulus building, and a plethora of imported wares suggest it was a fairly prosperous time (DeVries 2005; Henrickson 1993:140; Voigt 2005). Regional survey, too, suggests the Middle Phrygian was a time of prosperity and agricultural expansion (Kealhofer 2005).

Late Phrygian economic expansion. The Late Phrygian phase at Gordion is the time of the Persian/Achaemenid conquest. Gordion's political importance probably had waned, but it appears to have been a prosperous economic center; most of the Greek pottery comes from these deposits, demonstrating contact with the west, as well (Henrickson 1993; Voigt 1994).

Hellenization and the meeting of peoples. The Phrygian presence continued long after the Persian conquest. In the ceramic assemblage, "the adoption of Greek forms becomes even more pervasive, affecting even basic types like cooking pots" (Henrickson 1993:155). At the same time, finds, both spectacular and quotidian, demonstrate Celtic occupation at Gordion (Dandoy et al. 2002; Voigt 2004).

Medieval. During the Medieval period new cultural interactions might have had some affect on land use. In the case of Gordion, there is enough pig bone to suggest the presence of a resident non-Muslim population. We might expect that the influx of Central Asian Turkic tribes (Selçuks?) and political unification of new regions under Islam to have influenced trade networks and the material, including plants, that traveled along the routes.

Archaeobotanical Questions

The previous sections give some general archaeological and cultural background. Samples from the stratigraphic excavation contain a record of close to 2000 years. Data from plant macroremains, charred wood, seeds, and other plant parts, can address a number of issues concerning ancient plant use, land use and landscape. The long sequence allows us to trace vegetation history in the region, and evaluate the extent and nature of human impact. Charred wood indirectly provides evidence of forest composition, and the remains themselves come from fuel and construction. From the seeds of cultigens and wild plants we can infer the relative importance of agriculture and pastoralism over time. Somewhat more directly, the charred remains leave evidence of crop choice. The intensity of land use for agricultural and pastoral pursuits would have varied, too. In conjunction with the other archaeological interpretations, the botanical data can enrich our understanding of agriculture and economy in the Sakarya valley.

The question of original vegetation and changes in land use intensity

Aytu{g} (1970) proposed a landscape of anthropogenic steppe, certainly around Ankara, but even around Gordion. As Walter (1956:97) points out, "Die Grenze zwischen Wald und Steppe wird in Zentralanatolien noch dadurch kompliziert, daß dieses Land keine Hochebene im eigentlichen Sinne darstellt. Vielmehr wechseln weite Beckenlandschaften (als 'ova' bezeichnet) mit Gebirgsrücken ab. Auf den höheren Erhebungen findet man noch Waldreste, während die tiefer liegenden Teile baumlos sind." [The boundary between forest and steppe in Central Anatolia is complex, as this land is not a plateau in the proper sense. Basin landscapes, called 'ova', alternate with mountain ridges. On the higher slopes one finds relict woodland, while the low-lying parts are treeless.] He uses an analogy between Ankara and Salt Lake City to conclude that the natural vegetation would be grassy steppe. At least in the United States, comparable Artemisia steppe occurs in Nevada, e.g., with less than 300 mm (winter) rainfall. Around Ankara, in a fenced area, Walter saw perennial grasses, including various Stipa, and Bromus tomentellus, B. erectus, Festuca sulcata, Phleum sp., Melica sp., and other plants. He therefore suggests, at least for Ankara, an original Stipa-Bromus tomentellus steppe, and similar vegetation along route to Eski{s}ehir. Artemisia fragrans grows at the same elevation range.

Two types of natural vegetation characterize the central Anatolian steppe: perennial grasses and Artemisia. Botanists have argued about whether the Artemisia steppe is disturbed grassland or original vegetation cover (Walter 1956:98). I think it likely that around Gordion, whose elevation is so close to the steppe-forest boundary, relatively favorable conditions prevailed, allowing a dense grass cover that could have supported grazing animals, presumably wild in the distant past, but by the Middle Bronze Age, herds of domestic sheep and goat. Note that Marsh (2005:168) found "typical grassland soils" in the Sakarya valley below later erosion deposits.

The question of irrigation

A variety of evidence can potentially bear on the question of whether or not crops were irrigated. The first thing to consider is whether it would have been desirable and possible to irrigate. Given the erratic nature of the climate, anything that would even out harvests from year to year would be a good thing, especially in those time periods, such as the Middle Phrygian, when there was a relatively high population density. Since the late 1950s when the Sakarya was straightened, the river has been down-cutting the plain, and irrigation requires the use of pumps. Aerial photographs from the 1950s show a very different meandering river regime, but the annual flooding of the first half of the twentieth century may itself be a relatively recent phenomenon, post-dating the archaeological deposits (Marsh 2005).

Several types of botanical evidence address the question, but not all have been relevant to the data currently available from Gordion.

1) Weed seeds of irrigated and unirrigated fields. Due to the unfortunate (for the archaeobotanist) practice of suppressing weed growth in the fields, I am unable to make a comparison of the modern field weed vegetation. The evidence of the sedges, however, does suggest some changes in grazing habitats available in the valley that suggest the introduction or expansion of irrigation in the Early Iron Age (7A), and greater moist (hence, irrigated?) area in Hellenistic and Medieval times.

2) Crop choice. Some crops would have been irrigated because they are summer-grown (millets, and in the medieval samples, cotton and rice). The samples from the 1988/1989 excavation have few millets, and do not show a suggestive association with the sedge seeds. If wheat and barley were irrigated, one might expect some association with seeds of wet areas. Namely, in a situation (including the present) where both are cultivated, wheat is more likely than barley to be irrigated because it is less drought resistant and, favored as food, is the more valuable crop. Similarly, 6-row barley is more likely to irrigated than the 2-row type. The notable stability in the proportion of wheat to barley reveals no identifiable change in irrigation practices of the major cereals (wheat or barley).

3) Measurements of cereal grains. As discussed above, there is a similar lack of positive evidence for changes in irrigation practices based on the plumpness of the wheat and barley grains.

Ben Marsh (in Voigt and Young (1999:n. 6) has suggested that the the clay capping on the Early Phrygian level on the Citadel Mound Phrygians may have used sediments that resulted from "hydraulic work at the time of the reconstruction (e.g., digging irrigation canals or drainage ditches);" both activities, especially the former, support in interpretation that land use for agriculture intensified. It may be no accident, then, that two indications of a relative shift toward the agricultural side of the agropastoral continuum date to this period: a dip in the proportion of sheep and goat and an increase in the wild seed to cereal ratio (see discussion in concluding chapter).

Population movement

Several questions specific to the culture history of Gordion will also be addressed. For example, do changes in the agropastoral economy reflect changing ties to the world beyond the Sakarya valley. Turkey has long been a crossroads between east and west, and north and south. Based on both ancient texts and modern archaeology, Gordion has attracted scholarly attention concerning several ancient episodes of migrations, or at least of population movement. One group of questions for Young, Sams, Voigt, and others is: when and under what circumstances did Phrygians arrive in Anatolia, and can they be identified by non-linguistic material remains. The same questions can be asked of the Celtic (Galatian) arrival and presence. Voigt and Henrickson's stratigraphy-based analyses of changes in material culture have generated several hypotheses in this regard. Social, political and ethnic environment all may affect the agropastoral economy; assigning changes in the archaeobotanical record exclusively to these specific factors would be unwise.

By phrasing these questions somewhat less specifically, however, the archaeobotanical remains could provide some illumination as well. We all know that pots do not equal people, and archaeological cultures (typically recognized by pottery) do not equal ethnic groups. It is hard to think that plant remains could unequivocally distinguish Gordion's place in the orbit of the Hittites (9/8) from its independence during the heyday of the Phrygians (7, 6, 5), or mark the Persian conquest (4), the arrival of the Galatians (3), or contacts with the wider Islamic world (1). Voigt suggests that certain kinds of domestic, relatively private, habits can help identify cultural markers. Examples include hearth and fireplace form, which could relate to food preparation customs; one archaeobotanical contribution to the discussion is food remains.

The question of "ethnicity" (or cultural affiliation)

One of the results of the Gordion archaeobotanical study is that much of the evidence for environment and land use in the Sakarya valley shows incremental change that is not correlated in any obvious way with the apparent changes in the population or its cultural affiliation. Despite the dramatic history of population movement and replacement in the Sakarya valley, agricultural strategies appear to have been remarkably stable. I suggest that at a given level of technology within the Near Eastern agricultural tradition, the harsh environment of the Sakarya valley strongly constrains the agricultural possibilities, and that when any newcomers arrived, it behooved them to learn how to be successful farmers from the local population, if they did not already know. This is not to deny any agricultural innovation at all, but that of necessity it was cautiously applied. In conjunction with data and interpretations generated by other researchers, two possible expressions of Phrygian identity may be suggested (see discussion in concluding chapter): the consumption of einkorn and a possible "heirloom" artifact made of alder.

Fig. 1.1 Early Phrygian Destruction Level; excavation units 1988/1989.

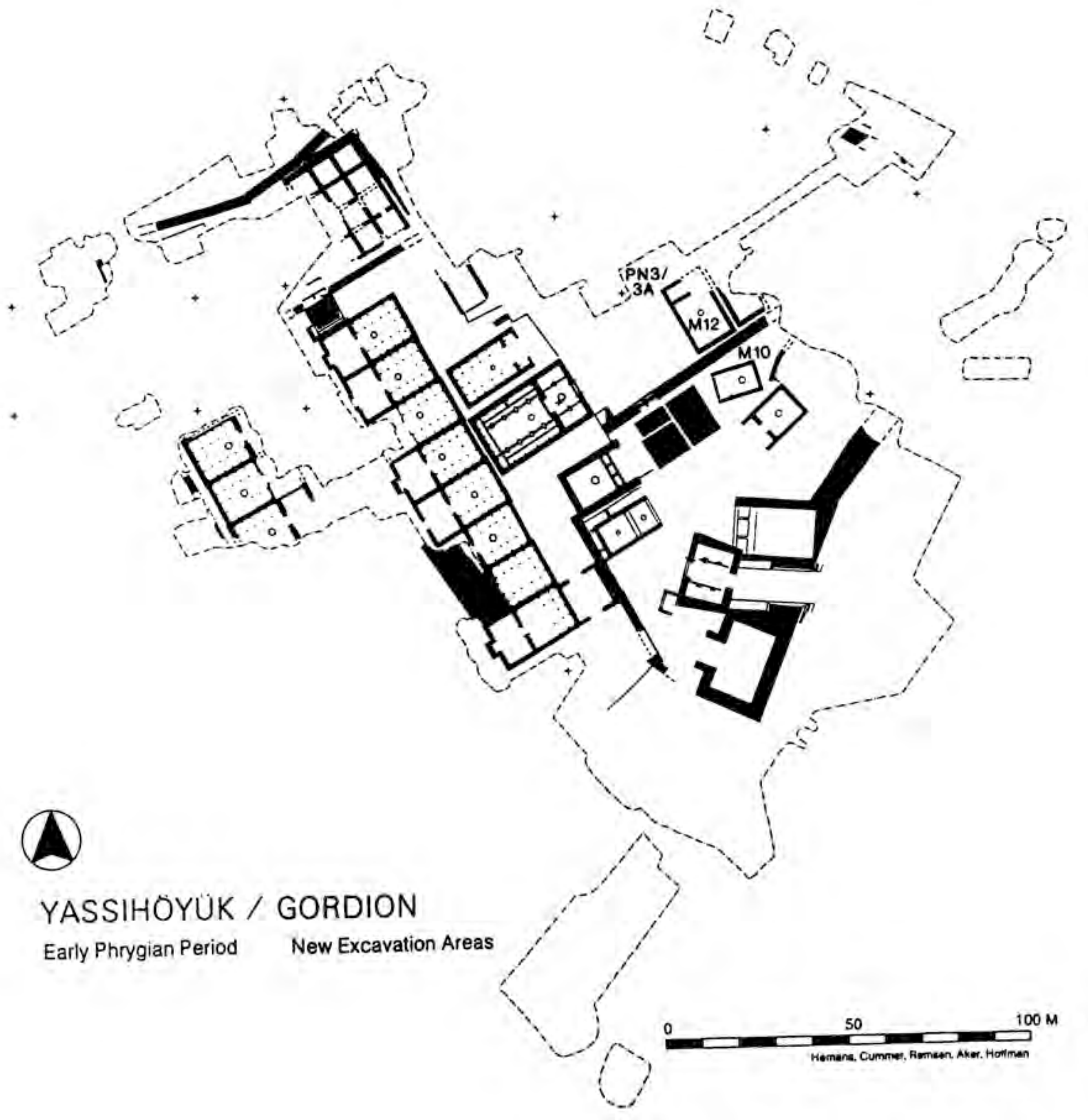


Table 1.1. Yassıhöyük Stratigraphic Sequence, approximate dates (source: Voigt 2005:27)

YHSS 1	Medieval	13–14th century A.D.
YHSS 2	Roman [not in these samples]	early 1st–5th century A.D.
YHSS 3	Hellenistic	330–mid-2nd century B.C.
YHSS 4	Late Phrygian	540–330 B.C.
YHSS 5	Middle Phrygian	800–540 B.C.
YHSS 6A	Early Phrygian ("Destruction level")	900–800 B.C.
YHSS 6B	Early Phrygian (courtyards)	950–900 B.C.
YHSS 7	Early Iron Age	12th century–950 B.C.
YHSS 8–9	Late Bronze Age	1500–12th century B.C.
YHSS 10	Middle Bronze Age	2000–1500 B.C.
—	Early Bronze Age [not in these samples]	2500–2000 B.C.

Chapter 2

Environment, Vegetation, and Land Use

Preliminary archaeobotanical work (Miller 1999), geomorphological studies (Marsh 2005), archaeological survey (Kealhofer 2005), ethnoarchaeological studies (Gürsan-Salzmann 2005) all show that the twentieth-century landscape of the Sakarya valley is quite different from that of three thousand, three hundred, or even thirty years ago. Even so, the present-day climate and vegetation provide a baseline against which one can assess the macrobotanical remains. Palynological studies from neighboring regions give independent information with some time depth.

Strong Mediterranean influence on the climate gives much of Turkey cool or cold wet winters and hot dry summers. Elevation, local topography, and distance from the coast create great variation—the climate becomes more continental in the interior, and there is some rain in the summer. Thanks to adequate rainfall, the natural vegetation of the coastal regions of Turkey is forested. Oak and pine dominate the Mediterranean forests of the west and south, and mixed hardwoods are characteristic of the Pontic (Black Sea coast) forests to the north (Zohary 1973:Map 7). As you go inland past the coastal mountains ranges, overall precipitation declines; in general, lower elevations experience less rainfall. The lower boundary of the central Anatolian true steppe is approximately 700 m, depending on local conditions. Gordion straddles that elevation boundary, so relatively minor differences in such factors as the water table, drainage, interannual rainfall variability could affect the natural vegetation cover and moisture available for crops. Human activities on the land could potentially affect these and other factors.

Topography, Soils, and Water

Some "natural" processes that might affect plant life occur regardless of human intervention, such as long-term climate shifts. More locally, down-cutting of the Sakarya river, or the shifting bed of aggrading streams would alter the land. At the time scale considered here, however, the archaeobotanical record reflects predominantly human manipulation of the landscape—intentional earth movement as well as erosion that results from deforestation and overgrazing.

The Sakarya river originates in western highlands of Anatolia; it flows north through Gordion toward its outlet in the Black Sea. The Porsuk river, which flows through Eski{s}ehir, meets the Sakarya about 4 km north of the site. Over time, the bed of the Sakarya has shifted; today it is down-cutting, but through the first part of the 20th century it meandered and flooded annually. Ben Marsh's geomorphological studies show several major shifts in the river over the occupation of the site (Marsh 2005).

Gordion is situated in a fertile alluvial valley (Figure 21). Within about 5 km of Gordion, the soils and geological substrate as mapped by Marsh (2000, 2005) show several different zones. Today, the Sakarya is down-cutting, and a narrow riparian strip supports an assortment of woody and herbaceous vegetation. The east side of the valley bottom, annually flooded before the river was straightened in the 1950s, consists of a strip of deep soils eroded from the eastern hillsides at most 2 km in width, but usually narrower. Just east of the flood plain are some gypsum outcrops; further east are siltstone pediment with basalt intrusions (Marsh 2000). To the west of the river are gypsum and conglomerate plateaus. The arable soils of today as mapped by Marsh (2000) include, from closest to most distant: a relatively small area of alluvial soils, light-colored, loose upland soils, and "dark-colored, light-textured basalt-derived soils." Alternate-year fallow allows the lighter soils to store moisture; the basalt-derived soils have "high nutrient and moisture" capacity. Most of the soils within 5 km of Gordion fit into the second category, and traditionally, the major land use was unirrigated cereals and grazing (Gürsan-Salzmann 2005).

Groundwater availability in antiquity would have been greater than it is under the eroded, de-vegetated conditions of today. According to Marsh (2000), "The streams are shallower and they flow less in the dry (summer) season. Springs also flow much less through the year and they have also been buried if they were close to the streams"; he also points out that mechanized pumping for irrigation is lowering the water table.

Climate near Gordion

The nearest town for which meteorological information is available is the district center of Polatlı, which is about 20 km northeast of Gordion at an elevation of 875 m (Meteoroloji 1974). For the forty-one years between 1930 and 1970, the average temperature was 11.9ºC, with about 65.5 days/year with the lowest temperature below freezing. Average yearly precipitation was 346.6 mm, with a moisture deficit from June to October (Figures 2.2, 2.3).)[1] The average number of days with snow was 12. These data suggest that Polatlı is within the territory of reasonably secure rainfall agriculture (allowing for some variation hidden by the use of averages, 250 mm/yr is considered the minimum for dry-farmed cereals in the Middle East). The 61-year precipitation average for the July to June agricultural year is 347 mm, with a standard deviation of 62. This suggests fairly erratic rainfall, but generally enough for dry-farming. Summers can be cool, and in contrast to much of the Near East, summer downpours are a normal, if occasional, aspect of the climate.

In inner Anatolia, precipitation tends to decline with elevation. Available moisture for natural vegetation as well as for rainfed crops would be somewhat less in the Sakarya valley near Yassıhöyük, because it is nearly 200 m lower than Polatlı in elevation. The relatively benign variability in Polatlı, therefore, might indicate a high proportion of serious drought years at Gordion. Indeed, from the balcony of the Gordion excavation house, it is common to see summer rainclouds skirt the edge of the valley without dropping any moisture. Even with pump irrigation, farming in Yassıhöyük seems risky; the bumper crop of a very wet year, 1988, gave way to nearly total crop failure in 1989. In those years (July to June), precipitation reported in Polatlı was 376.0 mm and 228.9 mm.

Modern Vegetation Overview

[1] Note that in those years precipitation reported in Polatlı was 407.2 mm and 245.5 mm; for the growing seasons, the figures for the crop of 1988 (July 1987–June 1988) was 373.7 mm and for 1989 (July 1988–June 1989) was 228.9. Particularly good years (precipitation > 450 mm) outnumber bad years (precipitation < 250 mm) 5 to 3.

Michael Zohary (1973:579) describes the natural vegetation of the Anatolian plateau between 700 and 2000 m as "steppe forest," commenting that the term forest is "not always appropriate to a formation in which the arboreal elements are sometimes so remotely scattered, that one can hardly catch two trees at one glance." This description certainly fits the modern landscape. One should think of this vegetation type as "a steppe sprinkled with solitary trees which under certain conditions may become condensed and turn into a forest-like formation" (ibid. 579). At an elevation of just under 700 m, Gordion itself would be at the upper boundary of the treeless Anatolian steppe, though terrain at 700 m elevation lies as close as 2 km.

Since 1988, I have conducted informal vegetation surveys in the region, most intensively within two kilometers of Gordion. Uncultivated habitats lying within this radius include the riverside, former floodplain, and degraded steppe on a gypseous substrate in which Artemisia fragrans and wild thyme (Thymus sp.) dominate. A small patch of grassy steppe vegetation that was relatively undisturbed until the mid-1990s straddles the boundary between Yassıhöyük's fields and those of a neighboring village, {S}abanözü (about 13 km to the northeast). Perennial grasses mixed with a variety of other plants covered the slope, but annual grasses are becoming more prominent.

Nowadays, any crop that can be irrigated is, but all irrigation is carried out with motor-driven pumps. Since the mid 1990s, a government water project has brought irrigation to the slopes, greatly expanding the area of irrigable and irrigated land. In and near the village of Yassıhöyük itself, trees grow primarily in protected gardens and the banks of the Sakarya river. Isolated trees (Elaeagnus angustifolia, Ulmus glabra, Prunus amygdalus, Salix sp.) grow near the edges of some fields. Between {S}abanözü and Av{s}ar, oak grows as close as 15 km from Gordion. To the northwest, the first stand of junipers (Juniperus excelsa and J. oxycedrus) mixed with oak en route to Hamidiye are near Ahırozu, about 30 km by road from Gordion (elev. ca. 1000 m). About 40 km from Gordion, soil changes and oak becomes more common. Continuing on to Hamidiye (Ya{g} Arslan), about 50 km from Gordion, oak and pine grow. Just past Hamidiye, larger trees, mainly pine with an understory of oak and juniper (J. oxycedrus), grow in the forest near Hamidiye (Figures 2.4, 2.5). The extent to which the poor aspect of the vegetation is due to climate or human interference (fuel gathering, grazing, and, in antiquity, construction projects) is not entirely clear, but the analyses of archaeological woods from Gordion illuminate this question.

Recent Land Use—Agriculture, Pastoralism, Fuel

Even since 1988, land use patterns in the Sakarya valley near Yassıhöyük have changed. Most obvious to the occasional visitor are the expansion of irrigation to previously dry-farmed fields and the increase in week-end day-trippers from Polatlı and Ankara. At a scale of centuries and millennia, climate fluctuations, shifting river channels, periods of erosion, and many other human and natural factors have affected the landscape, so arguably there is no "ethnographic present." Ay{s}e Gürsan-Salzmann (2005) is conducting a comprehensive historical and ethnographic study of the region; here I present a general description based on her work, other published sources, my own observations, and conversations and discussions with some of the villagers who work for the project (mainly Ekrem Bekler and Remzi Yılmaz) and some team members (A. Gürsan-Salzmann and B. Marsh).

Crops

The main occupation of Yassıhöyük villagers is still agriculture and related activities. The most important field crops are macaroni wheat, two-row barley, sugar beet, onions, sunflower, and melon. The last two of these are also grown in smaller gardens, along with tomato, eggplant, peppers, okra, and other vegetables for home consumption and market sale. Lentils and chickpeas are also grown. Several crops that were common in recent memory are no longer grown: rye, which is still a common weed of wheat fields, and cumin. One retired farmer (7/8/94) mentioned three kinds of barley that were once grown: beyaz arpa 'white barley', siyah arpa 'black barley', and peygambar arpa 'pilgrim barley' (common oat?). Several crops were grown for oil: keten 'linseed' (Linum usitatissimum), konjit/susam 'sesame' (Sesamum indicum), and a plant he called zıra (possible mishearing or variant of zeyrek 'flax', also L. usitatissimum, Ertu{g} 2000).

An older farmer remembers growing: burçak 'bitter vetch' (Vicia ervilia). Bitter vetch is harder to harvest than other fodder crops, so its culture declined after mechanization (H. Fırıncıo{g}lu, pers. comm. 7/12/01). These discontinued crops were not irrigated, as the villagers did not have pumps then. Both rye and barley are grown primarily for fodder.

Grain yields depend in part on moisture availability, and partly on the crop rotation. One farmer (E. Bekler, 7/18/94) said that barley yields can be relatively low because wheat is more likely to be planted after a fallow year, when the soil is more fertile. He used to sow unirrigated wheat at a rate of 20 kg/dunam (ca. 20 kg/ha), for an expected yield of about 10 teneke (130–150 kg). In a dry year, a field would yield 7–10 teneke; the best years yields are about 15–20 teneke. Irrigated wheat, which takes a lot of fertilizer and water will typically yield 25–30 teneke; yields in a dry year would be 13–15 teneke, and the best years could be as high as 35 teneke. Twenty-six kilograms of unirrigated barley planted after a fallow year ordinarily yield 20 teneke. The yield in a dry year would be only 5 or 6 teneke, and in a wet year would be 20. For irrigated barley, if you plant two teneke, you can expect a return of 30–35 teneke; in a dry year the yield would be 7 or 8 teneke, and 40 in the best year.

Farmer's yields mentioned to Ay{s}e Gürsan-Salzmann averaged about 200–250 kg/dunam for unirrigated, and 450–500/dunam for irrigated wheat (about the same or slightly higher than E. Bekler's estimates of about 150 up to 300 kg/dunam for unirrigated wheat in a good year, and 325–450, up to 500 kg/dunam for irrigated wheat in a good year).

Planting year

The agricultural year begins in the fall, before the winter rains, when winter cereals are planted (Table 2.2). In addition to the additional labor input for irrigation, nowadays farmers use commercial fertilizer and weed-killer (at least, the grain fields do not have broad-leaf weeds).

Although irrigation is not necessary for wheat and barley cultivation in this part of Turkey, under irrigation the cereals are watered three times (March, April, May). Sugar beet takes seven waterings; it also must be thinned and weeded. Cumin and the pulses do not have to be irrigated.

Water sources: irrigation and the Sakarya

Prior to the deepening and subsequent down-cutting of the river channel and the introduction of pumps, the Sakarya began to rise in February, and the waters were highest in March, but the valley would be flooded through April (Ekrem Bekler, pers. comm. 7/25/93). Along the river, willow, poplar, wild pear and apple, and elm grew in dense thickets (<u>bük</u>) where wild pigs resided in great numbers. Most of the plain was grazed rather than farmed. According to Remzi Yilmaz (pers. comm. 7/9/93), there used to be more mosquitoes, pasture plants, and kamı{s} (reeds and cattails—<u>Phragmites</u> and <u>Typha</u>). Field irrigation was limited to low-lying areas near the Sakarya, and rice was grown near the river.

With gasoline-fueled pumps, fields can be irrigated as far as 1500 m away from the river, but more commonly no more than 500–700 m. Piping is assembled as needed, so there is no need to dig irrigation ditches. A government-sponsored water project that was in operation by 1995 has brought water to areas never before irrigated. In the past, wheat was more likely to be irrigated than barley. Today, even sunflower is watered, even though it used to be dry-farmed. It is probably no coincidence that traditional dry-farmed crops like flax, bitter vetch, and cumin, have fallen out of favor. The gypsum plateau west of the Sakarya is still farmed without irrigation, however; in 1996, the main crop grown there was barley, along with a little wheat.

Some aspects of animal husbandry

A variety of animals are kept in the village: cows, sheep, a few goats, fowl (geese, turkeys, chickens). Given the vagaries of the weather and the market, mixed farming is an important strategy in the valley. A recent study in the Polatlı region has shown that goat husbandry, and reliance on pastoralism in general, is more important in the hills than on the plain (H. Fırıncıo{g}lu, pers. comm. 7/12/01); those who live in the mountains earn a lower proportion of their income from field crops, and they raise more goats and fewer sheep than people who live on the plain. This area depended much more heavily on pastoralism in the nineteenth and early part of the twentieth century than it does today (Gürsan-Salzmann 2005).

Overgrazing, a problem in much of Turkey, is certainly occurring at Yassıhöyük. Fields owned by individuals, but pasture is owned by the village. In the Polatlı area, the greatest stress on the pasture occurs in the spring, just when the perennial grasses and many other wild plants are flowering and fruiting: 50% of the fodder comes from pasture in April and May, and 100% in June (H. Fırıncıo{g}lu, pers. comm. 7/12/01). Animals are stall-fed at least part of the year, so fodder must be grown or purchased. During the winter, the animals are taken out of their stalls to be watered, but the ground is too muddy for them to graze. With overgrazing, plants such as üzerlik 'wild rue' and tiken 'camelthorn' (Peganum harmala and Alhagi pseudalhagi) increase. When fresh, they are avoided by the herds; Peganum does not taste good and Alhagi is spiny, but in the winter, when they have dried, sheep and goat will eat both (E. Bekler, pers. comm. 7/27/93). There archaeological presence is therefore an indicator of poor pasture.

Farming and herding have different seasonal labor and land requirements, some of which are mutually exclusive. A mixed strategy can enhance food security and provide products suitable for exchange in a groader system. The changing agropastoral economy at Gordion had to balance the goals of achieving security and surplus in an agriculturaly marginal but commercially central environment.

Fuel

Fuel is necessary for domestic cooking and heating. Nowadays, bottled gas (töp) and coal (kömür) are readily available for purchase. Other fuel-consuming activities known ethnographically or attested in the archaeological deposits include gypsum plaster production, ceramic firing, and metalworking. The traditional fuels for these activities are wood, charcoal, and dung.

Before the river was deepened, men used to cut wood in the woods along the river (bük 'thicket'), and in the dry months, women would make dung cakes. In the old days, shepherds would go out to the hills a few kilometers from the Yassıhöyük for days; family members would bring food. People would sweep up the the dung and bring it back as the main fuel. Dung was also collected from the animal pens, as it is to this day.

One use of dung cake fuel was to make gypsum plaster (tatlı kireç) (E. Bekler, pers. comm. 7/29/96). Gypsum from Kızlarkaya would be collected and burned for three or four days in a big pile (several meters high), until it got soft and powdery. The resulting gypsum plaster could then be applied to walls when mixed with water. It is not as good as the store-bought kind (acı kireç 'lime plaster'?) because it is powdery and comes off on your clothes. People would apply it three or four times a year, at holidays.

Dung is used for fuel in several forms, and its quality varies. Sheep, goat, and cow dung are all used for fuel, even today. Fuel from sheep and goat pellets is better than cow dung because it is inherently more compact, and after it has accumulated in the stalls over the winter, it is even denser.

Not surprisingly, there are several Turkish words for the different types of dung and dung fuel. Seona Anderson (1994/5) gives a detailed description of the various forms used near Aksaray; there appears to be some difference in usage between the people she spoke to and Ekrem Bekler, retired farmer. In Yassıhöyük, the two most common terms used are tezek and kerme.

tezek	general (and common) word for dried dung used as fuel (same in Aksaray)
kerme	sheep dung slabs dug out from stalls, also called kemre. In Aksaray, used for winter cow dung mixed with straw and water, unshaped
ki{g}	old word for sheep dung used as fuel (also used in Aksaray)
kaba teze{g}i	dry cow pats (yaban teze{g}i in Aksaray)
el yapması	cow dung shaped by hand (yapma in Aksaray)
mayıs	cow or horse dung
davar mayısı	sheep or goat dung

Several words reported by Anderson's consultants were unfamiliar to E. Bekler:

sarma	sheep dung dug out from byres
kön	soil like by product of cow dung—bedding or fertilizer
kareli	made from bits of kerme and sarma
kerpiç/kasnak	moulded cow dung with water, straw: E. Bekler knows the word as moulded cow and/or horse dung; kerpiç is also the Turkish word for mudbrick

Ancient Climate and Vegetation

Climate reconstructions are based primarily on proxy data, as there are few direct indicators of past climate conditions. Geomorphological, botanical (pollen, phytolith, and macroremains), and soil studies commonly reveal more about vegetation cover—episodes or erosion or deforestation—than they do about climate. This is particularly true for the the more recent (post-Bronze Age) periods, when human impact on the vegetation is so great that it masks the natural fluctuations of climate (Miller 1997a). And of course, dating non-archaeological deposits at a sufficiently fine scale to be useful is also problematic.

In any case, the climate record of central Anatolia for the past 3000 years is thin. In southwestern Turkey, both the Bey{s}ehir and Sö{g}üt pollen diagrams show an expansion of pine (apparent increase in moisture) at about 1000 BC, with pine remaining important until the top of the core; the modern deforested state of the vegetation post-dates the core (van Zeist and Bottema1991:81). about 120 km to the northeast, in the Yeniça{g}a core (inconclusive dates for the past 3000 years, Bottema et al. (1993/1994: 33) consider vegetation changes to be the result of human activities rather than climate. What would seem to be a constant, however, is a high interannual variability to which any occupants of the valley would have to adjust.

Earlier thought on the vegetation around Gordion and archaeobotanical finds

At least since the discovery of the great tumuli, with their incredibly well-preserved timbers and wooden furnishings, questions arose concerning the forests of the present virtually treeless landscape around Gordion. Rodney Young, director of the excavations from 1950 to 1974, wrote,

> "Although the modern landscape is as bare as bare can be and the few trees that grow now—poplar, willow, and wild pear—are limited to the margins of the river and the irrigation ditches, the hillsides were certainly once clothed in woods which have since disappeared. The profusion with which wood was used in

> Phrygian construction and the size of the timbers preclude importation from very far away." (Young 1960:3)

The wood and charcoal assemblage from Young's excavations provided significant information about the state of the forest and trade during Phrygian times. Pine timbers in the Yassıhöyük were extensively re-used (Kuniholm 1977:48). These large timbers would have been valued because they would have been difficult to transport, even over short distances; furthermore, the extensive building program of the Early Phrygian period could well have eliminated the largest (i.e. oldest) timbers closest to Gordion.

Although modern sources for some of the woods found on the Yassıhöyük and in the tumuli are fairly close to Gordion, other types, for example, Cedrus libani would have come from moister, higher (>1000 m) regions in Turkey well over 100 km away (Davis 1965; Kuniholm 1977:Pl.12). Proximity is therefore a relative concept, and it is not possible to specify the exact distance between Gordion and its sources of wood. Young seems to have envisioned fairly dense woodland during Phrygian times at the edge of the Sakarya valley (i.e., within 2 km of Gordion) (K. DeVries, pers. comm. 1991). This possibility seems unlikely, though the current research suggests a somewhat more wooded landscape than can be seen today. By the first millennium B.C., timber was being transported far and wide in the Near East. If indeed large cedars came from over 100 km away, Phrygian technology was clearly adequate to transport more local timbers like pine and juniper. As Richard Liebhart (pers. comm. 1999) points out, some of the logs in the chamber in Tumulus MM have

> "a flattened channel with a hole cut near the large end...[which] shows how the Phrygians transported logs: the cutting with its hole was placed on an axle between two wheels (a pin in the axle fit into the hole), and the smaller and lighter end of the log was lifted up, turning the log into a make-shift wagon for easier transport."

In contrast, ethnographic analogy suggests that fuel-gathering would probably not have been economical over distances greater than about 50 to 75 km.

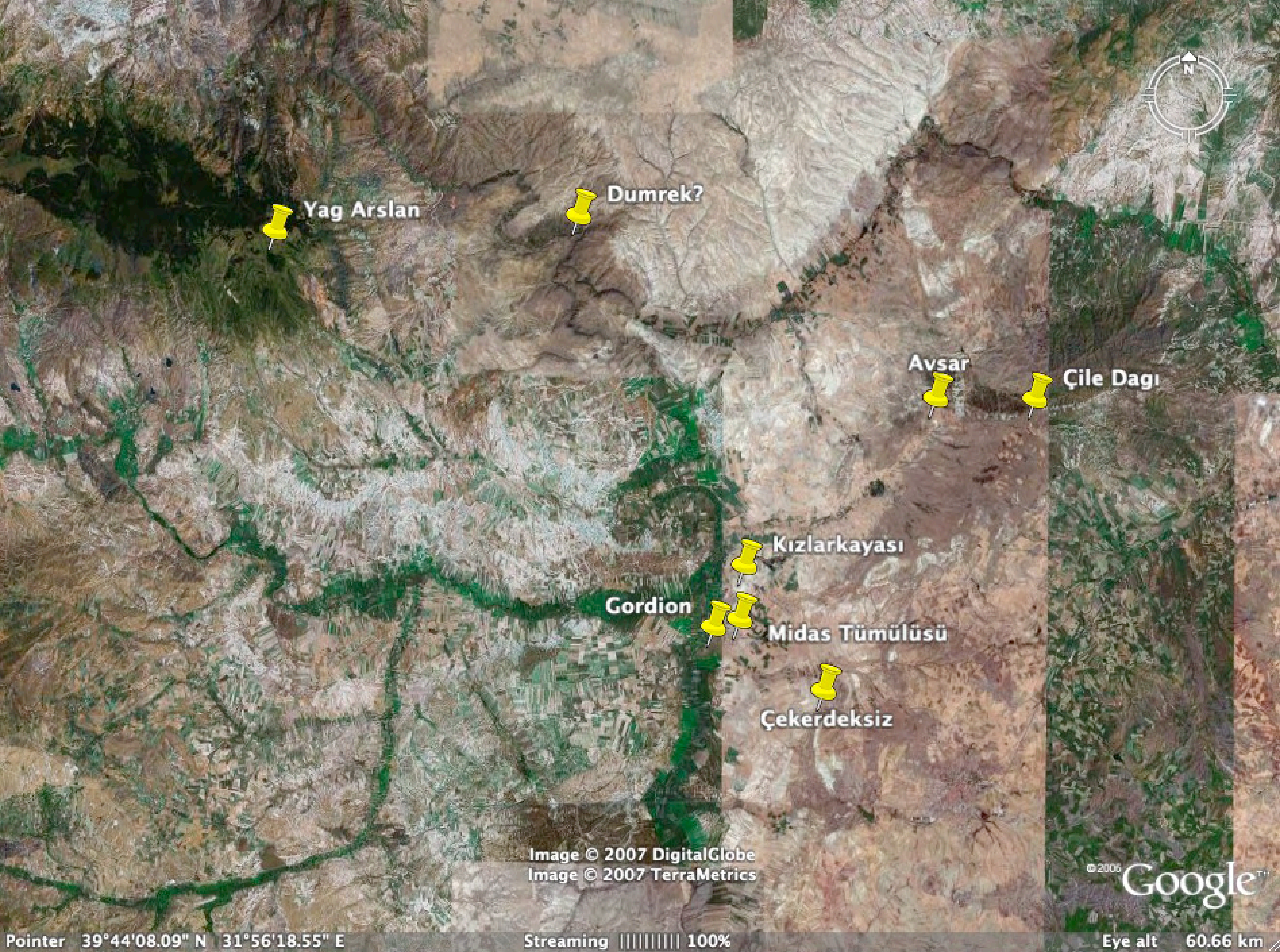
Other work on woods from Gordion and its tumuli has been carried out primarily by H. Kayacık and B. Aytu{g} (1968), Aytu{g} (1988), on the construction and furnishings of the MM Tumulus, by Blanchette and Simpson (1992) on "Midas'" coffin, and by Aytu{g} and Görcelio{g}lu (check date 1988) and Aytu{g} and Pehlivan (1989) on Tumulus 'P' tomb and furnishings.

Most of the wood from the excavations of 1950–1973 comes from the Early Phrygian Destruction level on the Yassıhöyük and Phrygian period tombs. The charred wooden beams and construction material found on the Yassıhöyük in the Terrace Buildings and elsewhere are pine (Pinus) and juniper (Juniperus) (Kuniholm and Tarter 1989, Kuniholm 1990, this report). Construction materials identified from the Midas Tumulus include pine (Pinus-wall, ceiling, beam), juniper (Juniperus-exterior), Lebanon cedar (Cedrus libani-floor)[2] (Kayacık and Aytu{g} 1968).[3] The tables, screen and coffin from Tumulus MM were made of boxwood (Buxus sempervirens), juniper (Juniperus), walnut (Juglans regia), (Aytu{g} 1988). The coffin woods have recently been determined to be pine and Lebanon cedar (Blanchette and Simpson 1992). The chamber in Tumulus P was made of black pine (Pinas nigra subsp. pallasiana) logs, with some internal planks of juniper (Aytu{g} and Pehlivan 1989); furnishings are boxwood, and juniper and walnut and poplar, according to Aytu{g} and Pehlivan (1989).

The results of the 1988 and 1989 excavations reported in Chapter 4 add considerably to the interpretations based on the materials excavated in the 1950–1973 seasons. First, the new samples greatly extend the time range of documented wood use: Middle Bronze Age to the Medieval period. Second, much of the charcoal is the residue of incompletely burned fuel, a better indicator of the state of the local woodland contemporary with a given deposit than are valuable timbers and possibly rare or exotic products of the cabinetmaker's art.

[2] Peter Kuniholm (pers. comm. 1992) expressed some doubt about the identification of Lebanon cedar in the floor sample.

[3] An earlier identification by Kayacık and Aytu{g} (1968), Aytu{g} (1988), Aytu{g} and Pehlivan (1989) has been revised; the yew (Taxus baccata) reported in the structure and furnishings of the Midas Tumulus is now recognized to be pine (Blanchette and Simpson 1992). Some of the specific determinations in the earlier works (especially Pinus silvestris rather than P. nigra, and Juniperus foetidissima rather than J. excelsa) should probably be revised on phytogeographical grounds). Similarly, some of R. Young's observations may not be valid [see Gordion I appendices]


Yag Arslan
Dumrek?
Avsar
Çile Dagı
Kızlarkayası
Gordion
Midas Tümülüsü
Çekerdeksiz
Image © 2007 DigitalGlobe
Image © 2007 TerraMetrics
©2006 Google
Pointer 39°44'08.09" N 31°56'18.55" E
Streaming 100%
Eye alt 60.66 km

a. Sakarya vegetation

b. Overgrazed pasture with Tumulus MM in midground and Kızlarkayası outcrop in background

c. "Grassy steppe" in 2000, before irrigation wrought land use changes

d. Former "grassy steppe" in 2007, after irrigation wrought land use changes (Tumulus MM visible in background)

Figure 2.4. Immediate environs of Gordion

a. Juniper (J. oxycedrus) and oak (Q. pubescens) over 1000 m (above Avsar)

b. Juniper (J. oxycedrus) and oak (Q. pubescens) over 1000 m en route to the pine forest at Hamidiye

c. Juniperus excelsa ca. 1200 m en route to the pine forest

d. Pinus nigra in clearing in pine forest

Figure 2.5. Woodland vegetation in the Gordion region

Fig. 2.1 Map of area showing: site, Yassıhöyük, Kızlarkaya, {S}abanözü, Çile Da{g}ı, Sakarya, Porsuk, Ahırozu, Mihalıççık, Hamidiye

Fig. 2.2 Climate diagram, Polatlı (39°35'N 32°08'E). Based on 41-yr average. Average monthly minimum always >0°C; absolute miminum <0°C January and February (source: Meteoroloji Bülteni 1974) [YH Book Fig. 2.2, 2.3]

Fig. 2.3 Polatlı rainfall, by growing season (July-June), 1929 to 1990. 60-year mean: 347 mm, S.D. 62 mm (source: Meteoroloji Bakanlık) [YH Book Fig. 2.2, 2.3]

Fig. 2.4 Vegetation in the immediate environs of Gordion

Fig. 2.5 Woodland vegetation in the Gordion region

Fig. 2.2 Climate diagram, Polatlı (39°35'N 32°08'E). Based on 41-yr average. Average monthly minimum always >0°C; absolute miminum <0°C January and February (source: Meteoroloji Bülteni 1974) [YH Book Fig. 2.2, 2.3]

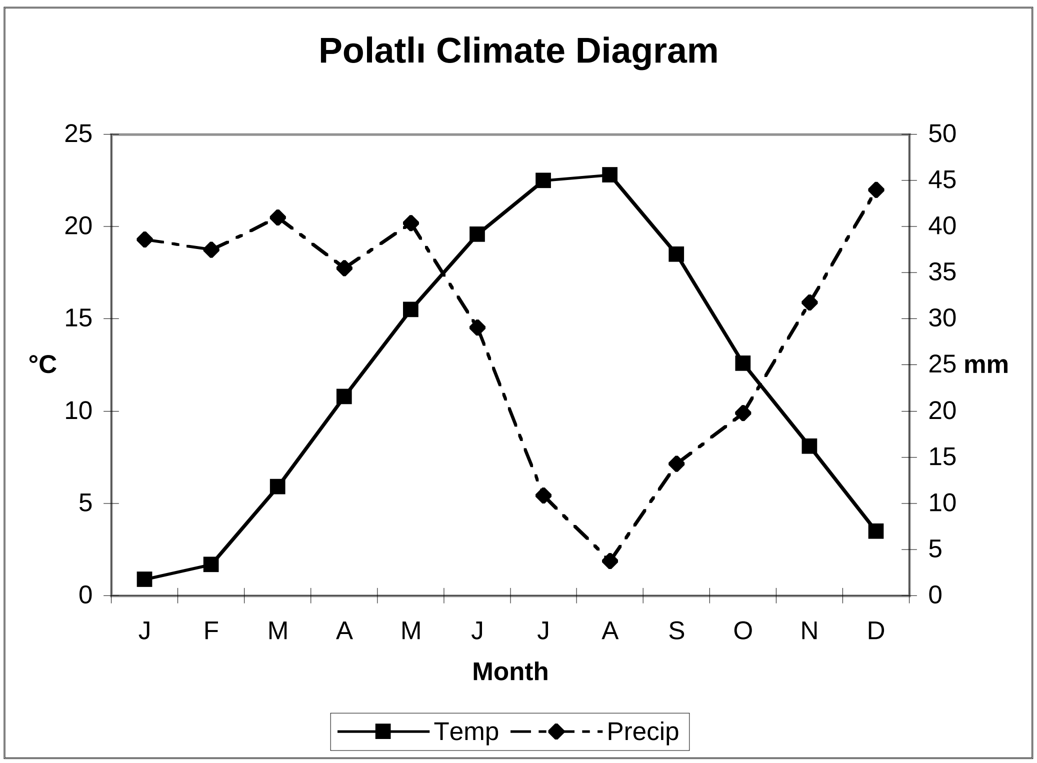


Fig. 2.3 Polatlı rainfall, by growing season (July-June), 1929 to 1990. 60-year mean: 347 mm, S.D. 62 mm (source: Meteoroloji Bakanlık) [YH Book Fig. 2.2, 2.3]

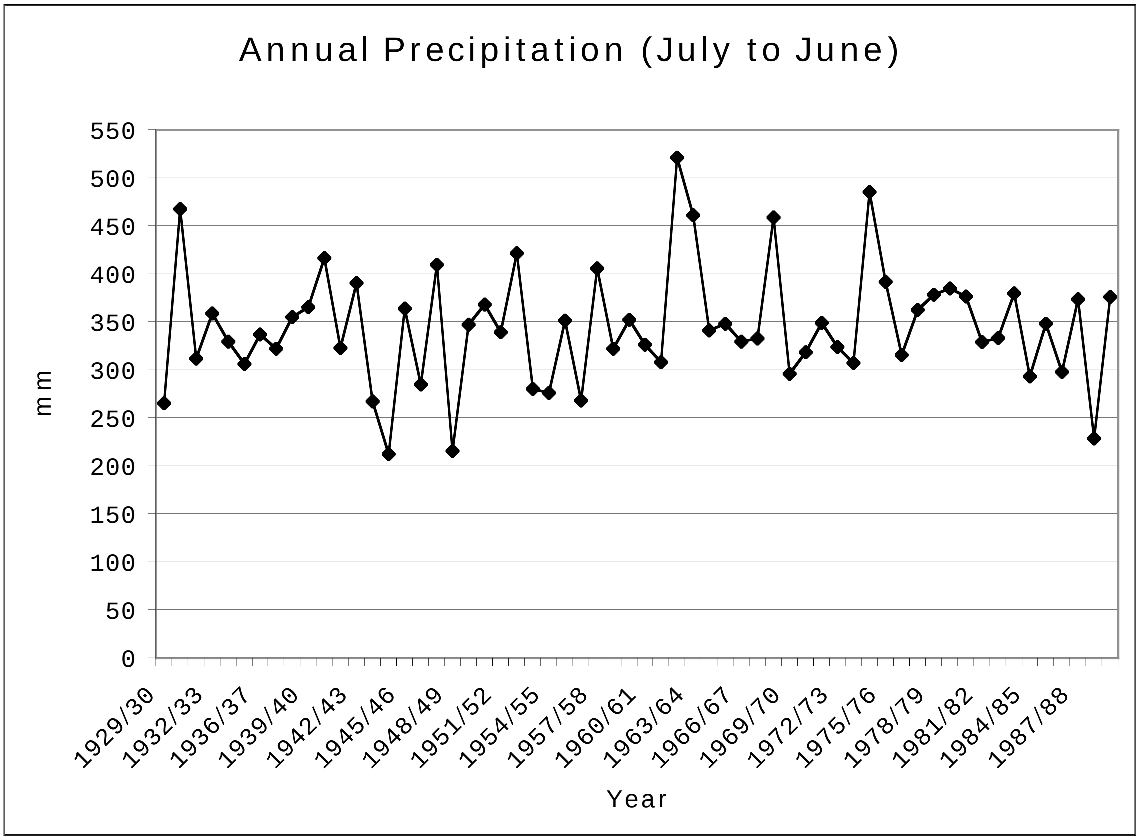


Table 2.1. Ekrem Bekler's yield estimates (pers. comm. July 18, 1994.

	Amount sown per dunam or hetare	Yield in teneke* under different conditions		
		Drought	Normal	Wet
Unirrigated wheat	20 kg	7–10	10	15–20
Irrigated wheat	20 kg	13–15	25–30	35
Unirrigated barley	20 kg	5–6	20	20
Irrigated barley	2 teneke (26–30 kg)	7–8	30–35	40

*1 teneke ≈13–15 kg

Table 2.2. Seasonal round according to Remzi Yılmaz (pers. comm. 1992)

September/October	plant winter wheat and barley
mid-November to mid-March	rains come
December	first frost
mid-December	ground freezes for up to a month, 5-20 cm
March-May	irrigate wheat (and barley)
April	plant summer crops: cumin, sugarbeet
May	plant summer crops: lentil, chickpea, melon, watermelon, garden crops
mid-June/mid-July	barley harvest, followed by wheat harvest; note that harvest is a few weeks earlier in Sakarya valley than between Polatlı and Ankara); in a dry year, harvest may be several weeks earlier
July	harvest cumin, chickpea, lentil
July, August	harvest melons, garden crops; weed sugar beet
September	harvest sugar beet

Chapter 3

Field to Laboratory: Collection and Processing of Wood Charcoal and Flotation Samples

Nature of the Deposits—Burnt Buildings vs. Ordinary Occupation Debris

Two basic types of deposits were encountered in the 1988/1989 seasons—burnt buildings and ordinary occupation debris. Because the former is likely to include a substantial amount of construction debris, and the latter is likely to include a substantial amount of spent fuel, there is no reason to sample and analyze them in the same way. The three structures represent different occupation phases and types of houses: the Burnt Reed House is an Iron Age wattle and daub structure, Terrace Building 2 probably housed support staff for the Early Phrygian Destruction Level elite quarter, and a Hellenistic structure appears to be domestic. In contrast to the more ordinary occupation debris, the plant material from these buildings is a mixture of construction debris and whatever seeds and wooden objects were left behind.

Field Collection of Wood Charcoal

Supervisors and workers were told to collect wood charcoal visible in the course of excavation and from screened deposits. If it was obvious that a sample came from a single large piece, they were asked to label the bag as such. It was not practical to even try to collect all the charcoal from the burned buildings. Nevertheless, relatively large samples of fractured beams and other construction materials were collected. Most charcoal from ordinary occupation debris came from pieces scattered in the excavated 'lot' of soil.

Some large pieces were wrapped in string and sent to the Cornell Tree Ring Laboratory in Ithaca, New York, as possibly useful for dendrochronological study.

Field Sampling for Flotation

Excavation supervisors were told to take samples for flotation of approximately 10–15 liters of an archaeological deposit, which they put into heavy duty plastic bags. Some excavators were more conscientious than others, but the guidelines were to take samples from all hearths and pits; places with high density of charred material (e.g., trash deposits); just above ancient floors and surfaces (from ca. 5 cm above down to the upper edge of the surface); sediments associated with hearths, pits, and other sampled features ("control samples"); any deposit about which an excavator was curious. Along with wood charcoal samples, flotation samples were taken from the burned buildings, too.

In 1988 and 1989, flotation was accomplished with the aid of a Siraf-like machine (French 1971) built by Mark Nesbitt and loaned to the project by the British Institute of Archaeology in Ankara; Nesbitt also provided detailed instructions on its use. Rather than a stiff inset lined with metal screening, the heavy fraction of the samples was caught in synthetic window-screen mesh (ca. 1 mm squares, variable). The light fractions flowed into polyester cloth set in an agricultural sieve through which only dust could pass. The dried samples were transferred to plastic bags and sent to the MASCA laboratory with the permission of the Museum of Anatolian Civilizations in Ankara.

Representativeness

Most of the botanical macroremains from Gordion are preserved in charred form. Flotation of sediment samples concentrates remains that are dispersed in the site matrix. Most such material is assumed to represent incompletely burned fuel remnants redeposited as trash, intentionally burned trash, or accidentally burned material (see, for example, Hillman 1984; Miller and Smart 1984; Minnis 1981). We also floated samples from burned buildings, partly in order to be able to make quantitative comparisons with the dispersed material, and partly to pick up small items mixed in with or part of the charred construction debris.

In an ideal world, large pieces of charcoal would be recovered at the same rate as ceramics and bone, so questions about representativeness within excavation units would be irrelevant; one would, of course, still have to worry about how the excavation units were chosen. In reality, however, not all charcoal was recovered, because it tends to be smaller and of less obvious interest to the archaeologists and workmen than artifacts. In this context, relative amounts of the different types are more significant than absolute quantities, so the hand-picked charcoal from occupation debris is treated as though it is a fair representation of what theoretically could have been collected.

The goal of sampling for flotation was to get a collection of charred seeds and wood representative of the remains in the excavated deposits. At Gordion, as in most archaeological sites, excavation units were not chosen randomly, but rather in relation to the archaeological, historical, and chronological questions outlined in Chapter 1. Therefore, interpretations presented are not based on formal statistical significance of the quantified remains. Rather, the sampling for macroremains aimed at obtaining an assemblage that would reflect what was in the excavated deposits and that would include enough material to analyze.

Although I cannot provide any statistical certainty, it is likely that the source of charred remains in settlement debris (excluding burnt buildings) is redeposited hearth sweepings. Partial justification for this conclusion is that for any given time period, different types of deposits tend to share taxa (i.e., hearths yield the same range of taxa as pits or trash).

Laboratory Procedures—Samples, Sorting, Recording, and Quantification

Wood charcoal

Charcoal was collected by hand in the field as noticed. There were several burnt buildings, notably the Burnt Reed House, the so-called Abandoned Village occupation, and Terrace Building 2A. Especially in the first-mentioned, not all charcoal was collected. Approximate quantities of charcoal are listed, but must be weighted according to total charcoal in sample to be meaningful.

The samples were mixed with varying amounts of dirt. As the tiniest pieces of charcoal are not readily identified or quantified, samples were sieved through 2 mm mesh, and only the pieces caught in the 2 mm mesh were measured and weighed. An attempt was made to identify pieces with at least one complete growth ring, to avoid over-representing easily identified taxa such as oak.

Two microscopes were used to make determinations. A stereozoom microscope, magnification 7.5–75x, was used for initial determinations, and an incident-light compound microscope was used at magnifications up to 400x, but usually 100x or 200x for smaller features. See Chapter 4 for details of charcoal analysis.

<u>Sampling and its influence on the interpretation of diversity</u>

"Sample" refers to charcoal included under one YH#. Consequently, "sample" is a totally arbitrary unit in terms of archaeological context, and there is no set size or excavated volume of deposit from which it comes. A sample may be as small as one piece of charcoal, 2 mm in diameter, or big enough to fill a shoebox or two. As noted in the text above, it seemed most reasonable to make major comparisons between time periods. Comparative analysis by archaeological context of fuel remains awaits further archaeological analysis and excavation (see, e.g., Marston 2007, in prep.).

Since it was neither possible nor productive to analyze all pieces of charcoal in every sample, I used several criteria to help determine the number of pieces I would examine. the goal was to get a reasonable view of the variability within a sample (cf. Smart and Hoffman 1988).

1) I identified at least ten pieces per sample, unless a sample had fewer than 10 pieces or if a samplewas clearly (on visual inspection) all the same type (this was most often the case for some of the bags of pine from Terrace Building 2A).
2) If only one or two taxa were seen in the first ten pieces, no more were examined. If more were seen, up to 10 additional pieces were looked at.

The laboratory sampling strategy enhanced the chances that the number of pieces analyzed would be directly associated with the number of types. This makes statements about variety problematic. In particular, as one might expect, the Late Phrygian period with the greatest variety (13 distinct types) had the most pieces analyzed. Even so, the possibility cannot be excluded that changes in variety are due to long-term vegetation change or functional differences beween, say, a preponderance of industrial trash from pits (Late Phrygian) and household trash (Early Iron). Diversity indices and measures of evenness would have been calculated but the sample sizes were too small (Popper 1988).

Variety is generally associated with the number of pieces analyzed per level, but it is not associated with the weight actually analyzed, on which the interpretation rests (Table 3.1). It is also noteworthy that even correcting for analyzed sample size, the later periods seem to have higher variety; for example, there are almost twice as many types (at least 9) in the Hellenistic deposits as in the Early Iron deposits (at least 5), though both are similarly domestic in character with comparable numbers of charcoal pieces examined (232 and 251).

Flotation samples

Charred material is very well preserved at Gordion, and it was not possible to analyze all samples taken. The main criteria were to get a broad functional representation of deposits from different time periods; if more than one sample from a particular archaeological feature was taken, a judgment was made based on amount of material and complexity of the deposit. For example, small samples from a single deposit might be combined for analysis, and several samples from an extensive trashy deposit might be examined to see if the deposit is homogenous or not. Most samples were sorted by me, but occasionally by a student or laboratory assistant. In all cases, I checked the work.

Sorting and analysis instructions that were generally followed for the light fractions appear in Appendix A. The basic procedure was to sieve each sample through graded mesh, partly for ease of sorting. In addition, categories of plant remains are recognizable and identifiable at different sizes, so size-sorting serves an analytical function. Wood charcoal is easy to sort to 2 mm, though pieces smaller than about 5 mm become progressively more difficult to identify. A catch-all category, "charred material > 2mm," was separated out, but not analyzed. It probably includes parenchyma and other plant fragments, but the amounts are very small. Seeds such as grain, pulses, nutshell, and some plant parts may be confidently recognized to 1 mm, and many cultivated and wild seeds easily pass through 1-mm mesh.

Density of charred material (wood, seeds, and other plant parts) from an entire excavated context cannot be calculated for the hand-picked charcoal, but it can be estimated from flotation samples. As not all deposits were sampled for flotation, we cannot assume representativeness for the site, especially because sampling in the field favored deposits thought by the excavators to have charred plant remains. Even so, most sample densities (184 out of 224) are below the mean of 1.33. As the statistical distribution does not follow a normal curve, the mean density does not describe the population. The median for the samples as a group is only 0.55 g/liter (Figure 3.1).

Heavy fractions

At first, the heavy fractions of a small number of samples were examined to 1 mm with the help of a dissecting microscope, but so few seeds were recovered (and those that were included the same types as those found in the light fraction), that further recording would not change the interpretations. Subsequently, the heavy fractions were examined down to 2 mm. Some seeds (especially large rounded ones like bitter vetch and Galium) are more likely to sink than others, and two types, chickpea and wild almond fragments, occur only in the heavy fraction. (See Appendix F8 for contents)

Fig. 3.1. Median densities according to period (YH App F summaries)

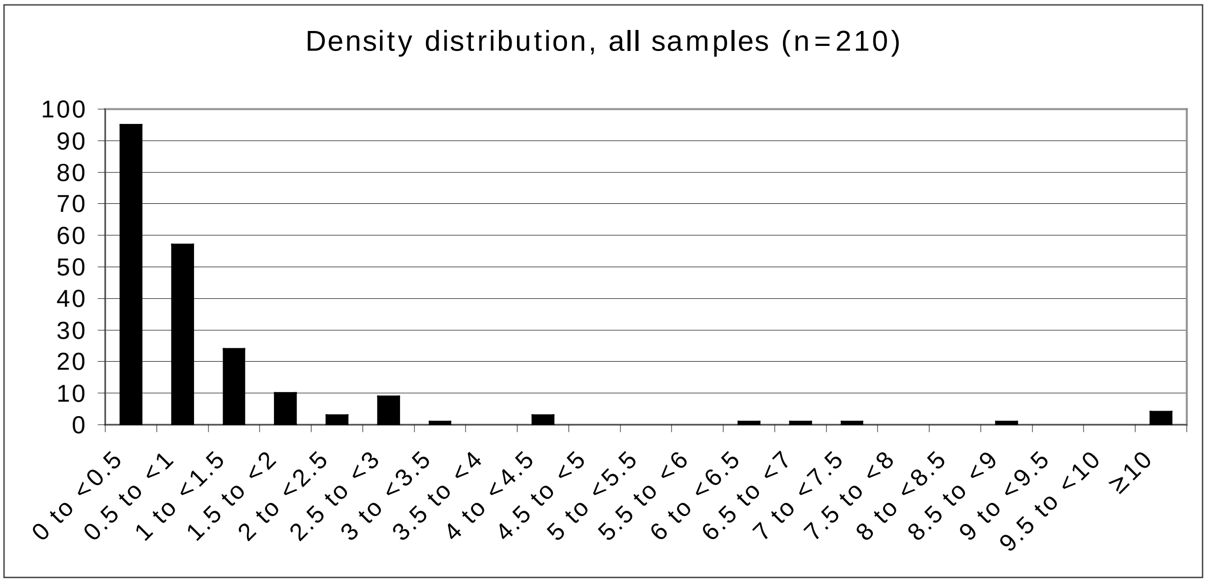


Table 3.1. Number of distinct taxa (excluding "unidentified") from hand-picked charcoal samples from occupation debris

YHSS	No. samples	No. distinct taxa	No. pieces analyzed	Wt. pieces analyzed (grams)
9&8	13	4	70	75.61
7	52	5	251	183.8
6	16	6	76	28.57
5	8	4	54	53.73
4	71	13	475	235.86
3	36	9	232	118.56
1	12	7	67	20.38

Chapter 4

Analysis of the Wood Charcoal Sample

Archaeological Context

The stratigraphic sounding undertaken in 1988 and 1989 established a sequence of archaeological phases and the excavations greatly expanded the amount and variety of plant materials available for study. Excavators were asked to collect all chunks of charcoal seen in the course of excavation; this goal was not reached. The three burnt buildings contained too much charcoal from construction debris, and even from the other kinds of deposits, excavators were somewhat erratic in their zeal to collect plant remains. The new materials come primarily from occupation debris including pits in residential areas, trash pits, ordinary occupation debris, and occupation debris from an elite quarter. Wood charcoal from three burnt structures gives evidence of building materials in Early Iron Age, Early Phrygian, and Hellenistic times. Finally, wood from the Tumulus MM tomb chamber and its furnishings identified by the wood anatomists mentioned above adds another context type.

In short, the archaeobotanical remains come from structures, furnishings, and occupation debris. The structures and furnishings provide material most like traditional archaeological artifact categories, and in many respects can be analyzed accordingly, in terms of function, source, and distribution within the site. The most wood and charcoal comes from burnt buildings on the Citadel Mound and the wooden tomb at the bottom of the Midas Mound. The second source of plant materials, tomb furnishings, consists of small but high-status items made of wood. The most widespread material, however, consists of charcoal and seeds from settlement debris.

Methodological and Analytical Assumptions

The Gordion excavation uncovered burnt building levels interspersed with other structures and settlement debris accumulated over time. This means that the charred wood recovered archaeologically came to be on the site for a variety of reasons, the most obvious being as fuel and construction material. With regard to fuel residues, I presume that quantities of the various taxa reflect availability in the local vegetation, in general terms. People are more selective in choosing construction materials. Presumed construction charcoal is therefore tallied and analyzed separately from more ordinary charcoal that is most probably the incompletely burned residue of fuel. In reality, "construction" and "fuel" deposit types are not mutually exclusive. Nevertheless, occasional inaccurate functional designation of charcoal should not mask the overall patterns. The functional assignment of any one sample (material included under one YH#) to fuel or construction may be wrong, but such errors will be insignificant if the number of samples analyzed is large enough.

There are several ways to quantify charcoal remains: weight, count, ubiquity, and volume. Mass is more directly related to ancient fuel use than number of pieces or volume. It is most useful for the analysis of the fuel remains, even though wood density varies between types. For example, oak is very dense, pine is not, and juniper is in between; analysis by weight would therefore tend to over-represent oak, and analysis by volume would over-represent pine. For the fuel charcoals, I report the weight of charcoal larger than 2 mm, as well as the proportion (by weight) of the sample that was analyzed and the number of pieces examined. The sample-by-sample inventory lists the weight of charcoal actually examined (Appendix E). The summary charts of fuel (Table 4.1) gives the weighted percents as well as counts and ubiquity. For the summary graphs, the samples are weighted by the total weight of the charcoal per sample (in grams). That is, the summary graph by weight presumes that the examined charcoal in any one sample is representative of the total in that sample (Figure 4.1). Since an attempt was made to collect all charcoal that was noticed during excavation, I have decided to treat the major time periods as the analytical units; that is, I added the weighted totals of the samples together and divided by the total weight of charcoal retrieved to calculate the percent of different types by period. Counts of identified pieces are a less likely to be representative of sample composition, because a large piece carries the same numerical importance as a small one. Ubiquity, though relatively imprecise, allows the quantities of each taxon to be assessed independently of the others (Figure 4.2). Volume is not a practical measure because many samples contain only one or two pieces of charcoal. Regardless, percentages by weight, count, and ubiquity of the major types found in the samples tend to follow the same trends by period (Figure 4.3).

Measures appropriate for assessing the importance of the fuel and construction remains are not the same. Quantification by weight is not that useful, because the wood from burned buildings represents individual objects, such as roof beams. In general, counts are not that practical to use because the number of pieces identified cannot easily be standardized between samples. As with the debris samples, volume is not a practical measure for these samples either. Especially in Terrace Building 2A, it was not practical to collect every piece, and it is not reasonable to compare either counts or weights of these essentially single, albeit incomplete and broken artifacts. I provide summary data for the weight of the charcoal so the reader can have some idea of the quantity of material on which the analysis is based (Table 4.2a). For the actual analysis, I use only ubiquity (per cent of samples in which a given taxon occurs) by YHSS phase (Table 4.2b). Tables 4.1c and 4.2b enable rough comparisons between fuel and construction material.

The Taxa: Ecological Significance

The bulk of the charcoal from the excavations of 1988 and 1989 is juniper (Juniperus), pine (Pinus), and oak (Quercus). These three types are the dominant genera today in the mountains within 50 km of the site (see Appendix C). Tentatively identified species I collected southeast of Ahırozu at an elevation of ca. 1100 m include Juniperus cf. oxycedrus, J. cf. excelsa, and Quercus pubescens. Pinus nigra was obtained south of Saray (elev. ca. 1000 m). The limit of the present day forest depends on the availability of moisture, which is in turn associated with temperature and elevation.[1] These and other

[1] As elevation rises, precipitation increases (Zohary 1973: Map 5), and it is probably cooler higher up, as well.

trees were once more numerous, and probably grew in denser stands closer to the site than they do today.

A minor component of the archaeological assemblage is the wood of pear or hawthorn (Pyrus/Crataegus). These two types cannot be distinguished on the basis of wood anatomy (Schweingruber 1982). Hawthorn was collected from an isolated tree on the edge of a field and was also seen near the junction of the Sakarya and the Ankara Çay. According to Zohary (1973), it is, along with wild pear (Pyrus elaeagnifolia), a constituent of many of the arboreal associations of central Anatolia, and occurs early in forest succession in a clearings in the pine forest (pers. obs.)

Two types of elms were encountered, Ulmus glabra, in a field just north of Yassıhöyük, and the other, Ulmus minor, on the slopes near Av{s}ar. As Zohary points out, however, some elms (Ulmus) "are confined to hydric habitats, others are scattered among mountain forests" (Zohary 1973:367). One piece of charcoal conforms to a Prunus type, (almond/peach/apricot; not further distinguishable on the basis of wood according to Schweingruber [1982]). Wild almond does grow not far from Yassıhöyük, near Çekerdeksiz to the east and above Yeni Köseler to the west; a few fragments of almond shell in the archaeological deposits (and the absence of peach and apricot in contemporary archaeobotanical assemblages in Anatolia) support an identification of almond. Some fruits of Paliurus spina-christi, a spiny, shrubby tree in the Rhamnaceae, were found in one sample; it grows in open juniper woodland today.

Two types that were at least tentatively identified as part of the ancient assemblage grow today in the former bed of the Sakarya river: poplar (Populus) and tamarisk (Tamarix). The latter also grows in the old river flood plain. Tamarisk and willow (Salix) today grow on the banks of the river. As noted above, prior to the dredging and straightening of the river, Young saw wild pear there, as well.

Although I cannot personally attest to the probable sources of the remaining woods, Zohary (1973) and Davis (1965–1988) provide information about their habitats and ranges. Unfortunately, habitats for plant genera must usually be fairly broadly drawn. For example, one type of ash that grows in inner Anatolia, Fraxinus angustifolia subsp. angustifolia, is found on "dryish, rocky places" (elev. 650–1700 m), and another, F. angustifolia subsp. oxycarpa, is found "often in wet places, flood plains, by streams in mixed deciduous forest, s.l.–900 m" (Davis 1978:150 ff.). Alder (Alnus) would grow along watercourses, though the ancient specimens may not be local. Buckthorn (Rhamnus) is usually "unimportant vegetationally" in the Middle East (Zohary 1973:373).

The charcoals of the minor components of the Gordion assemblage (i.e., anything not pine, oak, or juniper) mostly come from minor components of the steppe-forest vegetation and from along watercourses. Some pieces may have come from trees planted or protected in areas of former steppe-forest. Considering that the non-dominant types are most heavily concentrated in the Late Phrygian levels and later, they may represent secondary succession plants and degraded steppe-forest vegetation (especially pear/hawthorn). That poplar, elm, and tamarisk were more prevalent in later times would also be consistent with this view; other things being equal, gallery forest can regenerate more easily than dry land types because more moisture is available. Note that the analysis of seeds and other plant parts recovered through flotation has begun to shed additional light on human induced vegetation change (see below).

Distribution of the Charcoal in Time and Space

Archaeological context provides the key for understanding the distribution of charcoals through the Gordion stratigraphic sequence. Charcoal does not occur "naturally;" simply tallying the different types by time period does not reveal the state of the vegetation. People bring wood onto a site for a variety of purposes—as building materials, tools and furnishings, and fuel. They select woods from among the ones that are most appropriate to a task, taking transport costs and availability into account. For example, a king or a cabinetmaker may be willing to import boxwood from the Black Sea coast to make fine furniture, but it is highly unlikely that such wood would routinely be burned for fuel. In contrast, people are much less discriminating about their choice of fuel wood for cooking, heating, and industry, and availability is a key factor (see Miller 1985).

The Gordion excavations of 1988 and 1989 produced a fair amount of charcoal, but the sequence is fairly long and the excavated area was relatively restricted:

1) Many of the phases are characterized with only a small amount of charcoal, less than 100 g total or fewer than 100 pieces examined (Table 4.1a, b); analysis of even a few additional samples could alter the proportions of the different woods.
2) Different phases are represented by different types of deposits. For example, YHSS 7 (Early Iron Age) and YHSS 3 (Hellenistic) deposits excavated in 1988 and 1989 are characterized by apparently residential architecture, the YHSS 6A and 6B (Early Phrygian) deposits have more substantial, "elite," architecture, and most of the YHSS 5 (Middle Phrygian) charcoal is from floors and trash pits.
3) Domestic and industrial trash can sometimes be distinguished, or at least inferred from the archaeological context (e.g., Feature 430.04, possible 'metallurgical pit' of YHSS 4), but as of this writing, and aside from the building materials of burnt structures, there are too few samples that can be grouped and compared on functional grounds.

Indeed, charcoal identified from subsequent excavation has already complicated the picture based on the 1988/1989 deep sounding, with the addition of new types, notably cornelian cherry (Marston 2003) and different proportions of some of the wood taxa (Marston 2003; Miller 2007). As a result, future reports and analyses will require some of the quantitative and qualitative generalizations presented here to be revised. In the meantime, it is important to understand the assumptions underlying the methodology and interpretation of the charcoal in order to appreciate the patterns that are beginning to emerge.

Charcoal from trash and other deposits

Availability is probably the major determinant of fuel use (see Miller 1985),[2] though wood fuel values (by volume) and burning characteristics vary. For example, oaks

[2] For example, "under Indian conditions, 65 km by bullock cart...[is] the maximum distance...over which it would be worthwhile to transport" fuel wood (Forest Research

generally produce a little more heat than pines, and burn more more slowly. Juniper and pine seem to be similar to each other in heat produced (Hall 1942; Graves 1919; Reynolds and Pierson 1942).

Ton for ton, wood charcoal averages 70% greater heat value than wood; by comparison, dung has about half the heat value of wood (Bogach 1985). For a given distance, charcoal is much more economical to transport than wood, so charcoal production in more distant wooded areas could have a significant effect on economics of fuel choice. Archaeologically, it is not possible to tell whether wood or wood charcoal was burned for fuel. Inferences about the vegetation that are based on the character of the charcoal assemblage will therefore always incorporate a certain amount of ambiguity.

The most striking characteristic of the assemblage is that oak and conifer (i.e., pine and juniper) predominate in all periods. Never less than 82% by weight and 79% by count (in Medieval deposits, YHSS 1), these three woods are especially characteristic from ca. 2000–540 BC (the beginning of the sequence to YHSS 5) (Figure 4.1, Table 4.1a, b). Conifers predominate into the Early Phrygian period (YHSS 6). In Middle Phrygian times (YHSS 5), oak is at its most important. Bottema and Woldring (1984:139) observe that

> "pine forests in Turkey often have an undergrowth of deciduous oak. The pines do not recover from cutting but the oaks do regenerate. Thus, pine forests are easily transformed into oak forests as long as grazing is not too heavy."

As they are today, juniper, pine and oak were the dominant trees of the woodland in ancient times. One should probably visualize bands of vegetation radiating upward from Gordion—from treeless steppe and riverine vegetation, to scrub juniper and oak, intergrading at the higher elevations with pine and oak forest. These woods would have been available within 50 km of the site, as now, but in greater quantities than today, even as late as the Medieval period. It is not clear to me how much of the scrubby aspect of the present woody vegetation below 1000 m is a result of climatic conditions or of grazing

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Institute 1972:617). Even in the United States, during the Second World War, "When other fuels are obtainable and moderately priced, regular use of wood fuel is rarely feasible if it must be transported more than about 20 miles [33 km] to the consumer by motortruck" (Hall 1942:4).

and fuel-cutting. It is at least plausible that the trees that did grow in the steppe-forest zone were taller.

Figure 4.1 shows the shift in proportions of the three main types, juniper, pine, and oak, and Figure 4.2 shows their ubiquity (percent of samples containing the taxon). Based on the present data, it is clear that juniper declines in importance. Of the three types, juniper probably grew closest to the site[3] and so would have been subject to the heaviest pressure from fuel-cutters.[4] By Hellenistic times, it is virtually absent from the assemblage, and presumably absent from the immediate environs of the site. Oak becomes the major fuel wood during the Middle Phrygian period, when Gordion had reached its maximum extent. Oak can be more sustainably harvested than pine or juniper, which could explain its prominence in the assemblage during a time of maximum population. It declines from that early peak, but remains a significant part of the assemblage.

Pine proportions are may be partly interpreted with the model of wood exploitation that I have proposed based on the modern vegetation zones and (overland) distance-related transport costs as the factors determining fuel use. Contrary to expectation for the Early Iron Age and Early Phrygian period, pine, which today would have to come from further away, exceeds or equals oak charcoal by weight and ubiquity. After Middle Phrygian times, the increase in pine follows the model of local depletion of wood sources. Preliminary results of Roman and Medieval samples excavated in 2004 strengthen this impression; pine predominates in these samples (Miller 2007). To explain the distribution of pine and oak in the first part of the sequence, several explanations come to mind:

1) Pine was mixed with oak at lower elevations closer to Gordion than today; perhaps a different, more xerophilous type of pine is involved. Remember Bottema and

[3]It is generally thought that "drought resistance [is] largely under genetic control...For example, Juniperus virginiana and J. communis are apparently more resistant to desiccation than many common species of Pinus" (Fritts 1976:196). The drought tolerance of at least one species of juniper that grows in central Anatolia, J. excelsa, is greater than that of oak (Pabot 1960:22).

[4]Note that some juniper (J. oxycedrus) growing in central Anatolia is considered weedy (Zohary 1973:349), and so might regenerate relatively quickly.

Woldring's (1984) observation that oak tends to replace pine in the pine-oak assocations in central Anatolia.

2) The pine peak occurs in the Early Phrygian levels, and the fuel charcoals come from the pre-Destruction level palace area. Coming from relatively far away, pine may have been a high status fuel. Perhaps during Early Phrygian times the economics of scale supported specialized charcoal cutters who provided charcoal fuel for the city; during other periods wood, which is heavier and bulkier than charcoal for equivalent heat value, was collected from sources that were a bit closer. Supporting this view is that clay sources of the Early Phrygian period "must have lain elsewhere in the valley or beyond" (Voigt and Henrickson 2000:51), unlike the earlier sources that came from local Sakarya valley sediments. Against this view is that the wealthiest period of occupation at Gordion is the Middle Phrygian, when household and industrial production presumably put the most stress on the woodlands.
3) Pine grew in the mountains upstream (?) from Gordion, and the fuel transport economy was based on the river, especially before the Middle Phrygian period, making pine a cheaper fuel than oak.
4) Pine was preferred, probably as charcoal, and so it would have been economical to transport it over relatively longer distances. (I.e., pine wood has somewhat lower heat value than oak wood by volume (and maybe by weight), but pine charcoal would have the same or higher heat value by both volume and weight. I suspect this is the case, but do not have directly comparable figures to prove it.
5) The observed trends are simply a result of small sample size, and will not hold up after more charcoal is analyzed.

These explanations are not mutually exclusive. Based on the analysis of the seed remains, the differences between time periods may relate to other aspects of land use (see Chapter 6). In any case, after the Early Iron Age juniper forms a negligible part of the assemblage, and oak and pine predominate from Middle Phrygian times on.

The minor components are more difficult to interpret, primarily because they represent such a small proportion of the total; any patterning and variability are heavily influenced by chance factors that have little to do with ancient plant use: where the excavation units were, the alertness of the excavators, and sampling in the laboratory. Nevertheless, some patterning can be discerned. First, the variety of types recognized is higher from Late Phrygian times on, and those types are not major forest trees. Rather, they are trees characteristic of degraded woodland that one would expect to remain after the steppe-forest is removed (hawthorn and some elms, for example) and types that grow in favorable conditions and might therefore regenerate quickly (hydrophilic types like poplar and tamarisk, and in central Anatolia, maybe pear and elm as well).

A few pieces of charcoal may be mulberry (see Appendix I for discussion of taxonomic difficulties); there is a possibility of confusion with elm, but a brief discussion is appropriate. Today, mulberry is planted as a street tree in Polatlı and elsewehere in Turkey, and its berries are edible, but people grow it commercially primarily for its leaves, to feed silkworms. Mulberry is not native to the Near East, but would probably have come from central Asia. Historical records place the beginnings of the silk industry in Byzantium to the reign of Justinian (527–565) (Braudel 1979:326), so I am not proposing that silk production had reached Gordion in the Early Iron Age or even by Late Phrygian times. Along with some mulberry wood reported from the well in the Northwest Palace of Assurnasirpal II at Nimrud (Mallowan 1953:25n.), and a single mulberry seed from a Roman deposit at Tell Hadidi (van Zeist and Bakker-Heeres 1985[1988]:308), however, these pieces (if indeed they are mulberry), would constitute the only evidence for that tree from ancient Near Eastern sites west of Iran.

Wood from "planks" from a "tray" on the floor of the Burnt Reed Structure is tentatively identifed as Alnus viridis. This species is anatomically quite distinct from two alders native to Turkey and those from Europe. Assuming the geographical distribution of A. viridis is the same as in antiquity, the closest source would have been south central Europe. Somewhat speculatively, one might propose the "tray" was an heirloom, brought by Phrygians who settled at Gordion during YHSS 7B (Voigt and Henrickson 2000).

Charcoal from burnt buildings

Several different functional considerations determine wood selected for building—if nothing else, a beam must be long enough, and ideally it should be resistant to decay and not too difficult to work (Table 4.2). Juniper is very resistant to decay, fairly soft, and some species grow tall and straight under favorable conditions (e.g., J. excelsa). Juniper would seem well-suited for construction, especially for the pole and mud construction of the Burnt Reed Structure coded as Phase 7A, feature 725. Pine became the timber of choice for the more monumental structures of YHSS 6 (Early Phrygian) times; it would have come from further away, but the most likely type, Pinus nigra var. pallasiana grows up to 30 m (compared to 20 m for Juniperus excelsa) (Davis 1965). Furthermore, pine grows faster than juniper, so it reaches a wide diameter sooner than juniper. Perhaps the closest oak, Quercus pubescens, was avoided in construction because it was hard to work or because the local oaks were too short to span the rooms (see Marston 2007).

Phase 7A (Early Iron Age) material includes samples from the building collapse and floor deposit of the Burnt Reed House. There is every likelihood that more than just "construction debris" is included on Table 4.2. For example, YH30419 is a bag of alder charcoal that the excavator labelled "planks." Most of the wood collected from the Burnt Reed House is juniper or pine, but here, too, the samples are mixed with other types: oak, poplar, and elm/mulberry. The proportions of the various fuel charcoals (material from trash deposits) in YHSS 7A deposits do not parallel those from the contemporary BRH (stratum 725). Furthermore, weight and ubiquity, as measures of "importance," do not show an unequivocal trend; by weight, juniper is the predominant fuel and construction wood, but by ubiquity it seems fairly unimportant compared to pine and oak in the samples excavated.

Early Phrygian construction debris comes from the Destruction Level (YHSS 6A), Terrace Building 2A (YH strata 610, 620). Nearly all the charcoal is pine. The small quantity of oak could have come from room furnishings, and is unlikely to have come from the ceiling beams.

YHSS 3 (Hellenistic) deposits sampled by the Yassıhöyük stratigraphic sounding that yielded charred construction wood include clearly burned roof material from a burnt room in the "Abandoned Village" (deposits from Operation 2 designated by YH strata 320, 330, 350). Most of the charcoal (by count, weight, and ubiquity) is pine, and there is an admixture of oak and a small amount of ash. Due to the fact that one unworked charcoal chunk looks pretty much like another, one cannot exclude the possibility that some of the charcoal comes from burnt furnishings, stored fuel wood, or other wooden items that might have been burned in the room. For example, if excavators had noted particular artifacts or concentrations, it would have been possible to separate construction debris from other functional categories of wooden objects. The fact that the distribution of charcoal types from the burnt room deposits is primarily pine rather than oak supports the view that the charcoal in these deposits is primarily construction debris.

Building materials in Terrace Building 2A parallel the predominant fuel wood of its time (YHSS 6A and 6B combined)—pine. The situation is quite different in YHSS 3, the Hellenistic deposits. Here, if one looked only at the construction debris, pine would look like the most important wood. By segregating out construction material from ordinary firewood, oak emerges as the main wood in the assemblage. This strongly suggests pine was not as economical for fuel as it had been in Early Phrygian times, though people were still willing to go some distance for construction material. Alternatively, perhaps this was a time when pine was grown or harvested for its timber, with firewood being an incidental use of trimmed branches. Under current conditions near Gordion, cultivated trees must be carefully watered until their roots get deep (K. DeVries, pers. comm. 1991), but such care would at least have had the benefit of reducing transport costs for a bulky item like lumber.

Other botanical indicators of climate and vegetation changes: pollen, phytoliths, and seeds

Where the landscape over time has been so influenced by a human presence, distinguishing "natural" from human-induced changes in the vegetation is not straightforward. Even if dryness has prevented non-riverine trees from growing in central Anatolia below 700 m, the precise boundaries between the treeless steppe, steppe-forest, and forest zones will probably never be known with certainty, much less the shifts that have occurred over the centuries. For the periods under discussion, however, major global climate change does not appear to be the primary factor in vegetation changes. Bottema and Woldring's (1990) review of Holocene pollen data suggests that many vegetation changes are most readily explained as the result of human interference with the vegetation, though there have been some climate fluctuations. For example, commonly observed decreases in the arboreal/non-arboreal (AP/NAP) ratios were "very likely caused by the impact of prehistoric people." Even so, at about 3200 BP (ca. 1500 calib. BC), a decrease in some Compositae pollen (Centaurea solstitialis-type) suggested "moisture conditions more favourable for tree growth" on the Anatolian plateau (ibid.); as mentioned earlier, this could explain the high proportion of pine in YHSS 9/10.

Even in the absence of world-wide or regional climate shifts, highly localized habitat shifts might occur in a landscape that would already be sensitive to small changes in moisture available to plants, since the vegetation cover itself influences available moisture. Depending on the scale of the disturbance, cutting down trees in central Anatolia could have some potentially far-reaching effects on the water balance. As Kuniholm (1977) points out, deforested land in the region suffers soon and severely from erosion (dust storms from the winds across the plateau can be quite dramatic), and forest soils would not last long. In turn, severe erosion in the hills would leave bare ground, increased run-off would follow, and the water table could be lowered as well. Loss of vegetation could allow temperatures to rise, which would intensify the effects of summer drought.

Widespread tree-felling could therefore have shifted the borders between the different vegetation zones, directly (by obliterating the trees) or indirectly (by inducing small changes in available soil moisture). Although the charcoal analysis cannot by itself locate the borders of ancient vegetation zones, a combination of geomorphological and phytolith research might help resolve this issue. For example, in a preliminary geomorphological study, Ben Marsh (1993) suggests post-Phrygian erosion on a massive scale could be relatively recent; he suggests over-grazing as a cause; sedimentary evidence of massive erosion is Medieval or later (Arlene Rosen (pc 7/12/99). The findings are consistent with the botanical evidence, which suggests that forest trees grew relatively close to Gordion as late as the Medieval period. If erosion has not totally destroyed original soils, or if paleosols can be found, transect sampling of soils across the current theoretical borders of vegetation zones might reveal the vegetation history. Although there are many difficulties with this approach, it is one that has been used in the United States to locate shifts in the prairie and forest edge (Wilding and Drees n.d., Mohlenbrock 1991). This sort of analysis can distinguish leaf phytoliths from grass phytoliths, and conifers could be distinguished by their distinctive cross-field pits in silicified tracheids (S. Mulholland, pers. comm. 1991). Thus, the actual and hypothetical vegetation is well-suited to this kind of analysis.

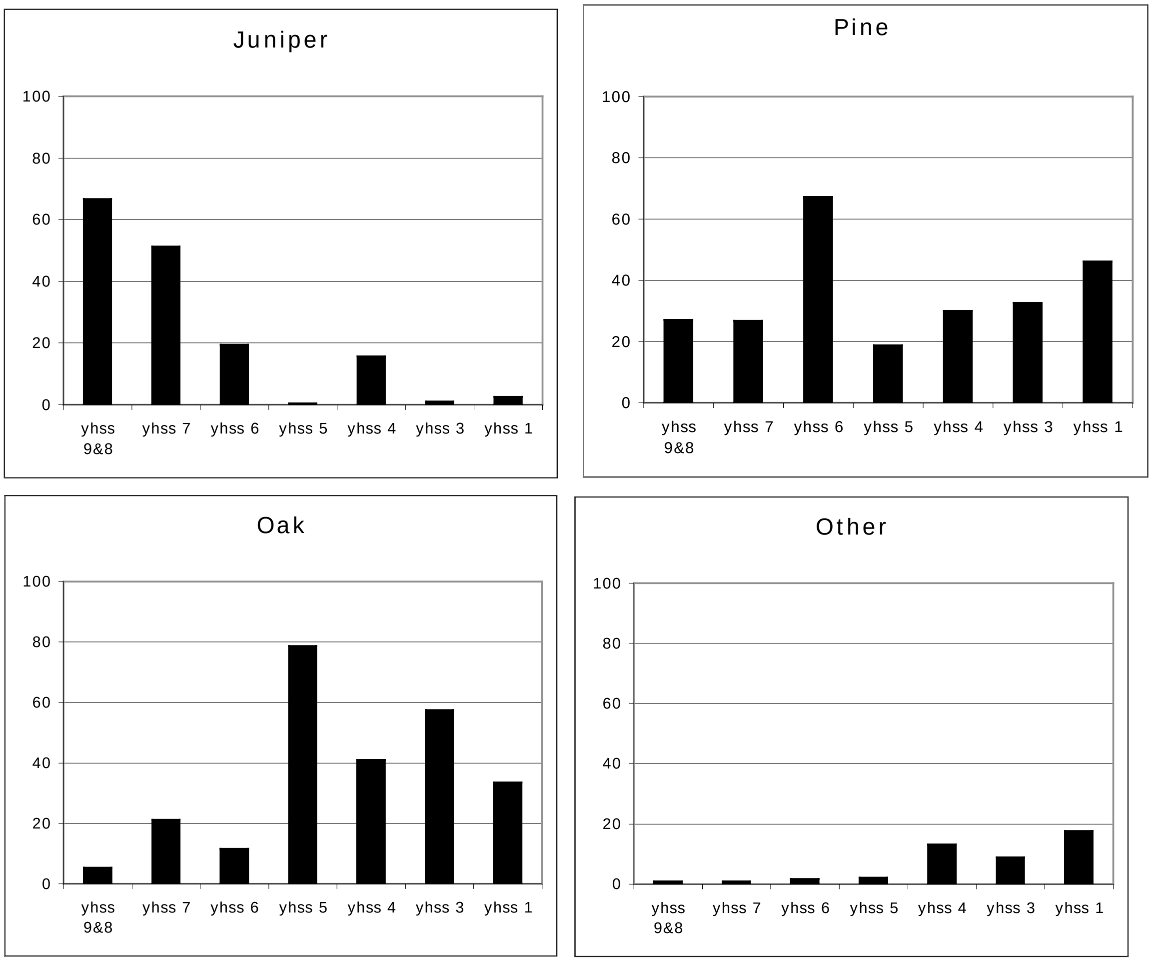
The vegetation zone least amenable to charcoal analysis is, of course, the treeless steppe. The primary steppe vegetation of central Anatolia is probably characterized by a high proportion of grasses (van Zeist et al. 1975:68); a few species of grasses and other plants may serve as indicators of steppe, as opposed to cultivated lands (Appendix C). Over time, even in the absence of cultivation, grazing on the natural steppe might encourage the survival and expansion of such unpalatable types as wild rue (Peganum harmala). Fortunately, flotation analysis of seed remains can be informative. The seeds of two anti-pastoral types (wild rue and camel thorn [Alhagi camelorum]) do seem to increase in frequency after the Early Phrygian period, and some of the hypothesized steppe plants may decline (see below).

Results of the Charcoal Analysis

1) Oak, pine, and juniper have been major components of the arboreal vegetation within a 50-km radius of Gordion since Late Hittite times. Pine may have extended into lower elevations than today, or at least grown closer to Gordion.
2) Over the entire sequence, juniper use declined. Oak and pine became the most prominent types in the arboreal vegetation. These shifts in the proportions of juniper, oak, pine, and the increase in the minor components are evidence of an overall reduction in arboreal vegetion near Gordion.
3) A decline in the three dominant types probably set in by Late Phrygian times.
4) There is no reason to invoke climate change to explain the inferred changes in wood use. The proposed vegetation shifts are not that dramatic, and mainly involve reduction in the number of trees. These changes are readily explained by human factors. This is not to say that climate did not change at all, or that climate shifts are necessarily irrelevant.

5) Archaeological fuel remains and charred construction debris provide different and complementary information about ancient vegetation and wood use. It is impossible to interpret the charcoal remains adequately without knowing the archaeological context of the finds.

Fig. 4.1. Bar graphs of major charcoal types (by weight, source Table 4.1a)



Data:

YHSS	N	oak	pine	juniper/conifer	other
9&8	13	5.26	27.13	66.71	0.90
7	52	21.13	26.72	51.23	0.92
6	16	11.66	67.17	19.5	1.68
5	8	78.69	18.72	0.46	2.12
4	71	41.04	30.05	15.76	13.16
3	36	57.46	32.64	1.02	8.88
1	12	33.51	46.22	2.6	17.71

Fig. 4.2 Ubiquity (%) of major types (source: Table 4.1c)

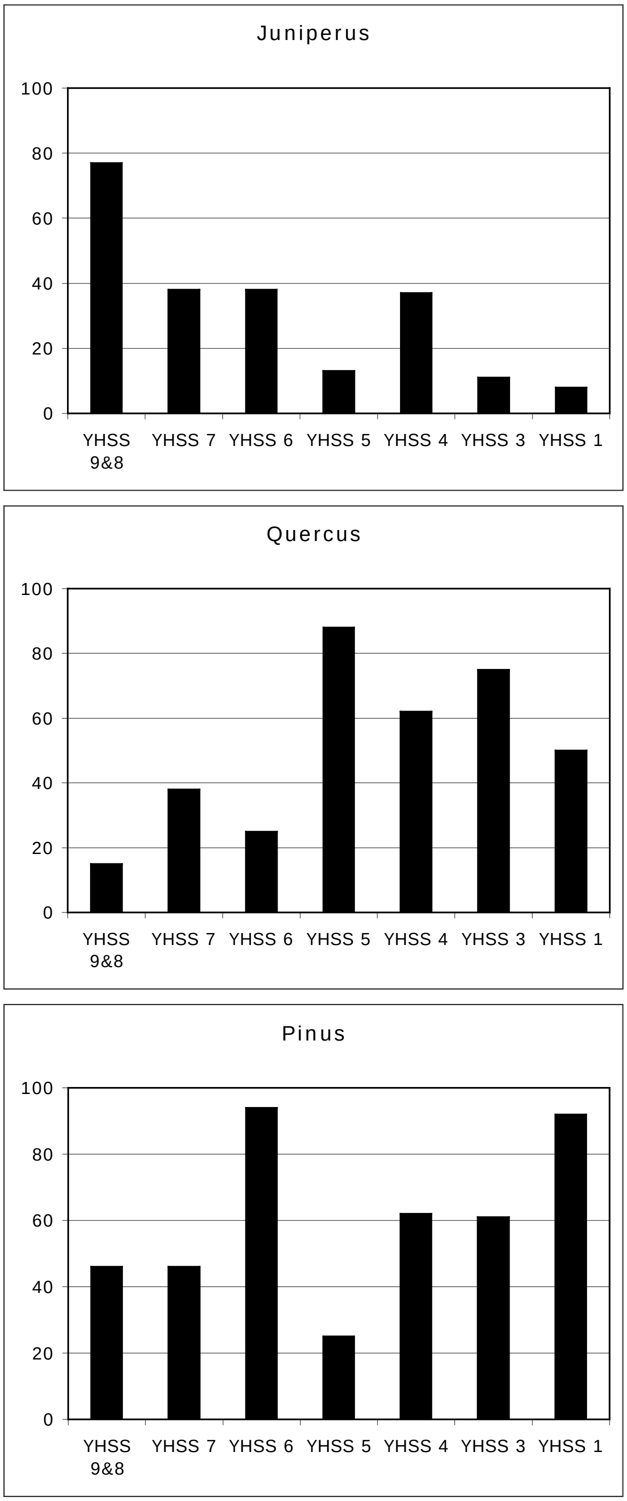
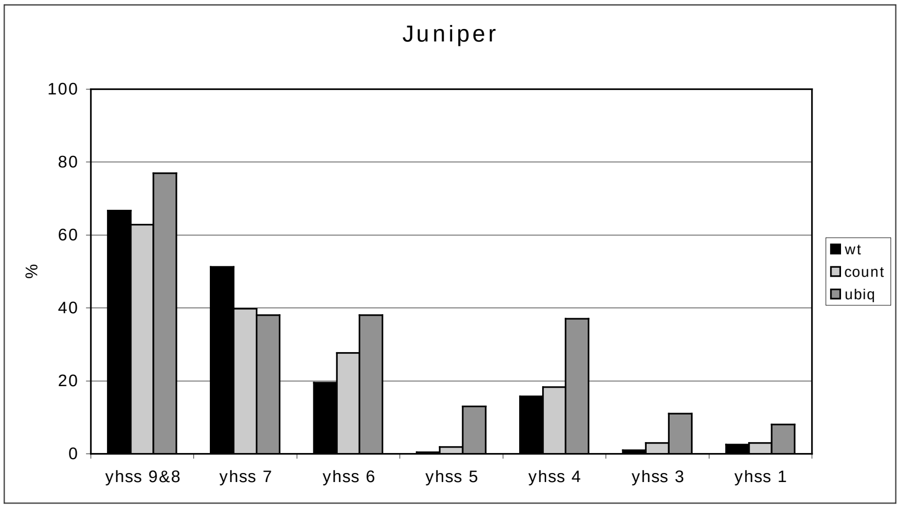
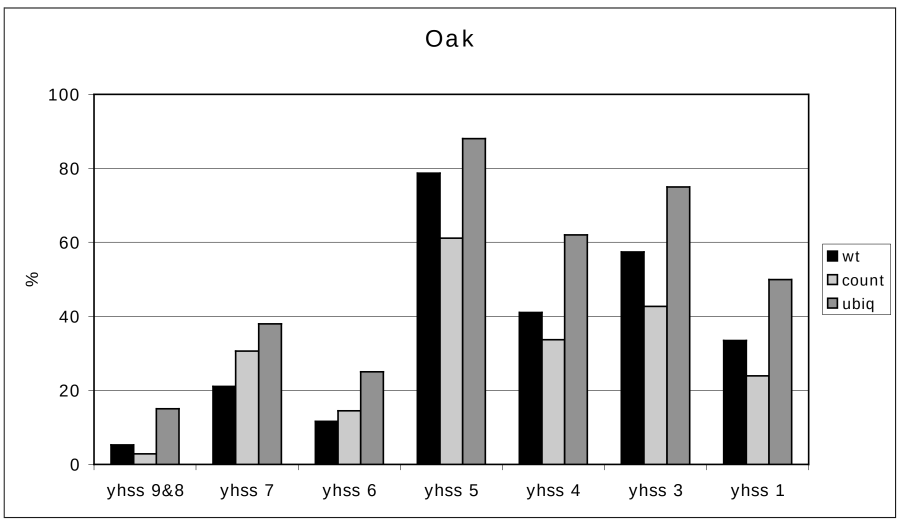


Figure 4.3 Comparison of percent by weight, count, and ubiquity for the major types (YH App E char data, char summaries)





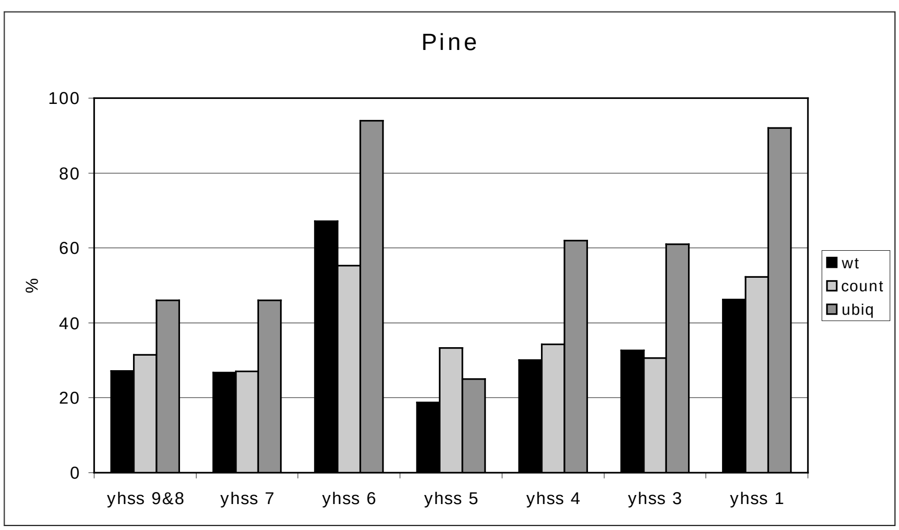


Table 4.1a. Charcoal from occupation debris (% by weight, g); data in Appendix E, sheet 1

YHSS	No. of samples	Tot. wt.	Wt. identified	Quercus	Pinus	Juniperus/ conifer	Other
9&8	13	117.96	75.61	5.26	27.13	66.71	0.90
7	52	362.58	178.32	21.13	26.72	51.23	0.92
6	16	42.52	34.05	11.66	67.17	19.50	1.68
5	8	173.03	53.73	78.69	18.72	0.46	2.12
4	71	365.59	235.86	41.04	30.05	15.76	13.16
3	36	211.68	118.56	57.46	32.64	1.02	8.88
1	12	27.80	20.38	33.51	46.22	2.55	17.71

Table 4.1b.Charcoal from occupation debris (% by count); data in Appendix E, sheet 1

YHSS	No. of samples	No. pieces identified	Quercus	Pinus	Juniperus/ conifer	Other
9&8	13	70	2.86	31.43	62.86	2.86
7	52	251	30.68	27.09	39.84	2.39
6	16	76	14.47	55.26	27.63	2.63
5	8	54	61.11	33.33	1.85	3.70
4	71	475	33.68	34.32	18.32	13.68
3	36	232	42.67	30.60	3.02	23.71
1	12	67	23.88	52.24	2.99	20.90

Table 4.1c.Charcoal from occupation debris (% ubiquity); data in Appendix E, sheet 1

YHSS N	9&8 13	7 52	6 16	5 8	4 71	3 36	1 12
Quercus	15	38	25	88	62	75	50
Pinus	46	46	94	25	62	61	92
Juniperus	77	38	38	13	37	11	8
Conifer	0	8	13	0	10	6	8
Fraxinus	0	2	0	0	3	0	0
Populus/Salix	0	0	0	0	3	22	17
Rhamnus	0	0	0	0	3	0	0
Morus	0	0	0	0	1	0	0
Ulmus	8	0	0	0	4	6	25
Pyrus/Crataegus	0	0	0	13	10	6	8
Prunus	0	0	6	0	0	0	0
Unknown 1	0	0	6	0	1	6	0
Unknown 3	0	0	0	0	3	0	0
Unknown 4	0	0	0	0	1	3	0
Tamarix?							
Indet.	0	8	0	0	7	11	17

Table 4.2a. Charcoal from burnt buildings (% by weight), data in App. E, sheet 1

	Early Iron Burnt Reed House	Early Phrygian Terrace Building 2A Destruction Level	Hellenistic "Abandoned Village"*
YHSS Phase	7A	6A	3
No. samples	21	28	23
Total sample wt. (g)	868.37	6661.65	1203.39 [654.95]
Wt. identified	374.30	4770.34	793.96 [245.52]
Quercus	6	3	18 [34]
Pinus	13	97	80 [64]
Juniperus	43	0	+ [+]
Fraxinus	+	0	1 [3]
Populus/Salix	5	0	+[+]
Ulmus	+	0	0 [0]
Alnus cf. viridis	33	0	0 [0]
Indet.	0	0	+ [+]

*bracketed number excludes outlier, a pine beam segment weighing 548.44 g

Table 4.2b. Charcoal from burnt buildings (% ubiquity)

	Early Iron Burnt Reed House	Early Phrygian Terrace Building 2A Destruction Level	Hellenistic "Abandoned Village"
YHSS Phase	7A	6A	3
No. samples	21	28	23
No. identified pieces	34	23	38
Quercus	14	7	57
Pinus	52	75	87
Juniperus	76	0	4
Fraxinus	0	0	9
Populus/Salix	10	0	4
Ulmus	5	0	0
Alnus cf. viridis	5	0	0
Indet.	0	0	4

Chapter 5
Analysis of the Flotation Samples

Methodological and Analytical Assumptions

During the 1988 and 1989 excavations seasons, over 600 flotation samples were taken from about 230 stratigraphically recognized deposits (Table 5.1). A small proportion of these were stratigraphically mixed in antiquity or were not as well excavated as they might have been. In choosing samples to analyze, I tried to get as full a time range as possible, as many in situ hearths and pits as there was time for (including multiple samples from complex deposits), and some samples that were from securely dated deposits but otherwise not noteworthy.

A variety of measures can be used to assess the importance of the different plant types for environmental and economic reconstructions. Absolute quantities of remains are less significant than densities and relative amounts. The seed/charcoal ratio reported here is based on the material larger than 2 mm, and is effectively a cereal/charcoal ratio, since only a few legumes and weed seeds were larger than 2 mm. It is difficult to generalize about minor differences between the time periods. Ideally, one would see some overall trends. But most comparisons between time periods, though not meaningless, are not easily interpreted. Despite extensive archaeobotanical sampling, patterning is hard to see for a few reasons. First, the samples are very diverse. Even after 200 soil samples had been examined, new types were occasionally discovered. The number of wild types represented by more than 100 specimens over the entire the sequence is about 70 (including unknowns), and those represented by more than 1000 is three. Second, there are many unknown types or taxa so broadly defined that they cannot be assigned to an ecological niche. For example, I have been able to designate only a few genera that seem to be indicators of steppe. Even so, a few patterns have begun to emerge.

Where possible, the summary statistics for each phase give each sample analyzed equal importance (wild:cereal, seed:charcoal). Some small samples have to be excluded from ratio analyses because the denominator would be zero or unmeasureable. In some cases, however, I have decided to add items together as totals for each phase. Statistically, this procedure weights samples by the value of the denominator; for example the total amount of wheat relative to the total amount of wheat and barley gives more importance to samples with more identified cereal (Miller 1988). The purpose is to give some idea of possible trends, and therefore may serve simply to suggest hypotheses that might be tested using additional data.

Excavators were instructed to take soil samples from the full range of deposits they encountered. In order to maximize the quantity of material recovered without ignoring deposits poor in remains, the sampling procedure emphasized deposits most likely to have charred remains: hearths, pits, and deposits where charred material was obvious. The debris lying on floors was also sampled. Unlike the debris samples, flotation samples from the three burnt buildings more commonly consist of charcoal in overwhelming proportions, with almost no seeds (i.e., fallen roofing and other construction materials), or virtually pure crop seed samples, easily recognized as such by the excavators in the field. For that reason, material from the burnt buildings is analyzed separately.

Quantification of the Remains from Occupation Debris

It is not possible to reconstitute the totality of plants or even of seeds that were brought to the site and burnt. The goal of the procedures for quantifying the archaeobotanical remains is somewhat more modest: it should enable one to discover patterns of deposition and preservation as they vary in time and space. It is also hoped that the presentation of results will be a fair representation of the assemblage. When and if enough samples are analyzed, one would hope that the observed patterns would be relatively stable, even if one analyzed additional samples.

Density of charred material in the soil samples reflects how intact the material is in a given deposit. One might expect in situ hearth deposits to have higher densities of charred material than hearth sweepings, but an efficient fire might produce more ash than charcoal. For example, highly combustible straw will burn faster and more completely than wood, and fuel in a fire that is tended will be exposed to oxygen and leave ash rather than charcoal. (Table 5.2, Figure 5.1). The distribution, which shows that most samples have little charred material, suggests that even hearths do not have in situ deposits. Rather, the charred material in most samples is most likely redeposited hearth sweepings. With four exceptions, even the material excavated from hearths is likely to be from settlement debris rather than from the last fire burned in it. The distribution of charred material density by time period is similarly uninterpretable; as with deposit type, most samples have relatively low densities of material (Table 5.3, Figure 5.2).

Because excavators had been asked to collect all the visible wood charcoal they came across, the estimates of charcoal quantities of all samples from a given time period were simply added together to generate percentages of the various taxa and changes through time. One can argue with the validity of the results, but had this ideal sampling strategy been followed, the assumption is reasonable. This assumption does not apply to the flotation samples. Not all deposits were sampled, and not all samples were analyzed for this report. Neither the stratigraphic units nor the samples extracted from them come from equivalent soil volume, and they contain different densities of charred material, so in principle it is not appropriate to simply add the taxa, as has been done for the wood charcoal. On the other hand, the density distribution over time and space supports the contention that there is one major source of botanical material: charred residues of fires. Sampling in the field and laboratory favored pits and hearths, and in several cases, more than one sample per stratigraphic unit was analyzed. Nevertheless, based on the provenience information available in between 1988 and 1991, samples were chosen for analysis that would represent all time periods and a variety of functional deposits.

Even though absolute amounts of material have little meaning, some variables can characterize the samples independent of soil volume or total amount, and will be discussed below: the seed:charcoal ratio as an indicator of fuel choice (dung, wood) and the wild:cereal ratio as an indicator of fodder choice (pasture, fodder crop). To isolate indicators of importance for particular species, percentages and frequencies (for some taxa) for some taxa are considered for samples grouped by time period, even though this requires the assumption that the distribution of the remains fairly represents the charred material withing the excavated deposits and ultimately for each time period. Insofar as different ways of arranging the data reveal similar or supporting patterns, those patterns will be considered more secure, and are likely to remain stable with further analysis. Some of the patterns are simply a function of sample size; so few samples were taken or so few seeds were recovered from some periods that the full range of taxa cannot be expressed. Note that in many of the graphs, periods YHSS 5, 6B, and 1 have few deposits sampled and fewer than 100 seeds each, and dramatic shifts, especially in those phases, are most safely attributed to chance.

In Appendix F, data are listed individually by sample, so that others may experiment with different assumptions.

The Taxa: Economic and Ecological Significance

The diversity of types in these samples is remarkable; I have already noticed over different 70 types of seeds and a variety of other plant parts (straw, grain rachis fragments, the heads of two types of composites; for full accounting, see Appendix F Tables F.2–7). Cultigens include barley (probably hulled 2- and 6-row types), one-seeded einkorn, emmer, bread or hard wheat, rice, lentil, bitter vetch, chickpea, possibly pea, flax, and grape. There was also some almond and other nutshell. Despite conscientious collecting of voucher specimens and seeds in the area around Gordion, a number of the archaeological types remain unidentified, and many more have only been identified only to the level of family. For identification criteria and ecological or economic significance of the wild and weedy taxa, see Appendix D. Appendix G contains details of floristic studies carried out in the Yassıhöyük area. Following common archaeobotanical practice, I refer to the preserved reproductive parts of the plants as seeds, though technically some are fruits (for example, the achenes of the Asteraceae).

Crop plants

Cereals

Wheat (Triticum). At least two broad categories of wheat are present in these samples. The most numerous in grain and rachis is bread wheat (Triticum aestivum (Table 5.4), including some of the compact type). A small number of rachis fragments are attributed to macaroni wheat (T. durum), so on the data charts the grains are listed as Triticum aestivum/durum (Appendix F2, F5). Einkorn (T. monococcum) and emmer (T. dicoccum), two glumed wheats, also make an appearance as grain and spikelet forks.

The flotation samples contained varying amounts of intact, measurable wheat grains. Although interpretations are not straightforward, grain size and shape can help distinguish different taxa or cultivation practices. For example, among the naked wheats, the compact type is characterized by short broad grains. Within a given variety, irrigation may affect the shape of the grain; measurements of two modern 200-grain samples hinted that irrigation may reduce the L:B ratio (Miller 1982:112). For purposes of the analysis, I treat the grains from each time period as a unit if they come from occupation trash and debris rather than burnt structures. The samples which seem to be cleaned crops are not included. That is, I treat "prime grains" (in the sense of Hillman 1984:23) separately from the rest, because they are less likely to come from the waste fraction of crop cleaning or burned dung fuel. In general, the "prime grain" (from the BRH YHSS 725) is larger than the other wheat from the Early Iron Age, but the difference is not great. There is no significant change in the other grain between the Middle Bronze Age and Medieval times, despite the fact that the site underwent major cultural change and that the wheat assemblage may well be heterogeneous (more than one type of naked wheat). The barley shows a similar homogeneity (see below for discussion).

Some Triticum aestivum from TB2A and BRH burnt buildings are most probably cleaned crops (Table 5.4b). The Destruction Level seeds come from a crop sample in a small jar. The wheat, which is quite small from the intense burning, is similar in shape measures to the wheat sample from the Burnt Reed House. Thus, there are no obvious morphological differences.

Einkorn (Triticum monococcum). Although no caches or pure samples were found, it is likely that einkorn was a field crop, at least during the Iron Age (Table 5.5). Einkorn is a minor component of archaeobotanical assemblages in the Near East that date to the second millennium B.C. and later (Miller 1991). It was known to and grown by the

Hittites (Hoffner 1974), but it remained popular in southeastern Europe well after it had become a minor crop plant in the Near East (see Hubbard 1976; Kroll 1991). Never numerous at Gordion, einkorn relative to other wheat and barley increases in the Early Iron Age (Figure 5.3). It is possible that this anomalous increase was due to Phrygians from southeastern Europe as postulated by Voigt and others above. It virtually disappears as a crop after the Early Phrygian period (as a percent of wheat).

Emmer (Triticum dicoccum). The presence of low quantities of emmer overall suggest it was either a very minor crop or a minor contaminant of other crops.

Barley (Hordeum vulgare var. distichum and Hordeum vulgare var. hexastichum). Both two-row and six-row barley are attested. Of the determinable grains, most are twisted (indicative of six-row barley), yet most of the determinable rachis fragments come from the two-row type (Table 5.6, 5.7). The stems and leaves of both types are good for fodder. The cultivation of two-row barley is totally consistent with what we know about the drinking habits of the Phrygians, not to mention the Hittites before them and every other group that lived at Gordion, up to and including the archaeologists (Sams 1977; Hoffner 1974; pers. obs.). Namely, two-row barley is preferred for beer-making, because it is starchier than the six-row type. Six-row barley grain is more likely to be fodder, and usually needs more water than the two-row type. In recent times, barley is grown primarily for fodder (grain and leaf), but it may also be eaten.

The proportions of wheat and barley vary. In most periods, barley constitutes more than half of the identified grain (by weight), but less than half by rachis fragments (count) (Figure 5.4)

Millets. (Setaria sp., Panicum sp.). Millets occur in small quantities through most of the sequence, though not always the domesticated types. Setaria italica shows an increase over time relative to other cereals (the categories bread/hard wheat and barley) (Figure 5.5). Based on concentrations encountered during R. Young's excavation of the Destruction Level, millets—Setaria italica and Panicum miliaceum, were undoubtedly crop plants by that time (Nesbitt and Summers 1988). As a summer crop, they would would have been irrigated.

Rice (Oryza sativa). Six grains from a Medieval period oven (YHSS 150.03) presumably would have been irrigated. One of the rice grains still had a fragment of the hull attached, which suggests it may have been locally grown, and several samples had silicified rice hull fragments. Rice was grown by the villagers of Yassıhöyük until the late 1950s (Ay{s}e Gürsan-Salzmann, e-mail 1/18/07) so this is not an outlandish possibility.

Cotton (Gossypium)

Six cotton seeds from two Medieval deposits were identified. Like rice and millet, cotton is a summer-irrigated crop.

Pulses

Bitter Vetch (Vicia ervilia). Bitter vetch is the most common and plentiful cultivated legume in the Gordion assemblage. The finds of a concentration of bitter vetch in the BRH (burnt reed house) (YHSS 7) and several in the destruction level (pers. obs. and M. Nesbitt, letter dated 22 January 1989, Gordion archive) shows that it was grown as a crop. Although bitter vetch is usually considered a fodder plant, Hans Helbaek identified it from food storage contexts at Late Bronze Age Beycesultan (Helbaek 1961), and at least some of the Gordion remains could represent food. Its toxicity make special processing necessary to render the seeds fit for human consumption (Enneking 1995:9). Bitter vetch was an early cultigen in southeastern Europe and Turkey (Zohary and Hopf 1994), but it became a minor crop that is grown primarily for fodder. It occurs in all periods at Gordion; in addition to incidental inclusion in debris samples, a concentration of bitter vetch was found in the Iron Age burnt structure (YH 33335) and YHSS 6.

Lentil (Lens). Several concentrations of lentil in Terrace Building 1 (YHSS 6) demonstrate that it, too, was grown, one of which is reported here. As a food plant for humans, lentil is far superior to bitter vetch, yet it tends to be less common in the occupation debris. This suggests that the pulses found in those samples might have originally come from fodder that found its way into dung fuel. At issue is a total of 78 lentils and 191 bitter vetch in the assemblage analyzed to date, so these numbers may not be significant.

Chickpea (Cicer arietinum). Their presence in the heavy fractions of two samples (YH 21068, YHSS 3 and YH 23774, YHSS 4) is enough to suggest that chickpea may have been grown, but it does not appear to have been a major crop plant. Mark Nesbitt reports a sample with chickpeas as well (letter dated 22 January 1989, Gordion archive).

Nuts, fruits, and oil seeds

Nuts. Almond (Prunus spp.), both cultivated and possibly wild, and a thin nutshell (Pistacia) were found. Wild almond (Prunus sp.) was seen in five light fractions and nine heavy fractions, mostly in Iron Age and Late Phrygian contexts. A domesticated almond (P. amygdalus) was found in the destruction level. Today, a spiny branched wild almond (acı badem; Prunus = Amygdalus orientalis) grows within about 15 km of the site (near Çekerdeksiz and Dümrek, in both cases on basalt substrate). The domestic type is grown in Yassıhöyük. Pistachio is not cultivated today, and the one identifiable nearly whole nut is of the wild type, similar to çitlenbik (Pistacia cf. terebinthus) that is for sale in the local market [see Figure D.114]. Mark Nesbitt identified hazelnuts in several samples from the destruction level (letter dated 22 January 1989, Gordion archive).

Grape (Vitis vinifera). Grape occurs only rarely at Gordion, in fragments. Nowadays one sees a few grapevines in gardens, but even with watering, the vine is not a common plant in the area today. Organic residue analysis identified tartaric acid indicative of wine in vessels from the funerary feast remains of Tumulus MM, but the wine could have been produced elsewhere (McGovern et al. 1999); wine is well-attested in Hittite sources (Hoffner 1974: 39–41), and into the twentieth century, vineyards were tended in the Ankara.

Cherry. A single cherry pit (Prunus sp.) occurred in the heavy fraction of YH 29541, a Late Phrygian sample. Mark Nesbitt (letter dated 22 January 1989, Gordion archive) encountered several uncharred, rodent-gnawed cherry pits from Young's excavations.

Hackberry. Although the wood of Celtis was not encountered, it is a component of the central Anatolian steppe forest, and Celtis cf. glabrata was seen growing about 45 km west of Gordion near Yunusemre.

Flax (Linum usitatissimum). In addition to two probably wild specimens found in flotation samples, a jar of flax seeds was found in the Destruction Level of Terrace Building 2A (YH 33595).[1] Flax seed size is influenced by irrigation practices (Helbaek 1959), and flax grown for oil tends to have larger seeds than that grown for fiber (Zohary and Hopf 1994: 119). Unfortunately, intense burning reduced the mass of the seeds so much that measurements are meaningless. The room in which the seeds were found had loomweights and other evidence of weaving (Voigt 1994: 272), and flax fiber was found in the Tumulus MM (Bellinger 1962), so one might suppose these seeds to be the stock for the fiber plant. On the other hand, in the same room were similarly placed small jars of obvious food plants (wheat, barley, and lentil). It is not possible to ascertain whether the seed was grown for fiber or oil, or whether it was irrigated or not. Note that in an earlier publication I mistakenly reported these seeds to be sesame (Miller 1991:153).

Wild and Weedy

Plant taxa differ in the breadth of their ecological requirements. Some grow in a variety of habitats, and others are quite restricted in their distribution. An entire plant family may characteristically grow in a particular environment (New World cacti in moisture-poor areas, sedges in moist ones), though such tendencies tend to be manifested at lower levels in the taxonomic hierarchy. But even at the level of genus or species, there will always be exceptions. It is clear from the Flora of Turkey, as well as personal observation, that very few taxa are restricted to fields (irrigated or unirrigated), gardens, steppe, or streamsides. In an attempt to identify plants that might be indicative of different growing conditions, informal vegetation surveys have been conducted within easy walking distance of the site (up to about 2 km) during the late spring and summer seasons of 1988, 1989, and the late spring and early summers of most years thereafter. I have carried out much of my collecting activity within the barbed wire enclosure of the approximately 2-ha main excavation area itself. The unprotected areas in which I

[1] I am grateful to Gordon Hillman (1993, pers. comm.) for identifying these specimens.

collected tend to be within easy reach of fields. I was generally unable to investigate the fields themselves. Peering into the grain fields from the edge (to avoid trampling them), it was clear that weed-killing chemicals are in use. In the spring of 1996, the authorities erected a fence around Tumulus MM. Beginning in 1997 (and subsequent years), I began a more formal vegetation survey within the protected area (Miller 1999; Miller and Bluemel 1999; Appendix C).

Even though the modern vegetation is by no means "natural," there are some generalizations that are probably valid. I was particularly interested in recognizing the following contrasting situations: steppe/disturbed steppe; steppe/agricultural field; unirrigated field/irrigated field or garden (Table 5.8). It would also be of interest to be able to distinguish plants whose seeds ripen in spring or fall, for that might enable one to recognize summer cropping, e.g., of millets or sesame (cf. Nesbitt and Summers 1988). The Flora of Turkey has general indications of flowering and fruiting times.

Due to the difficulties inherent in identifying charred seeds (namely, one is delighted to determine genus, let alone species), I have not been able to isolate many types that would be indicators of these situations. Some of the most common archaeological seeds (e.g., Galium) have extremely broad ecological tolerance. Most seed types occur in small numbers, making determinations even more uncertain.

Distribution of the Taxa in Time and Space

The two best-represented families are grasses and legumes (more than 7000 seeds apiece), followed by the sedges more than 4000). If you add Chenopodiaceae, mustards, mints, and composites (daisy family), these eight families account for about 75% of the seeds (90% of the seeds identified at least to family). Because of the inherent variability of the samples in quantity of remains and taxa, the strongest conclusions tend to be based on multiple lines of evidence, such as seeds and charcoal. This section attempts to reconcile results based on different types of quantification. Note further that some periods are characterized with very few samples. There are only two Middle Bronze (YHSS 10) samples, so I exclude them from the discussion and illustrations.

Ubiquity (frequency) (Tables 5.9, 5.10; Figures 5.6-5.10; Appendix G1).

The first and simplest measure of taxon importance is percent ubiquity (the percentage of samples containing at least one exemplar of a given taxon) (Hubbard 1975; ck Hubbard and Clapham 1992). This measure is inappropriate to track rare types over time, and it is inappropriate if there are very few samples in a phase. Of the eight phases, four have relatively few samples and seeds (YHSS 6B, 5, and 1), so low ubiquity values for some taxa in those samples may simply indicate that there were few seeds of any sort, and low values are due to chance preservation. Even though the number of seeds per sample in the other phases is high enough so that ubiquity values do not misrepresent the sample population, ubiquity is not as valuable an indicator as we might like. Represented by many samples containing many seeds, changes between YHSS 8/9 and 7 and between YHSS 4 and 3 are most stable.

The two most important crop plants (in terms of total amount), Hordeum and Triticum aestivum/durum, have similar frequencies, and for all time periods appear in at least 80% of the samples. Triticum dicoccum and Lens occur in smaller amounts in many fewer samples. Triticum monococcum appears to decline over time, as does, arguably, Vicia ervilia.

Even ubiquity of the most numerous seeds of wild plants is not as informative as we would hope; I include graphs so readers may judge for themselves. Possible exceptions are small but noticeable long-term increases in anti-pastoral vegetation (Peganum harmala, with its hallucinogenic alkaloids and Alhagi, with its spiny stems) (from YHSS 8/9 and 7 to YHSS 4 and 3.

Ratios

Seed:Charcoal (Table 5.11, Figure 5.11). In arid or relatively treeless regions, the seed to charcoal ratio is commonly a rough measure of dung fuel vs. wood fuel (Miller 1984, 1988; Miller and Smart 1984). If that relationship is strong, long-term vegetation shifts can be monitored. This measure cannot be calculated for a particular sample if there is an unmeasureable amount of charcoal or none, since the denominator cannot be zero, but this is not a major drawback at Gordion. Assuming the results are not due to sample numbers too small to overcome chance intersample variability, they do not show a simple trend. Rather, the relatively low average values (between 0.06 and 0.28) are very similar to those for sites thought to be located in steppe-forest and open woodland environments (Table 5.12). This is consistent with the conclusion based on the wood charcoal analysis that despite some loss of arboreal vegetation, wood fuel was available throughout the sequence. The statistical distribution of the seed:charcoal ratio does not follow a normal distribution, however, so the mean was calculated only to provide some rough comparability with other sites. Typical of many archaeobotanical data, the distribution is skewed left (i.e., most samples are characterized by relatively low values). If the median values are plotted by period, a low-point in the seed:charcoal ratio occurs during the Middle Phrygian period (Figure 5.11a; YH App F summaries). The wild:charcoal ratios show similar, though not identical trends (Figure 5.11b). Both ratios calculated as mean or medium consistently show lowest values for the Middle Phrygian samples. This suggests that wood fuel was most available at that time, but the shifts are not that large. That is, the changes that did occur, e.g., in species composition, were easily accommodated in the fuel economy.

Wild:Cereal. Insofar as the seeds come from dung fuel, the wild:cereal ratio allows one to assess grazing and foddering practices. Along the Euphrates, where herding is an increasingly important subsistence strategy in the rainfall agriculture zone as one goes from the moister north (precipitation greater than 350 mm/year) to the drier south (precipitation under 300 mm/year). Archaeologically, this is reflected in the wild:cereal ratio and proportion of sheep and goat relative to cattle and pig (Miller 1997b). In all periods at Gordion, sheep and goat are the predominant domestic herbivores (Zeder and Arter 1994), so their feeding habits would provide the predominant impression of fodder and wild plant cover. Similar to the seed:charcoal ratio, the statistical distribution of the wild:cereal does not follow a normal distribution, so it is not appropriate to compare the mean values by period; most samples are characterized by relatively low values. Some patterning appears when the data are organized in two slightly different ways. First, I recognized four "natural" groupings of samples (figure 5.12), those with wild/cereal values 0 to ≤375; 375 to ≤775; 775 to ≤1900, and ≥1900. The proportion of samples with relatively high wild:cereal ratios declines from the beginning of the sequence until Middle Phrygian times, and then increases (Figure 5.13). A similar pattern appears if one simply plots the median by time period (Figure 5.14). These results are consistent with an interpretation that herding was least important relative to farming during the Middle Phrygian period (see discussion in Chapter 6).

Percentages

Percentages allow comparisons within categories that are homogeneous with regard to a particular question. For example, they may suggest relative importance of a taxon within an ecological or economic category (e.g., percent Trigonella relative to wild seeds, percent Triticum relative to cereals or relative to field crops). Some variables, such as volume of soil, weight of charcoal or seeds, or number of wild seeds, always or nearly always have a measureable amount. Therefore, their values can be used to calculate various ratios for each sample, and if the resulting distribution is close to normal, average values per period could have meaning. For plant taxa, however, most samples contain none of that type, but a few samples may have many. In this context, average per sample is meaningless. Therefore, to detect changes over time, even changes without provable statistical significance, archaeobotanical analysis has to use less than perfect approaches in an attempt to discover those changes. It is in that spirit that I consider the cereals and the seeds of some of the more common wild taxa relative to wild seeds as a group, by time period (Trigonella, Cyperaceae). I also consider groups of taxa that individually are not common, but might be indicative of particular environmental conditions (Table 5.8, 5.13; Hans Helbaek (1969) introduced this approach in his study of Ali Kosh). Although many taxa can grow under a fairly broad range of conditions, for this report, I have assigned taxa to ecological group based on personal observation since 1988, as well as information in the Flora of Turkey (Davis 1965–1988).

The trend in the percentage of barley relative to wheat and barley grain is opposite to that of the wild:cereal ratio, which suggests barley is more likely to be grown as fodder when the animals are not sent out to pasture. The full data set does not fully support this seemingly obvious conclusion, as there does not appear to be as tight a correspondence between percent barley (relative to wheat) and percent barley rachis fragments (relative to wheat rachis fragments) (Figure 5.4).

Ecological groups indicative of steppe, overgrazed steppe, roadsides and disturbed ground (ruderals), flood plain, and irrigated and streamside. Some taxa occur commonly under more than one condition (e.g., ruderal and overgrazed, floodplain and ruderal). Trigonella constitutes the bulk of the seeds of healthy steppe plants (Figure 5.15a). The category "overgrazed steppe" includes taxa that are minor natural components of steppe, but significant components of disturbed steppe, especially Peganum harmala (Figure 5.16c). Never common, the later part of the sequence arguably has more of these types. Ruderal types show a similar distribution, due in part to overlap in the types represented (Figure 17). Combining taxa, including Galium, that are characteristic ruderal and overgrazed areas suggests a general indicator of disturbance (Figure 18). Here, too, the end of the sequence has more of those types, but they are never very numerous. The present-day floodplain is severely overgrazed, but it does include types that are not common elsewhere (Figure 19). Archaeologically, seeds of this zone are few. The sedge family (Cyperaceae) comprises most of the seeds of irrigated fields and streamsides (Figures 20). Overall, there seems to be an increase in these taxa.

This chapter has introduced several ways of quantifying the plant remains from flotation samples. By themselves, the plant remains show few clear chronological trends. Measures of ubiquity are disappointingly uninformative, and for the most part are not noticeably consistent with other kinds of percentage data. As will be seen in the concluding chapter, when the plant remains are viewed in the context of the broader agropastoral system, interpretable patterns emerge.

Flotation Samples from Burned Buildings

Samples from the burned buildings excavated in 1988 and 1989 are considered separately. Floor deposits from the burnt reed house (BRH; YHSS 725) and Terrace Building 2 of the Destruction Level (YHSS 620) both had in situ concentrations of crop plants. The floor deposits from the Abandoned Village (YHSS 350) had roofing debris.

The Burnt Reed House

The Burnt Reed House was a wattle-and-daub structure. Its construction material is discussed in Chaper 4 (the charcoal). Excavators found traces of basketry and associated crop remains. Concentrations of bitter vetch (YH 33335), barley (YH 33368), and bread or hard wheat (YH 33382, YH 33402) were found on the floor and some bread or hard wheat (YH 33394) was found in a pit. Of the samples not analyzed, part of YH 30416 and YH 33379 were sent for radiocarbon dating; they contained wheat and barley. The remainder did not have noticeable amounts of crop seeds.

The Destruction Level, Terrace Building 2 (TB2)

The end of the Early Phrygian (YHSS 6) period is marked by the catastrophic fire that covered much of the central part of the Citadel Mound, including a row of ten attached buildings that backed on to the "palace" precinct. Most of the Terrace Buildings were excavated by Rodney Young's team. The contents varied, but the basic structure was repeated: each building had a front room and a back room; the back rooms had grinding stones in the back. Seed remains from the terrace buildings included naked wheat, hulled six-row barley, lentils, and bitter vetch (Mark Nesbitt, letter 22 January 1989, Gordion Archive). The analyzed samples from the antechamber of Terrace Building 2 had concentrations of barley (YH 33575 and YH 33613), naked wheat (YH 33246), and lentil (YH 33575). Other seed concentrations in TB2 include barley (from the floor: YH 33230, YH 33574, YH 33587, YH 33600, YH 33602 and from pottery jars (YH 33554 and YH 33590); naked wheat from a jar (YH 33580); lentils from a jar (YH 33243); and flax from a jar (YH 33595). The last two were sent for radiocarbon dating (DeVries et al. 2003).

The Abandoned Village structure

Samples from the floor of a burned Hellenistic domestic structure had quite a bit of wood charcoal and straw, presumably from roofing debris. There were no in situ seed concentrations.

Fig. 5.1. Median densities (grams/liter) according to deposit type. (YH App F summaries)

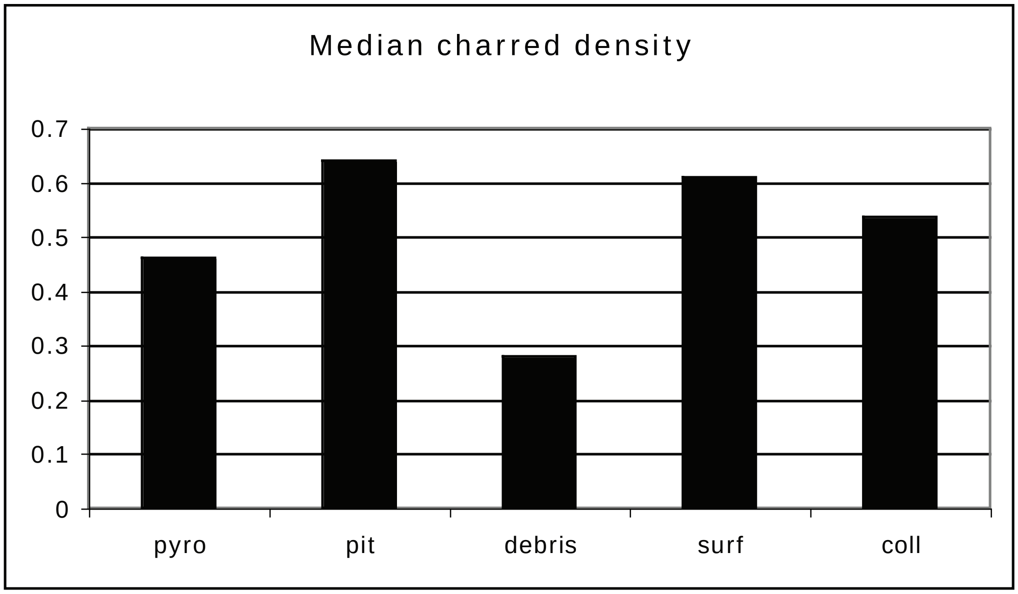


Fig. 5.2 Median densities (grams/liter) according to period (YH App F summaries)

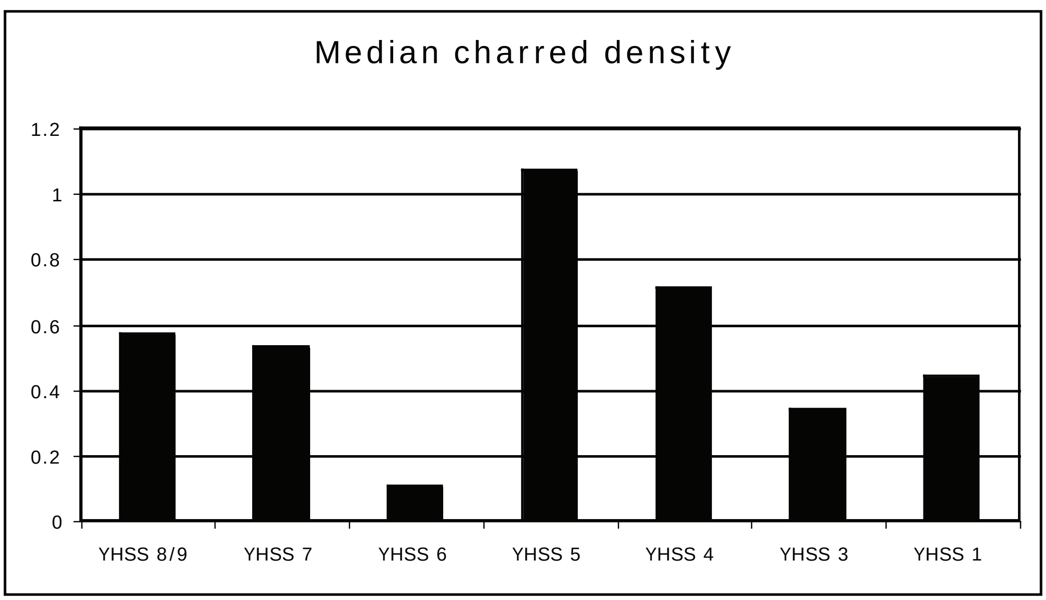


Fig. 5.11a Seed: Charcoal (g/g, mean; data in Table 5.11

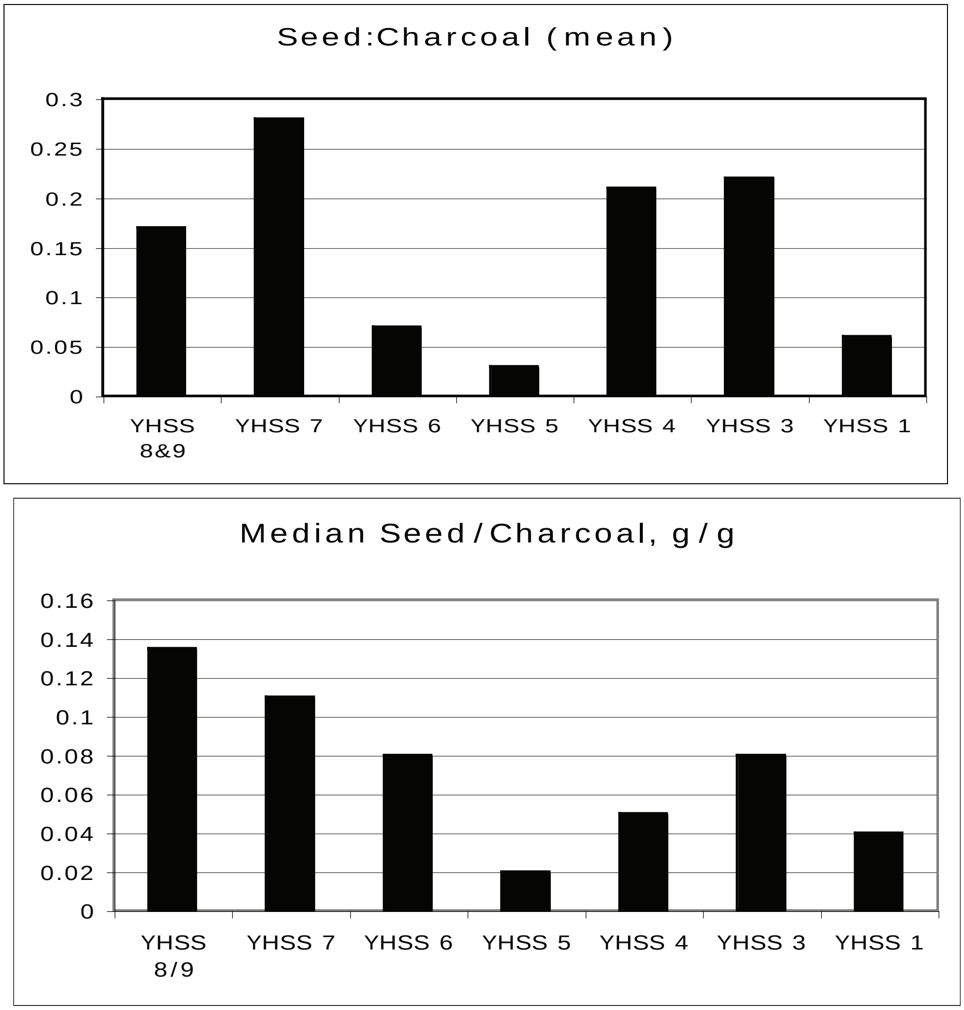


Fig. 5.11b Wild:Charcoal (count/wt.; data in Table 5.11)

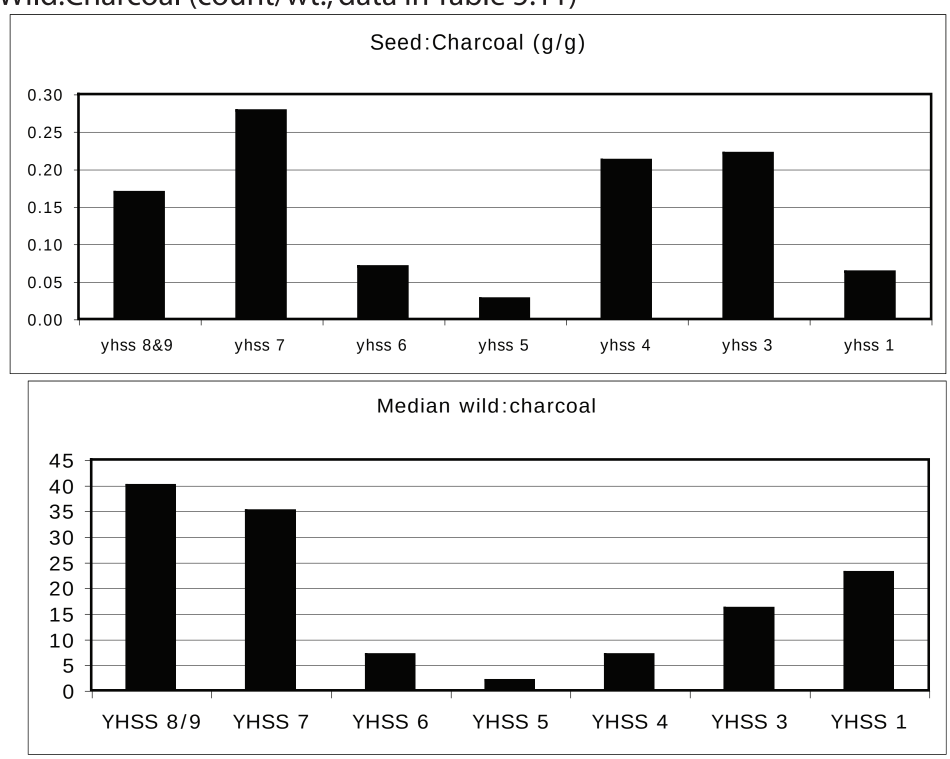


Figure 5.12 Distribution of Wild/Cereal (#/g), for all periods, all samples with ratio calculated. (Data in YH App F summaries, wild:cereal distribution); total number of samples included: 216

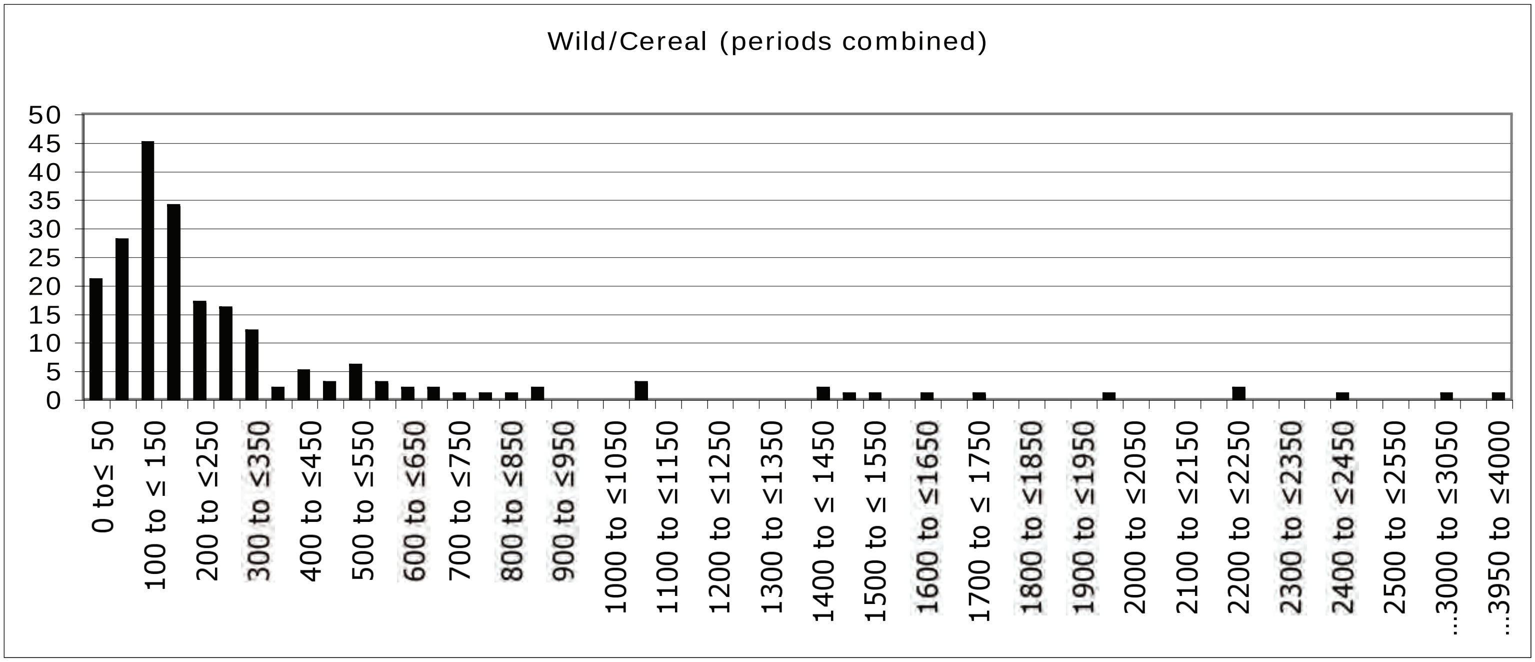
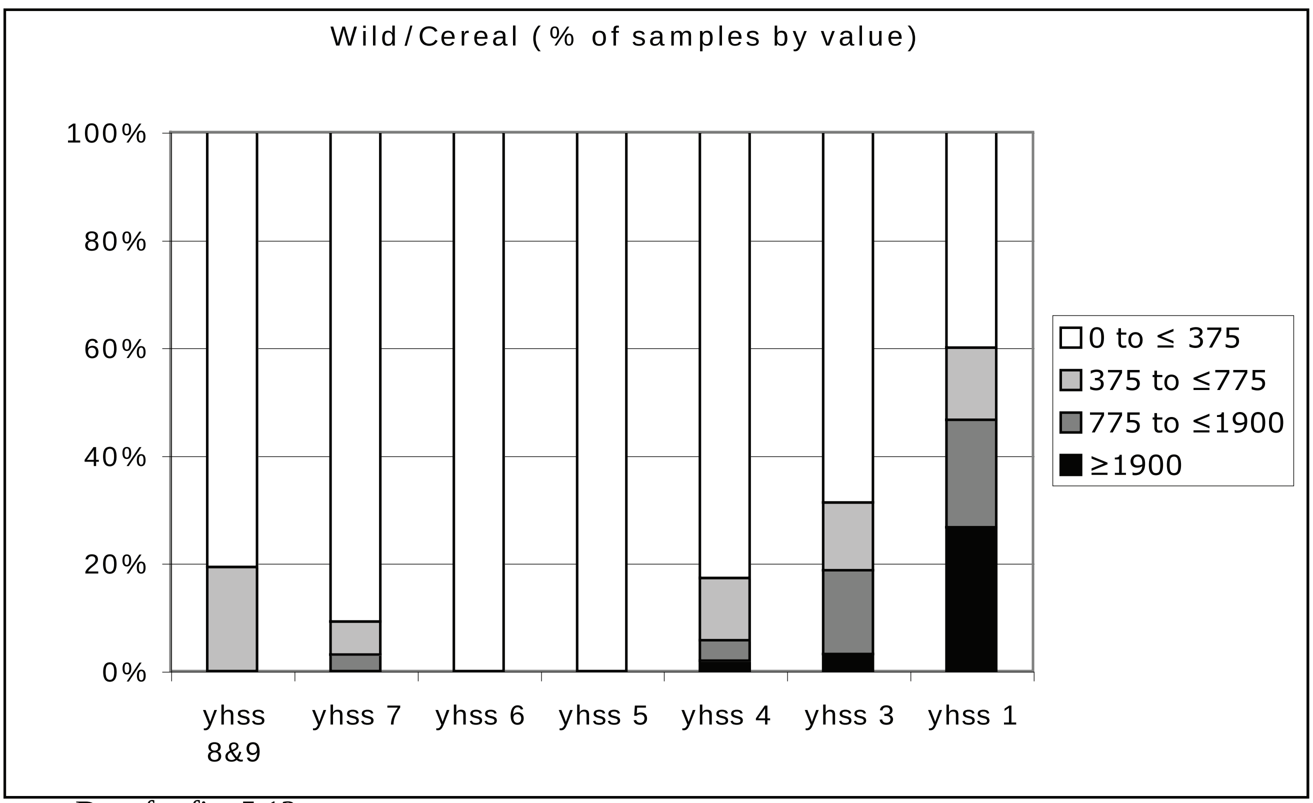


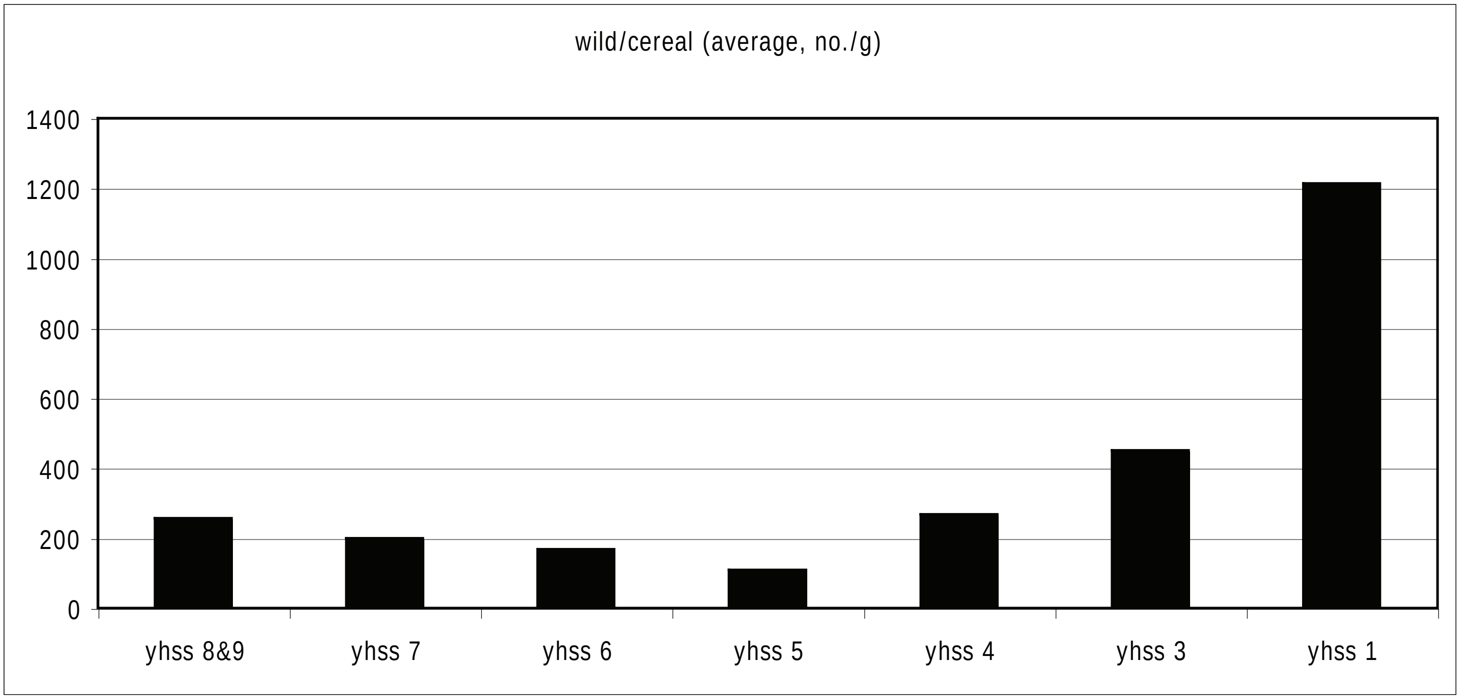
Figure 5.13 Wild/Cereal (% of samples by value)

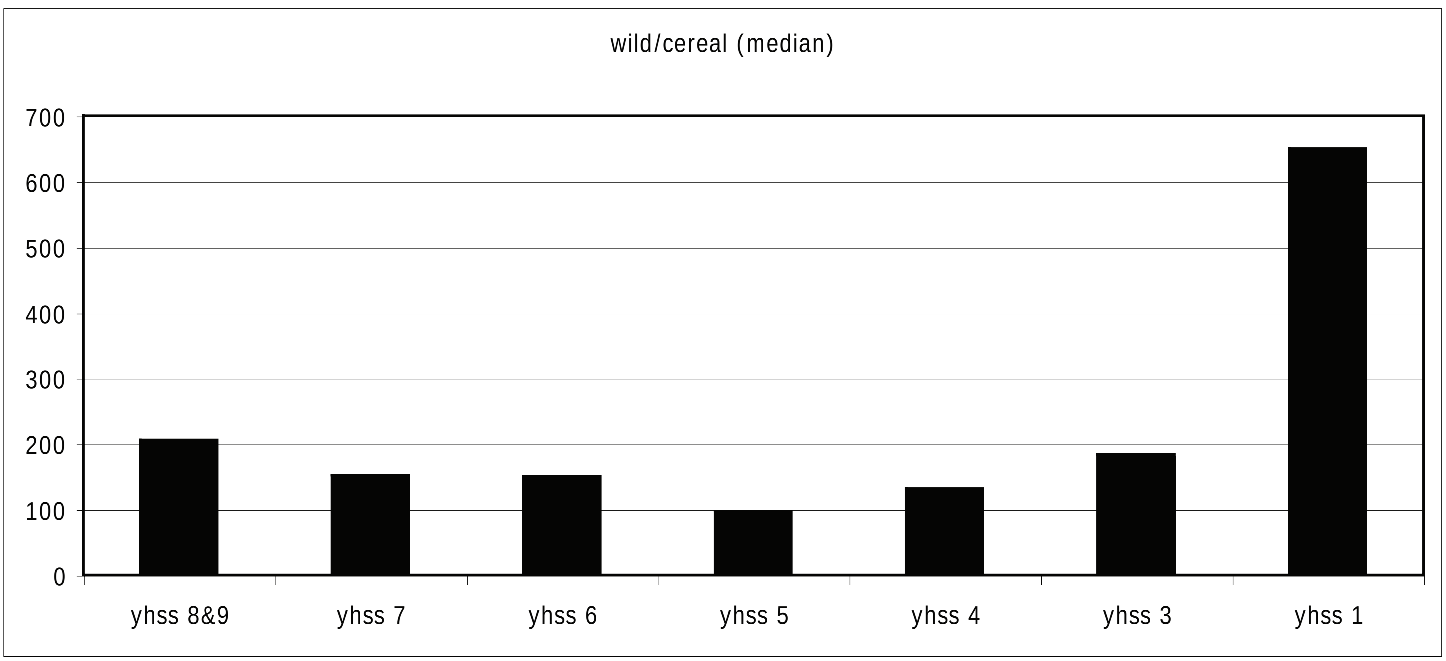


Data for fig. 5.13

Wild/Cereal value group	YHSS 8&9	YHSS 7	YHSS 6	YHSS 5	YHSS 4	YHSS 3	YHSS 1	YHSS 10
≥1900	0	0	0	0	1	1	4	0
775 to ≤1900	0	2	0	0	2	5	3	1
375 to ≤775	6	4	0	0	6	4	2	0
0 to ≤ 375	25	59	5	14	43	22	6	1
No. samples	31	65	5	14	52	32	15	2

Fig. 5.14. Mean and median wild/cereal (Data in YH App G2 summaries

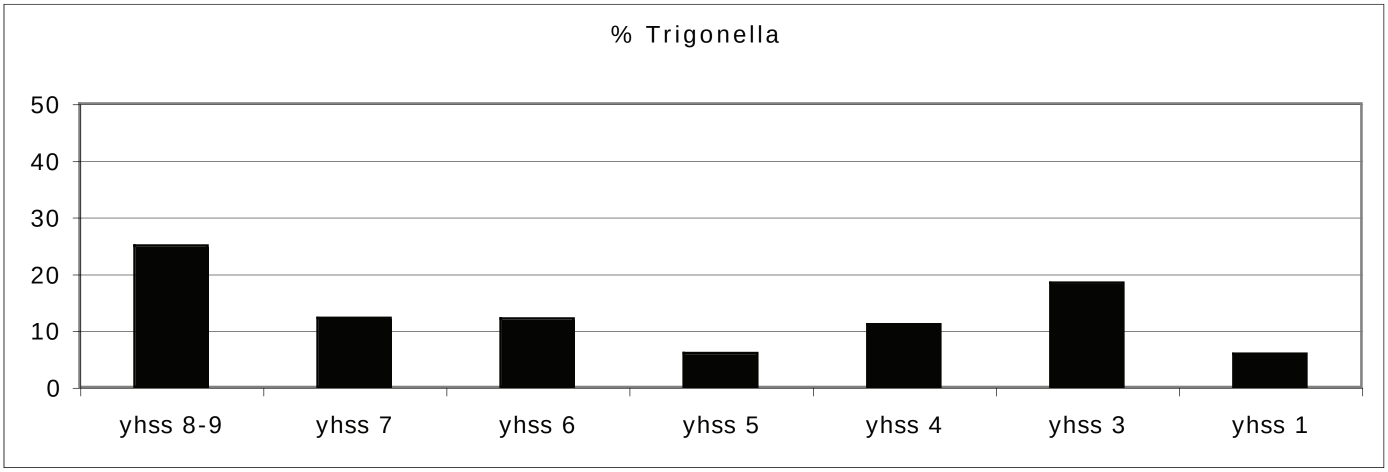




Phase	No. samples included	No. samples with no cereal	Median	Range
YHSS 1	15		650	0 to 3975
YHSS 3	32	2 n/c	184	65 to 1994
YHSS 4	51	1 n/c	132	11 to 2249
YHSS 5	14	1 n/c	97	19 to 286
YHSS 6	5	3 n/c	150	100 to 300
YHSS 7	65	1 n/c	152	5 to 896
YHSS 8-9	32		206	50 to 631

Figure 5.15. Percentages of common types (data in YH App G3)

a. Trigonella and Trigonella astroites-type (percent of total number of seeds per period)



b. Galium (percent of total number of seeds per period)

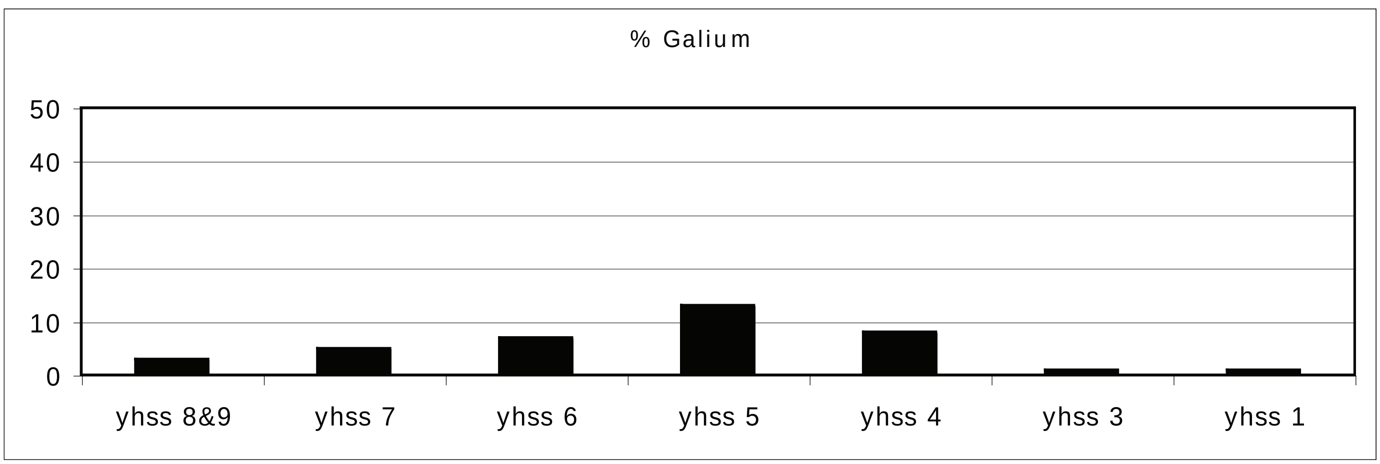


Figure 5.16. Plants of overgrazed steppe (percent of total number of seeds per period)

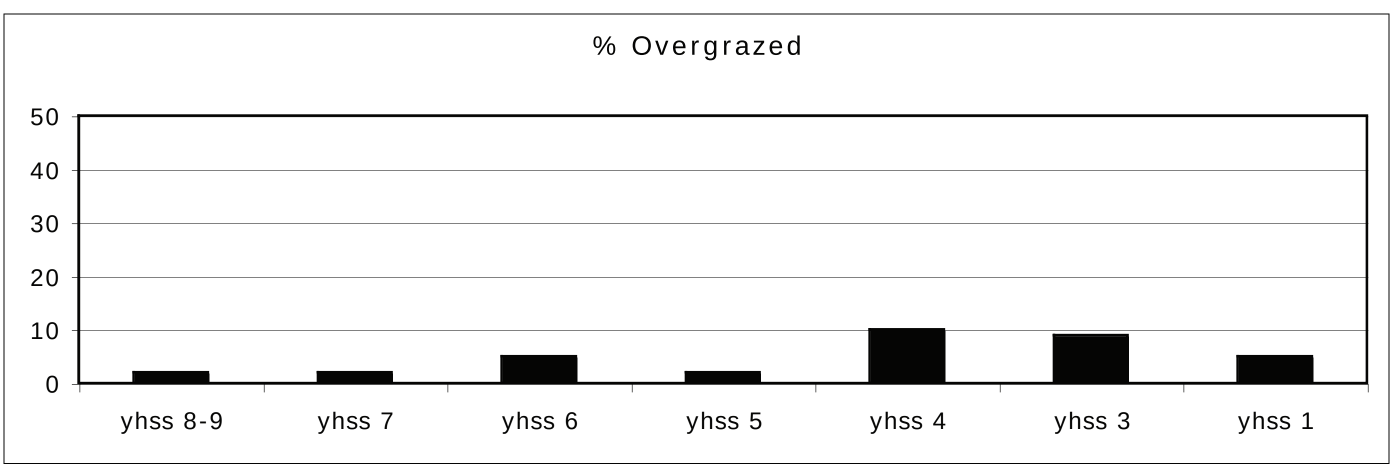


Figure 5.17. Ruderal plants (percent of total number of seeds per period)

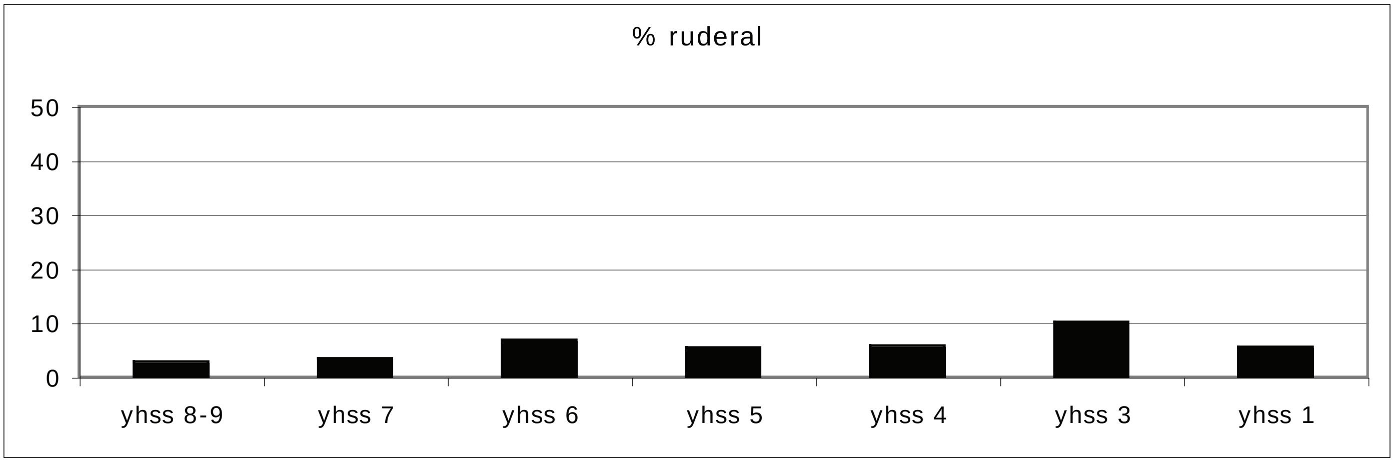


Figure 5.18. Galium, ruderal, overgrazed, combined (percent of total number of seeds per period)

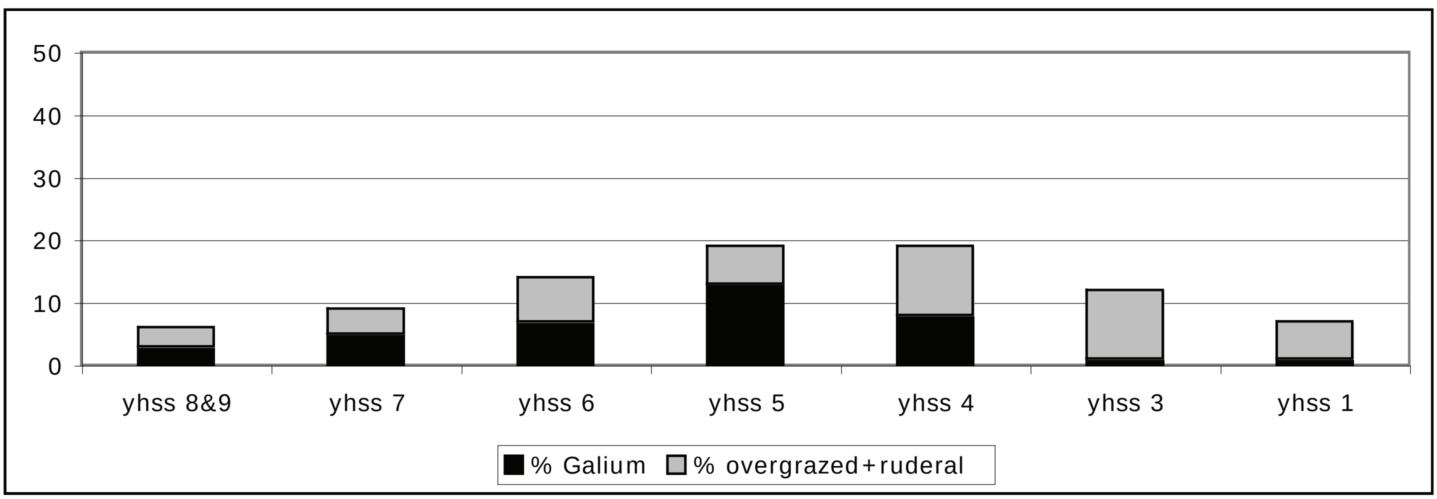


Figure 5.19. Floodplain types ((percent of total number of seeds per period)

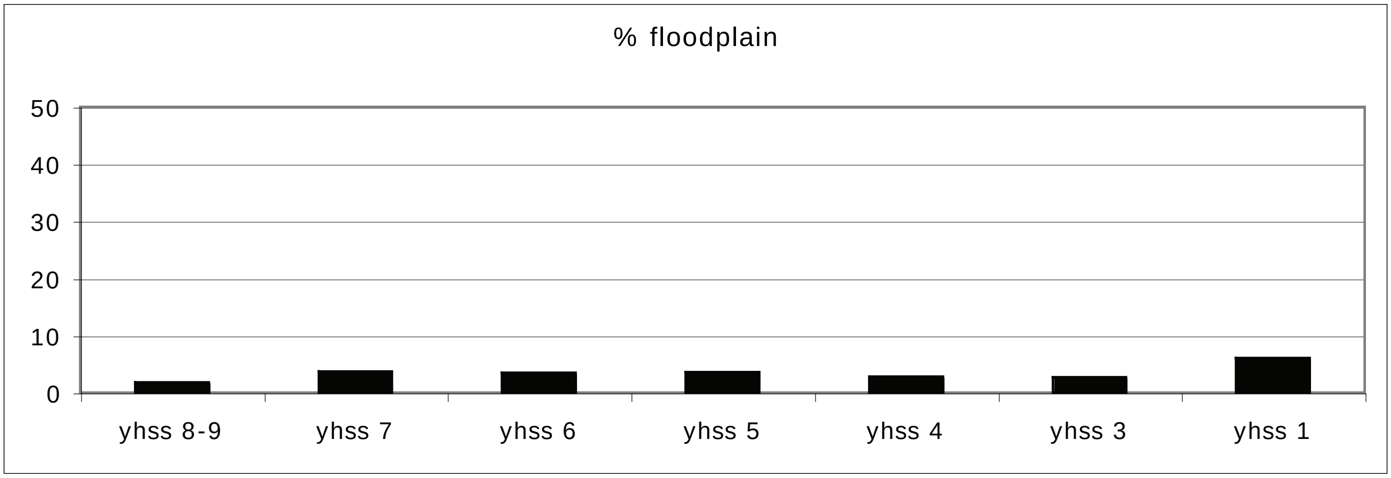


Figure 5.20. Indicators of irrigation and streamsides (percent of total number of seeds per period)

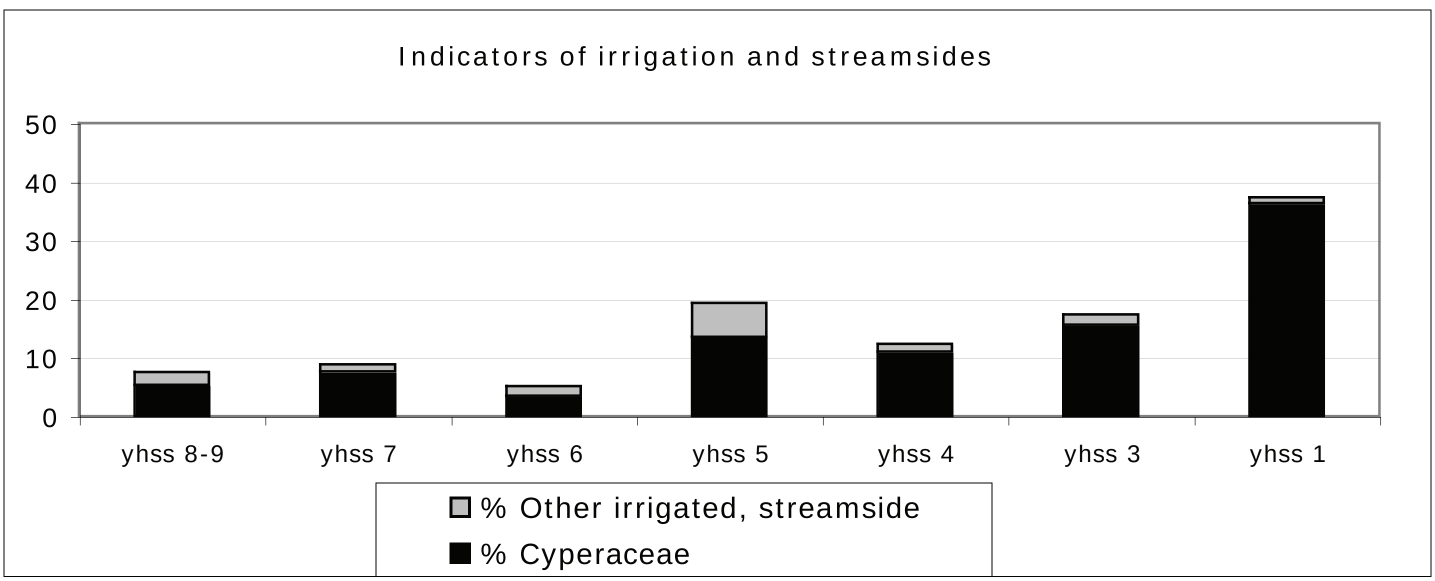
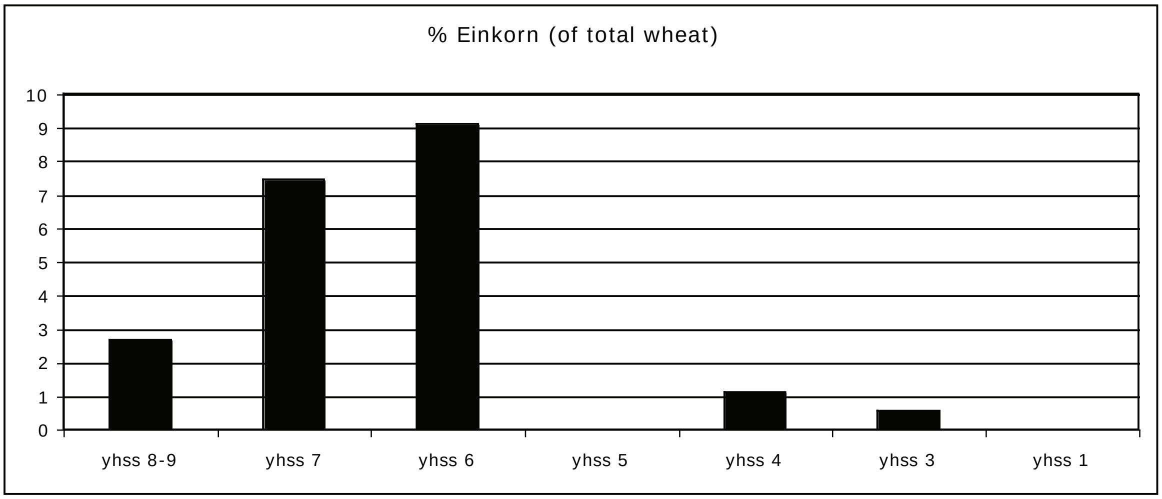
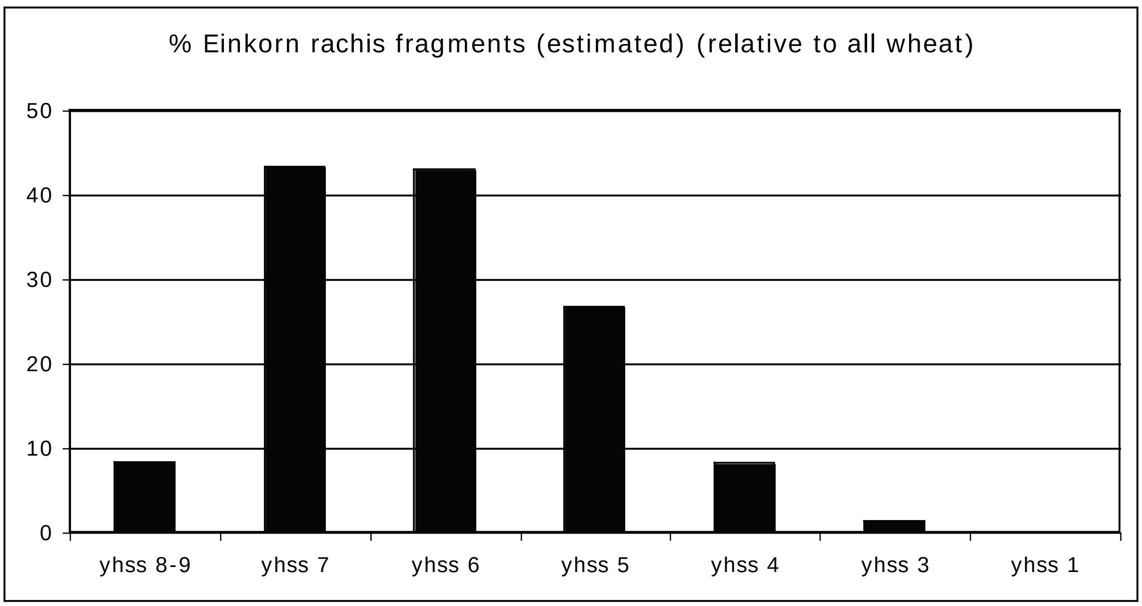


Fig. 5.3 Triticum boeoticum





Data for fig. 5.3: [put in table 5.13]

	yhss 8-9	yhss 7	yhss 6	yhss 5	yhss 4	yhss 3	yhss 1
Einkorn (total g)	0.17	1.79	0.01	0	0.13	0.03	0
% Einkorn (of all wheat)	0.17	1.79	0.01	0	0.13	0.03	0
Einkorn rachis fragments (est. no. spikelet forks)	32	433	0	4	292	11	0
% Einkorn rachis fragments (of all wheat)	8	43	43	27	8	1	0

Figure 5.4. Proportions of wheat and barley

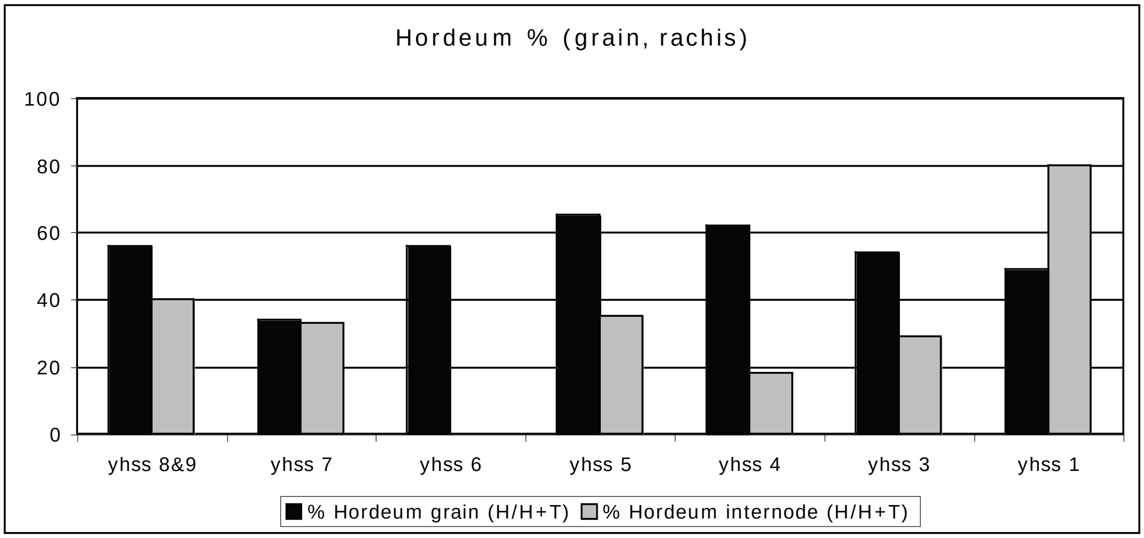
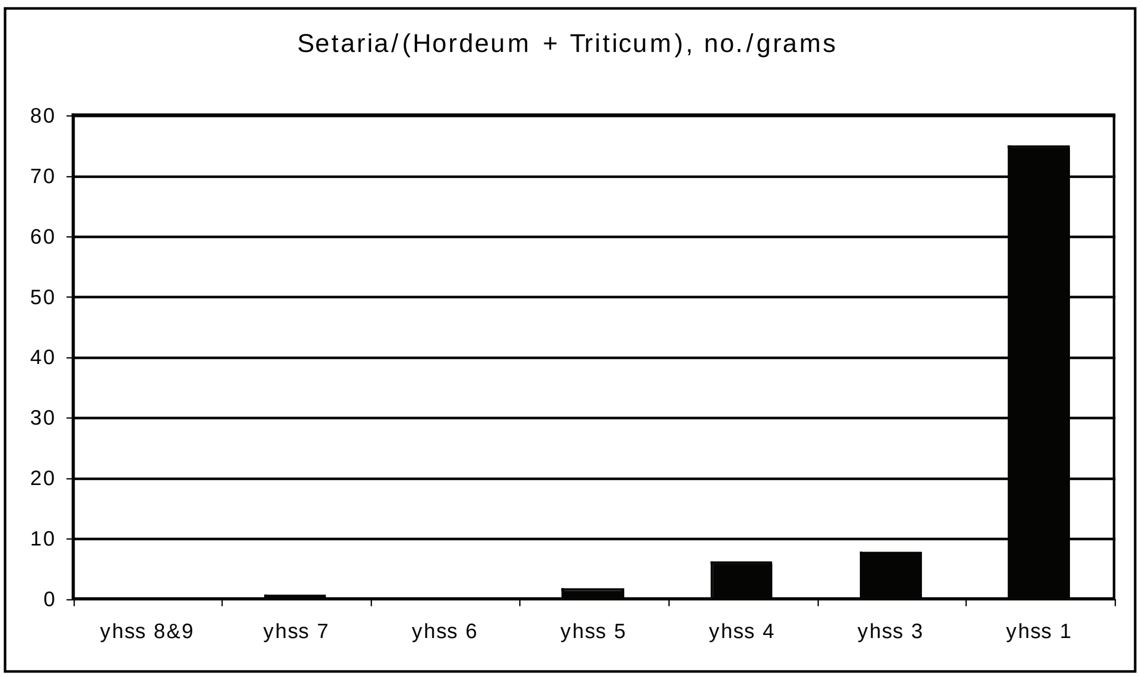


Figure 5.5. Setaria italica relative to Triticum aestivum and Hordeum vulgare var. distichum (no./g)



data on which fig. 5.5 is based:

	yhss 8&9	yhss 7	yhss 6	yhss 5	yhss 4	yhss 3	yhss 1
no. samples	32	66	5	15	53	32	15
Setaria italica (count)	0	9	0	3	161	77	91
Triticum aestivum (g)	5.36	18.86	0.08	0.66	9.07	4.07	0.54
Hordeum vulgare var distichum (g)	7.9	12.41	0.13	1.53	18.33	6.27	0.68
S/(H+T)	0	0.29	0	1.37	5.88	7.45	74.59

Fig. 5.6 Ubiquity: crops

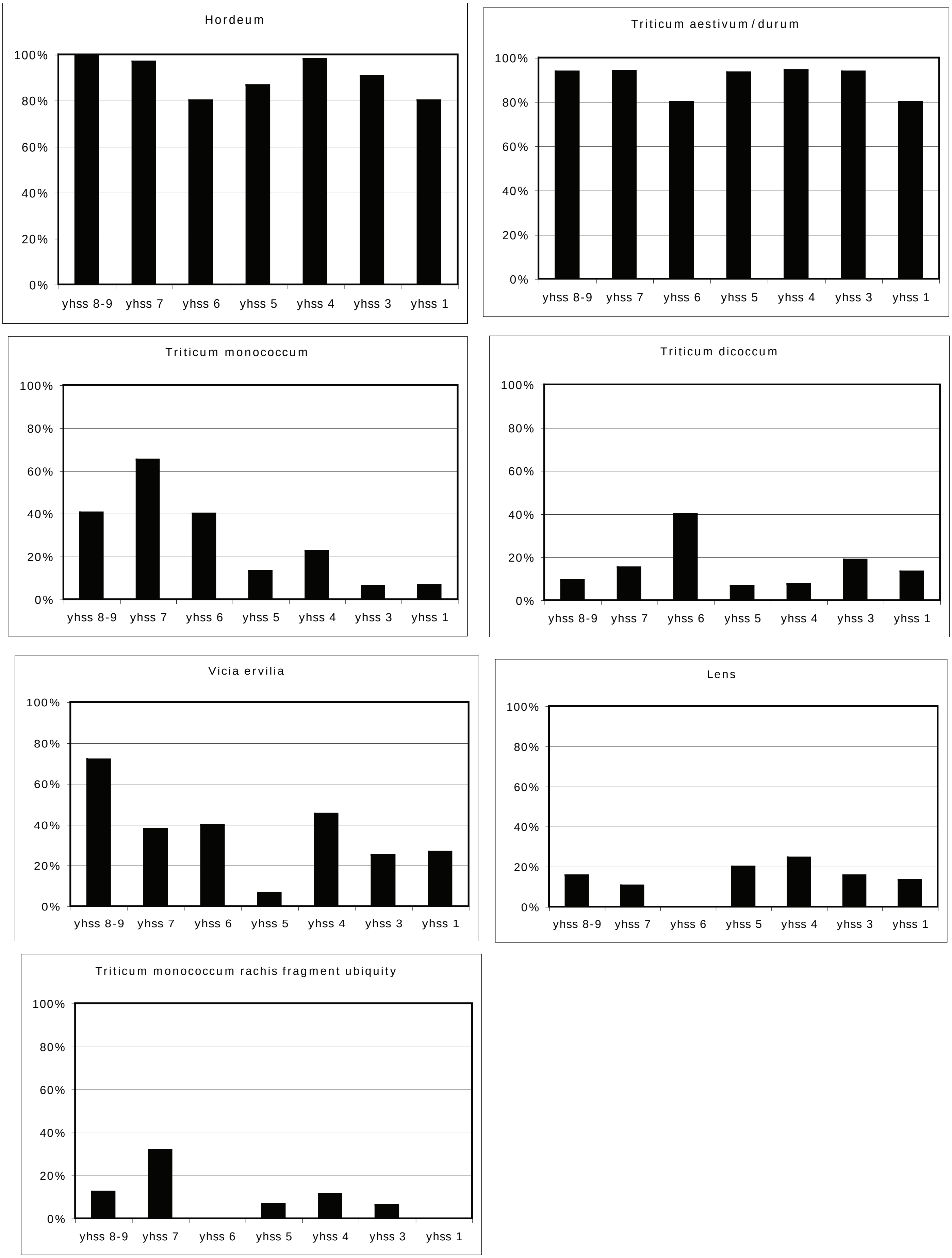
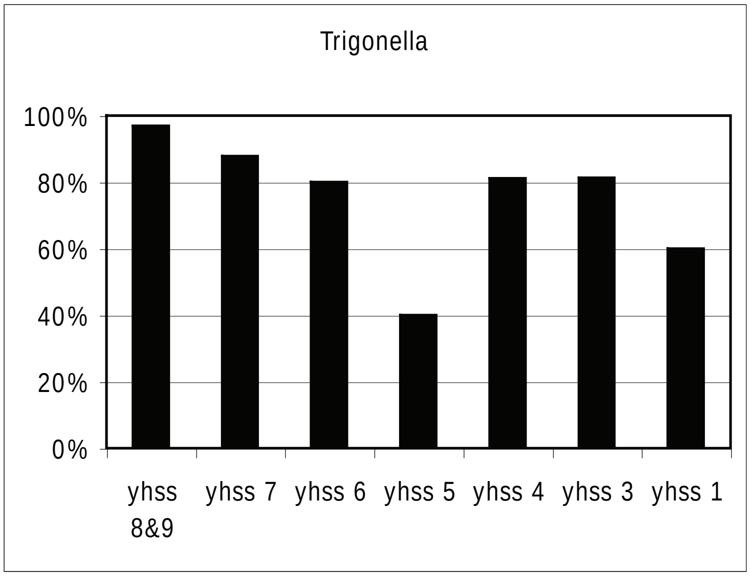
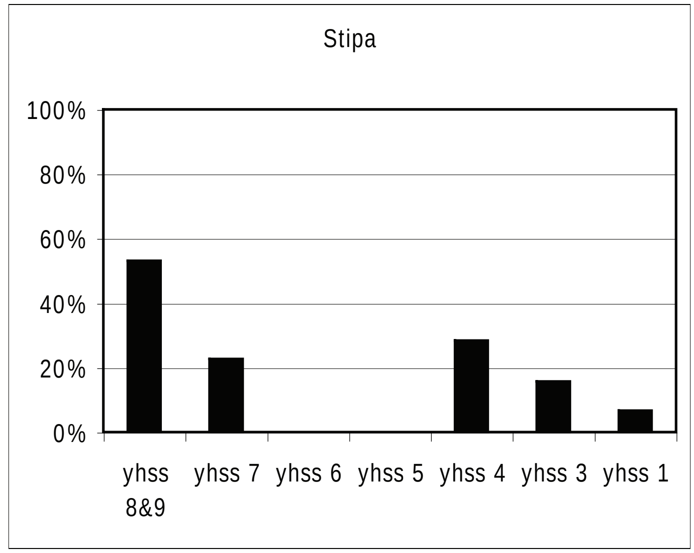
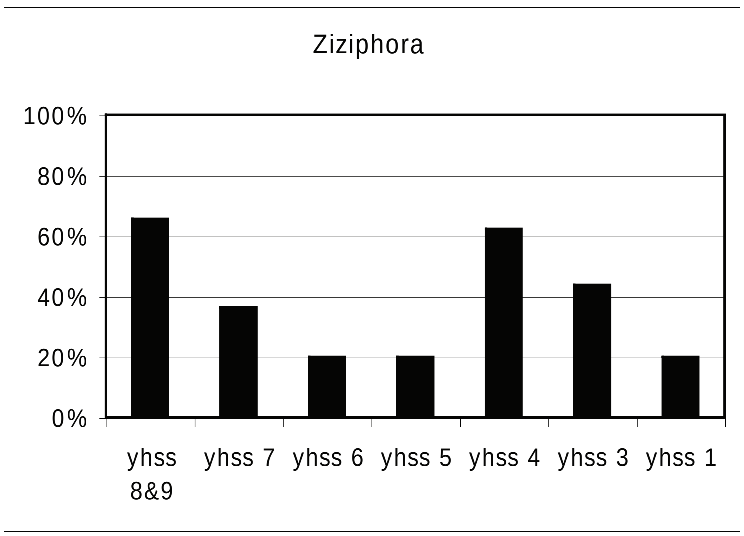


Fig. 5.7 Ubiquity, plants of steppe







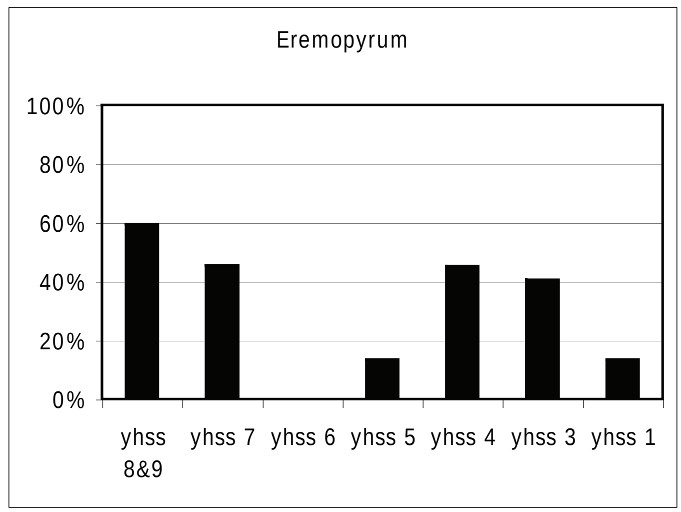
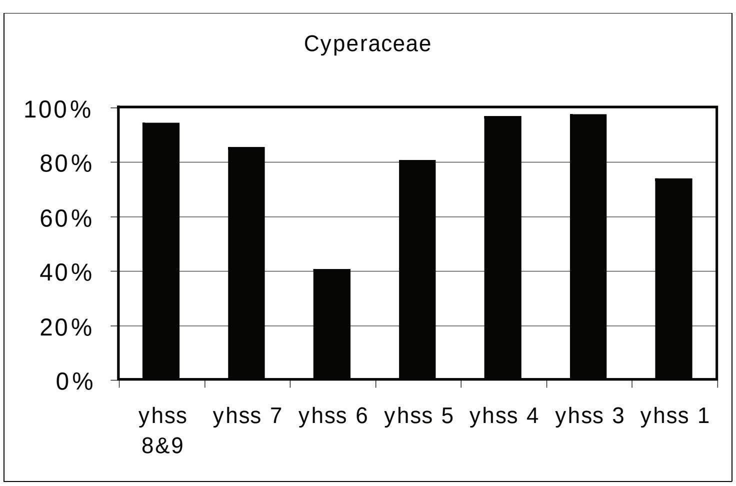


Fig. 5.8 Ubiquity, plants of moist areas



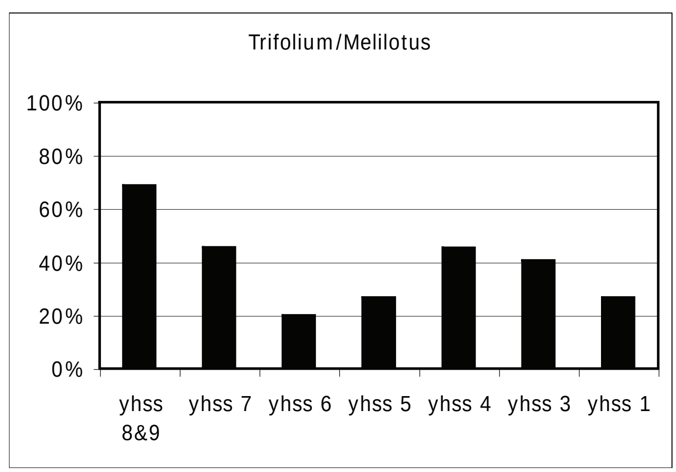
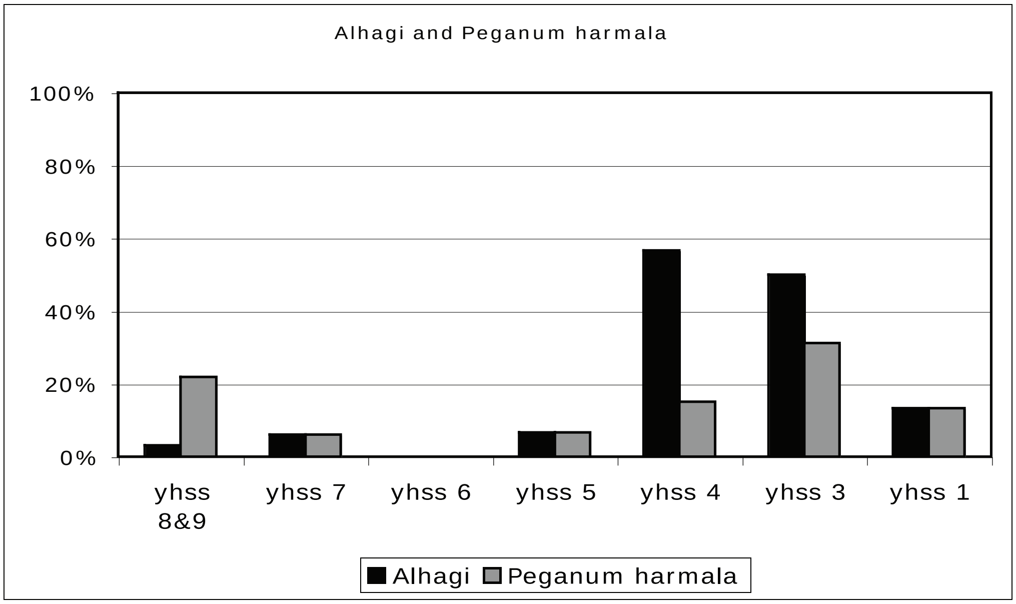


Fig. 5.9 Ubiquity, plants of disturbance



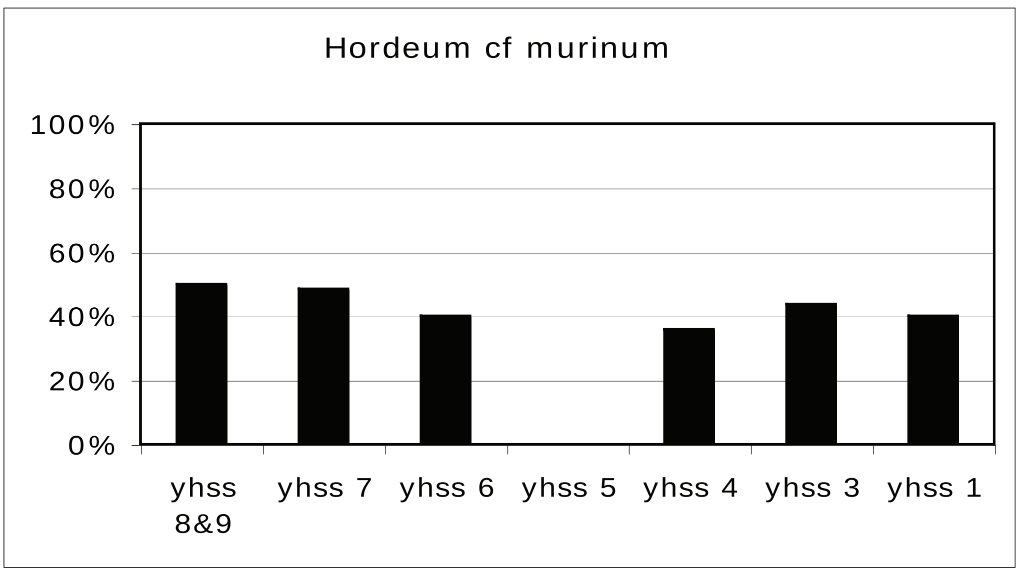
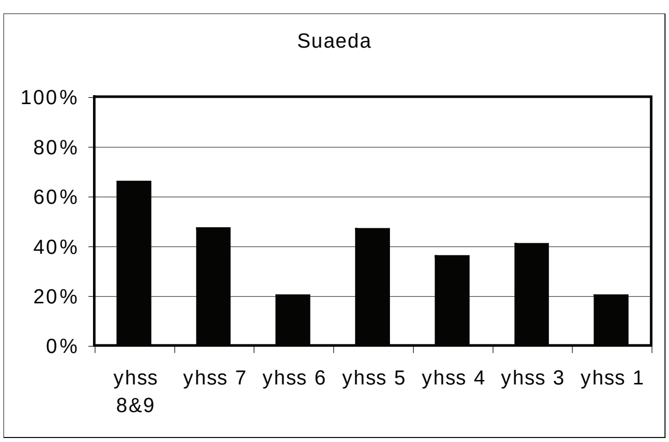


Fig. 5.10 Ubiquity of other common taxa



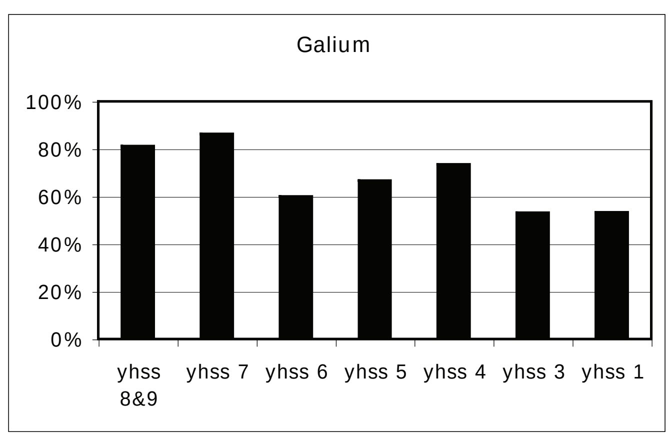


Table 5.1. Distribution of flotation samples across time (including burnt levels, excluding "0")

YHSS	no. samples taken	no. deposits sampled	no. samples analyzed	no. deposits analyzed
1 Medieval	30	13	15	10
3 Hellenistic	83	40	35	29
4 Late Phrygian	131	60	53	48
5 Middle Phrygian	26	17	15	14
6 Early Phrygian	84	14	13	5
7 Iron Age	193	66	70	55
8&9 Late Bronze	65	16	32	13
10 Middle Bronze	3	1	2	1
Totals	601	228	241	162

Table 5.2. Density of charred material from flotation samples by deposit type (grams of material > 2 mm/liter of soil; N=number of samples). [source: YH App F summaries]

Deposit type:	Collapse (within structures)	Surface (directly over floor, etc.)	Debris (trash, other)	Pit	Pyrotechnic installation
N (210) range median	18 0.05 to 1.19 0.535	18 0.21 to 2.97 0.61	35 0.04 to 11.50 0.28	103 0.13 to 7.22 0.64	36 0 to 41.22 0.45
0 to <0.5	8	6	22	40	19
0.5 to <1	7	9	6	26	9
1 to <1.5	3		4	16	1
1.5 to <2		1	1	6	2
2 to <2.5				3	
2.5 to <3		2		7	
3 to <3.5					1
3.5 to <4					
4 to <4.5			1	2	
4.5 to <5					
5 to <5.5					
5.5 to <6					
6 to <6.5				1	
6.5 to <7				1	
7 to <7.5				1	
7.5 to <8					
8 to <8.5					
8.5 to <9					1
9 to <9.5					
9.5 to <10					
≥10			1		3

Table 5.3. Density of charred material from flotation samples by date (grams of material > 2 mm/liter of soil; N=number of samples). [source: YH App F summaries]

Period:	YHSS 1	YHSS 3	YHSS 4	YHSS 5	YHSS 6	YHSS 7	YHSS 8/9	YHSS 10
N (210)	15	30	51	13	8	61	31	1
range	0.06 to 2.65	0.11 to 41.22	0.19 to 10.03	0.55 to 7.22	0 to 0.17	0.09 to 16.02	0.05 to 4.49	0.71
median	0.44	0.365	0.71	1.07	0.105	0.53	0.58	n/a
0 to <0.5	8	19	17		8	29	14	1
0.5 to <1	6	9	13	5		14	9	
1 to <1.5		1	11	2		6	4	
1.5 to <2			4	1		5		
2 to <2.5			1	1		1		
2.5 to <3	1		3	3			2	
3 to <3.5							1	
3.5 to <4								
4 to <4.5						2	1	
4.5 to <5								
5 to <5.5								
5.5 to <6								
6 to <6.5						1		
6.5 to <7						1		
7 to <7.5				1				
7.5 to <8								
8 to <8.5								
8.5 to <9			1					
9 to <9.5								
9.5 to <10								
≥10		1	1			2		

Table 5.4a. Triticum aestivum/durum measurements (mm), from debris

	N	Length	Breadth	Thickness	L:B	T:B
Medieval (YHSS 1)	17	4.4 (2.8–5.7)	2.8 (1.7–4.0)	2.3 (1.5–3.1)	1.60 (1.20–1.91)	0.82 (0.70–0.94)
Hellenistic (YHSS 3)	126	4.4 (2.3–6.2)	2.7 (1.2–3.8)	2.3 (0.9–3.5)	1.63 (1.15–2.50)	0.84 (0.69–1.05)
Late Phrygian (YHSS 4)	407	4.2 (2.0–5.7)	2.5 (1.2–3.8)	2.1 (1.0–3.5)	1.73 (0.96–2.79)	0.84 (0.55–1.07)
Middle Phrygian (YHSS 5)	14	4.1 (2.8–5.2)	2.5 (1.3–3.4)	2.1 (1.3–2.7)	1.74 (1.29–2.54)	0.87 (0.79–1.00)
Early Phrygian (YHSS 6B)	2	4.7 (4.5–4.9)	3.1 (2.8–3.4)	2.4 (2.3–2.4)	1.52 (1.44–1.61)	0.76 (0.71–0.82)
Early Iron (YHSS 7)	326	4.0 (1.7–5.6)	2.5 (1.1–3.9)	2.1 (0.9–3.1)	1.60 (1.06–2.54)	0.83 (0.57–1.13)
Late Bronze (YHSS 8 & 9)	227	4.1 (2.1–5.9)	2.6 (0.9–3.7)	2.2 (0.8–3.1)	1.61 (1.12–2.64)	0.83 (0.61–1.33)
Middle Bronze (YHSS 10)	2	4.1 (4.0–4.1)	2.2 (2.1–2.2)	2.1 (1.8–2.4)	1.88 (1.86–1.90)	0.98 (0.82–1.14)

Table 5.4b. Triticum aestivum/durum measurements (mm) from concentrations

	YH no. N stratum	Length	Breadth	Thickness	L:B	T:B
Early Phrygian (YHSS 6B)	33246 N=50 620	3.9 (2.5–5.0)	2.5 (1.6–3.4)	2.0 (1.3–2.7)	1.59 (1.29–1.94)	0.82 (0.67–1.111)
Early Iron (YHSS 7)	33368 N=35 725;barley sample	4.9 (3.4–6.0)	3.1 (2.4–3.9)	2.7 (1.8–3.4)	1.58 (1.38–2.00)	0.88 (0.72–1.07)
Early Iron (YHSS 7)	33382 N=64 725; wheat sample	4.2 (2.9–5.7)	2.6 (1.3–3.5)	2.1 (1.2–3.1)	1.62 (1.21–2.23)	0.82 (0.69–1.04)
Early Iron (YHSS 7)	33402 N=399 725; wheat sample	4.4 (2.5–5.5)	2.8 (1.4–3.7)	2.3 (1.1–3.4)	1.60 (1.07–2.43)	0.83 (0.65–1.19)

Table 5.4c Triticum aestivum/durum measurements by shape...

	N	Length	Breadth	Thickness	L:B	T:B
"compact"	763	4.2 (1.7–5.9)	2.9 (1.4–4.0)	2.4 (1.1–3.5)	1.48 (0.96–2.00)	0.84 (0.57–1.33)
"long"	142	3.8 (2.1–5.5)	1.8 (0.9–3.5)	1.5 (0.8–2.9)	2.10 (1.40–2.79)	0.82 (0.55–1.04)
"regular"	549	4.4 (2.3–5.9)	2.6 (1.2–3.6)	2.1 (1.0–3.2)	1.75 (1.24–2.45)	0.83 (0.6.1–1.07)
"compact" YH33402	119	4.2 (2.6–5.1)	2.9 (1.7–3.7)	2.4 (1.7–3.4)	1.46 (1.19–1.71)	0.83 (0.67–1.10)
"regular" YH33402	92	4.5 (2.7–5.4)	2.7 (1.4–3.6)	2.2 (1.1–3.1)	1.69 (1.39–2.43)	0.82 (0.65–1.00)

Table 5.5. Triticum boeoticum measurements (file: YH meas.xls)

	N	Length	Breadth	Thickness	L:B	T:B
whole sequence	109	5.1 (3.2–6.8)	2.3 (1.3–3.4)	2.5 (1.5–3.5)	2.27 (1.53–3.85)	1.08 (0.68–1.57)

Table 5.6 Hordeum vulgare var. distichum and H. vulgare var. hexastichum indicators (determinable whole grains and rachis fragments) (file: YH meas.xls)

YHSS	1	3	4	5	6	7	8&9
N whole grains	59	474	1275	78	9	872	581
% straight	19	28	20	18	44	21	25
% twisted	20	30	34	10	0	32	35
% indet.	61	42	46	72	56	46	40
N rachis	87	349	815	8	0	486	264
% 2-row	74	66	68	63	0	84	73
% 6-row	13	15	14	25	0	6	9
% compact	14	19	18	13	0	10	18

Table 5.7 <u>Hordeum</u> measurements for selected samples (str=straight grain; tw=twisted) (file: YH meas.xls)

YH no. (stratum)	N	Length	Breadth	Thickness	L:B	T:B
29540, str (495.04)	12	6.1 (4.5–7.0)	3.0 (2.1–3.5)	2.3 (1.6–3.1)	2.04 (1.63–2.87)	0.77 (0.65–0.89)
29540, tw (495.04)	19	6.2 (5.0–7.9)	2.9 (2.4–3.7)	2.3 (1.8–3.3)	2.17 (1.72–2.50)	0.81 (0.69–1.00
30664, str (450.10)	46	6.0 (4.8–7.4)	2.7 (2.0–3.6)	2.0 (1.3–2.9)	2.24 (1.90–3.08)	0.76 (0.59–0.87)
30664, tw (450.10)	100	6.0 (4.4–7.7)	2.8 (2.0–3.7)	2.2 (1.3–3.6)	2.12 (1.71–2.85)	0.78 (0.57–1.12)
33573 (620)	127	5.6 (4.0–7.1)	2.9 (1.6–3.7)	2.3 (1.2–3.0)	1.99 (1.50–2.75)	0.80 (0.67–1.00)
33368, str (725)	48	5.8 (4.6–7.5)	2.9 (2.0–3.9)	2.3 (1.2–4.1)	2.03 (1.67–2.60)	0.78 (0.60–1.64)
33368, tw (725)	98	6.1 (4.4–7.5)	3.1 (1.7–4.2)	2.4 (1.5–3.3)	1.95 (1.58–2.82)	0.77 (0.60–1.50)
31603, str (870.03)	19	5.8 (4.3–7.8)	2.9 (2.0–3.5)	2.2 (1.6–2.9)	2.04 (1.62–2.56)	0.78 (0.69–0.86)
31603, tw (870.03)	28	5.6 (4.2–7.2)	2.7 (1.8–3.7)	2.1 (1.0–3.0)	2.10 (1.76–2.83)	0.76 (0.50–0.97)

Table 5.8 Ecological grouping for common or diagnostic types

	Irrigated, streamside	Flood-plain	Segetal	Ruderal	Over-grazed	Steppe
Apiaceae <u>Eryngium</u>				√	√	
Asteraceae <u>Artemisia</u>					√	
<u>Onopordum</u>		√		√	√	
Boraginaceae <u>Heliotropium</u>		√		√		
Cistaceae						√

Helianthemum						
Cyperaceae Carex	√					
Carex 3	√					
Cyperaceae (includes Cyperaceae 1–8 and indet.	√					
Eleocharis	√					
Fimbristylis	√					
Dipsacaceae Scabiosa						√
Fabaceae Alhagi			√	√	√	
Medicago				√		√
Onobrychis						√
Trifolium/Melilotus	√					
Trigonella						√
Trigonella astroites type						√
Fumaricaceae Fumaria	√					
Lamiaceae Teucrium						√
Ziziphora						√
Papaveraceae Glaucium				√	√	
Plantaginaceae Plantago	√					
Poaceae Aegilops		√		√		
Eremopyrum			√			√
Hordeum cf. murinum		√		√	√	
Stipa						√
Taeniatherum				√		
Polygonaceae Polygonum	√					
Rumex	√			√		
Polygonaceae/Cyperaceae Polygonum/Cyperaceae		√				
Portulacaceae Portulaca	√					
Primulaceae Androsace						√
Ranunculaceae Adonis		√		√	√	

Thymeleaceae Thymelaea						√
Zygophyllaceae Peganum harmala					√	

Table 5.9. Ubiquity (%) of cultigen taxa (YHSS 10 excluded; only 2 samples) appearing in 25% or more of the samples. [for graphs, see summary oct.xls]. Number in parenthesis for cultigens is total in grams.

YHSS	1	3	4	5	6	7	8&9
N (samples)	15	36	53	15	8	66	32
Hordeum	80 (0.68)	91 (6.27)	98 (18.33)	87 (1.53)	80 (0.13)	97 (12.41)	100 (7.90)
Triticum aestivum/durum	80 (0.54)	94 (4.07)	94 (9.07)	93 (0.66)	80 (0.08)	94 (18.86)	94 (5.36)
Triticum monococcum	7 (+)	6 (0.03)	23 (0.13)	13 (+)	40 (0.01)	65 (1.79)	41 (0.17)
Triticum dicoccum	13 (0.02)	19 (0.12)	8 (0.07)	7 (+)	40 (0.01)	15 (0.35)	9 (0.03)
Vicia ervilia	27 (0.20)	25 (0.25)	45 (0.36)	7 (0.03)	40 (+)	38 (1.10)	72 (1.02)
Lens	13 (0.08)	16 (0.46)	25 (0.14)	20 (0.05)	0 (0)	11 (0.06)	16 (0.06)

Table 5.10. Ubiquity (%) of wild and weedy taxa (YHSS 10 excluded; only 2 samples) appearing in 50% or more samples (and Peganum); for Cyperaceae, all genera grouped. [for graphs, see summary oct.xls]. Number in parentheses for wild plants it is total number of that taxon.

YHSS	1	3	4	5	6	7	8&9
N (samples)	15	36	53	15	8	66	32
Caryophyllaceae Gypsophila	47 (15)	28 (23)	40 (63)	33 (6)	20 (1)	47 (67)	53 (95)
Chenopodiaceae Chenopodium	33 (46)	41 (99)	17 (15)	20 (7)	0 (0)	26 (47)	59 (139)
Suaeda	20 (8)	41 (28)	36 (41)	47 (17)	20 (1)	47 (95)	66 (82)
Cyperaceae Carex	60 (123)	75 (181)	77 (547)	27 (7)	0 (0)	52 (129)	91 (143)
Cyperaceae (including Carex)	73 (930)	97 (1029)	96 (969)	80 (50)	40 (2)	85 (592)	94 (328)
Fabaceae Alhagi	13 (4)	50 (398)	57 (219)	7 (3)	0 (0)	6 (8)	3 (1)
Trifolium/Melilotus	27 (13)	41 (96)	45 (84)	27 (10)	20 (1)	45 (209)	69 (95)
Trigonella	53 (131)	78 (1118)	75 (854)	40 (22)	80 (6)	86 (827)	97 (1049)
Trigonella cf. astroites	33 (20)	22 (87)	32 (112)	0 (0)	20 (1)	44 (110)	78 (216)
Lamiaceae Ziziphora	20 (7)	44 (123)	62 (159)	20 (4)	20 (1)	36 (204)	66 (89)
Poaceae Eremopyrum	13 (3)	41 (26)	45 (231)	13 (2)	0 (0)	45 (106)	59 (79)
Hordeum cf. murinum	4 (104)	44 (26)	36 (63)	0 (0)	40 (2)	48 (114)	50 (36)
Stipa	7 (2)	22 (11)	28 (73)	0 (0)	0 (0)	23 (34)	53 (42)
Rubiaceae Galium	53 (19)	53 (76)	74 (696)	67 (47)	60 (4)	86 (420)	81 (165)
Zygophyllaceae Peganum	13 (9)	31 (79)	15 (426)	7 (1)	0 (0)	6 (23)	22 (22)

Table 5.11. Summary chart based on averages by sample

YHSS	1	3	4	5	6	7	8&9	10
N	15	36	53	15	8	66	32	2
density g/l	0.56	1.70	1.23	3.49	0.11	1.33	0.89	0.45
seed:charcoal g/g	0.06	0.22	0.21	0.03	0.07	0.28	0.17	0.21
wild:charcoal #/g	50	97	67	3	10	51	45	40
wild:cereal #/g (divide by 100 for approx. #/cereal grain)	1213	451	267	109	168	199	257	582
median seed:charcoal	0.04	0.08	0.05	0.02	0.08	0.11	0.14	0.21
median wild:charcoal	23	16	7	2	7	29	35	40
median wild:cereal	650	184	132	97	150	152	206	468

wild:cereal excludes samples with no measureable cereal (0 in denominator); YH 30039 (YHSS 4), YH 32692(YHSS 5), YH 27277 (YHSS 7)

Table 5.12. Comparison of average seed:charcoal ratios, southeast Turkey and northwest Syria*

Site	Samples (no.)	Period	Vegetation inference	Ratio
Gritille	18	Medieval-later	depleted oak woodland	2.40
Gritille	14	Medieval-early	open oak woodland	0.12
Hacınebi	26	Chalcolithic	steppe-forest	0.24
Sweyhat	17	Early/Middle Bronze	steppe	1.13

Source: Gritille (Miller 1998); Hacinebi: Stein et al. (1996); Sweyhat: Miller (1997b)

Table 5.13. Summary chart based on amounts of cultigens and summed percents of wild and weedy types.

YHSS phase	yhss 8&9	yhss 7	yhss 6	yhss 5	yhss 4	yhss 3	yhss 1
columns in flot data charts, App F	bq to cv	c to bp	dp to dv	da to do	az to cz	r to ay -z-ao	c to q
no. samples	32	66	5	15	53	32	15
Cereals (inc. rice), total wt.	21.28	50	0.44	4.07	40.63	16.18	1.95
Wheat (g, sum) (inc. einkorn)	6.32	24.07	0.11	0.81	11.44	5.34	0.70
Barley (g, sum)	7.90	12.42	0.13	1.53	18.33	6.31	0.68
Einkorn (g, sum)	0.17	1.79	0.01	0	0.13	0.03	0
Bread or hard wheat	5.36	18.86	0.08	0.66	9.07	4.07	0.54
Setaria italica (count)	0	9	0	3	161	77	91
Vicia ervilia (g, sum)	1.02	1.10	+	0.03	0.36	0.25	0.20
Pulse (g, total, inc. Vicia)	1.43	1.38	1.00	2.18	0.73	0.99	0.38
Einkorn rechis fragments (est. no. spikelet forks	32	433	0	4	292	11	0
Total wheat rachis	390	1000	7	15	3605	863	22
Total barley rachis	264	486	0	8	815	349	87
% barley (B/(B+W))	56	34	54	65	62	54	49
% barley rachis (Brf/(Brf+Wrf))	40	33	0	35	18	29	80
wild & weedy (based on total per phase)	5060	7710	58	368	8765	6573	2557
% ruderal	3	3	7	5	6	10	6
% overgrazed	2	2	5	2	10	9	5
% overgrazed+ruderal	3	4	7	6	11	11	6
% steppe, including Trigonella	30	18	17	9	17	23	7
% Trigonella	25	12	12	6	11	18	6
% floodplain	2	4	3	4	3	3	6
% Cyperaceae (combined)	5	8	3	14	11	16	36
Other irrigated, steamside	2	1	2	6	1	2	1
% Galium	3	5	7	13	8	1	1

Ruderal: Adonis, Aegilips, Alhagi, Eryngium, Glaucium, Heliotropium, Hordeum cf. murinum, Medicago, Onopordum, Rumex, Taeniatherum

Overgrazed: Adonis, Alhagi, Artemisia, Eryngium, Glaucium, Hordeum cf. murinum, Onopordum, Peganum

Steppe: Androsace, Eremopyrum, Helianthemum, Medicago, Onobrychis, Scabiosa, Stipa, Teucrium, Thymelaea, Trigonella, Trigonella astroites-type, Ziziphora

Floodplain: Onopordum, Eleocharis, Adonis, Aegilops, Heliotropium, Hordeum cf. murinum, Polygonum/Cyperaceae

Irrigated, streamside: Carex, Cyperaceae, Fimbristylis, Eleocharis, other Cyperaceae, Fumaria, Plantago, Polygonum, Portulaca, Rumex, Trifolium/Melilotus

Chapter 6

Interpretation—Summary and Conclusions

There are a number of questions one can ask of macroremains. At the most basic level, one can record the plants that were growing in the region that were used for food, fuel, fodder, and construction in different time periods. Archaeobotanical data also speak to land-use practices and consequent long-term human impact on the vegetation and landscape. With a long, well-dated sequence that corresponds to the agropastoral economy, historical events, movement of peoples, and other cultural trends, there are several questions specific to Gordion that are worth addressing here. Some of the broad conclusions drawn from the archaeobotanical data are consistent with interpretations based on other data.

Vegetation Cover and Changes over Time

Climate conditions over the past three thousand years have been relatively stable. That means the people of Gordion had to contend with a high degree of uncertainty due to very high interannual variability in precipitation. During that same period, human activity changed the vegetation cover within a 50-kilometer radius of the settlement. Broadly, the modern zones of vegetation are similar to those of the past. The area immediately surrounding of Gordion probably supported grassy steppe, perhaps with isolated trees except along the river, which would have been home to riparian types such as willow. Where oak, juniper, and pine grow today, it is reasonable to assume similar climatic and edaphic conditions allowed them to grow in the past, as well. Some change has been irrevocable, however. In particular, with tree-cutting and land clearance on once-wooded slopes above Çekerdeksiz and along the Porsuk and Sakarya valleys, soil erosion has left bedrock or at best a thin soil layer in many areas. That means that areas at present bare or treeless once supported more woody vegetation. This loss of vegetation and soil adversely affected surface runoff and the water table, with a corresponding longlasting impact on the ability of vegetation to regenerate. Even local climate conditions may have changed as a result of vegetation, soil, and water loss.

Fuel-cutting

The dominant forest tree genera in the region are juniper (Juniperus oxycedra and J. excelsa), oak (primarily Quercus pubescens, but also Q. cerrris), and pine (Pinus nigra). One or another of these taxa predominate throughout the sequence, representing over 80% of the charcoal. Along with the increase in taxa of secondary forest and streamside the charcoal data support the view that tree cover overall did not suffer greatly with long-term exploitation of woodland. Consistent with this view, geomorphological studies severe soil erosion on the slopes is a relatively late phenomenon, occurring after A.D. 600 (Marsh 2005). The early importance and subsequent decline in juniper as a fuel wood suggests local changes in availability. In particular, it seems likely that scrubby juniper initially grew on the gypsum ridges at the edge of the valley within 0.5 km of the site. The maximum use of oak as fuel appears to be the Middle Phrygian; it is also the time of maximum wood fuel use relative to dung (i.e., high seed to charcoal ratios). This suggests that oak, unlike juniper, was sustainbly harvested at that time. Scrubby oak and juniper today co-occur on the basaltic soils of Çile Dagı above {S}abanozu; one imagines that cover extended along the hills to the south (Dua Tepe), and that the wooded area in general was less impacted by fuel-cutting.

Farming and herding

Throughout the Gordion sequence, both farming and herding were practiced within an integrated subsistence system, but they have somewhat different effects on the pre-existing vegetation cover. Clearance of woodland and steppe for agricultural fields changes species composition, replacing shallow-rooted perennials and trees with plants that tolerate soil disturbance (disproportionately weedy annuals, but also deep rooted perennials like camelthorn). As it takes time for crops to grow from seed, there is more opportunity for winds to carry off top soil, even on flat ground. Herding, too, promotes changes species composition; as the animals preferentially eat the palatable types, spiny and/or unpalatable types tend to proliferate, as well as species that can withstand trampling. Even in the absence of human occupation, wild herbivores graze and affect vegetation. The difference between low-intensity exploitation of wild game and heavy investment in herding is one of degree. Overgrazing can also create bare ground subject to wind erosion. Marsh (2005) identifies erosional processes as they affected the sediment load and course of the Sakarya river. He posits plowing as an important factor (p. 165), with grazing and fuel-cutting also having an impact. Marsh identifies erosion that is a probable result of agricultural activity as early as the Bronze Age, but precise dating eludes us. Charred seed remains that show shifting emphases on farming and herding can enrich our understanding of these processes.

The relationship between agricultural and pastoral production produces benefits for humans, crops and even the domesticated animals. Dung left by stubble-grazing animals fertilizes fields, the animals are protected from predation (though, of course, the males pay a disproportionate price through slaughter) and do not depend on wild plants year round for food. The balance between farming and herding is not a constant. Broadly, it may be determined by environmental climate factors, but even over decades and centuries, a wide variety of social factors can play a role in the emphasis people place on one susbistence activity or the other.

Based on analogies with sites along the Euphrates, I propose that the wild:cereal ratio may serve as an indicator of relative dependence on herding (high values) and farming (low values). The lowest value at Gordion dates to the Middle Phrygian period, a time of maximum settlement size when the city of King Midas was at its wealthiest) (Figure 5.14) (Voigt and Henrickson 2000). Trigonella, an indicator of healthy steppe, is also unlikely to be a weed of grain fields; its percent relative to other wild seeds mostly follows that of the wild:cereal ratio. An exception is at the end of the sequence, when the wild:cereal ratio is highest, but the proportions of Trigonella shrink (Figure 5.15). The best explanation is long-term decline in pasture quality that was manifest by the Medieval period. Over time, the indicators of disturbance (primarily Galium) are inversely distributed relative to the wild:cereal ratio (Figure 5.18), with maximum value for the time thought to have maximum dependence of farming. These gratifying results would be strengthened if the faunal data showed corresponding trends (see below).

Irrigation

Although we have not excavated ancient field surfaces or found traces of canals, irrigation leads to changes in species composition by changing the water balance in and around the fields. Seeds of water-loving plants may tentatively be put forward as indicators of irrigation. Certainty eludes us, because at least some of the same taxa might also grow along the river or in uncultivated marshy areas. The benefits of supplemental irrigation for rainfed crops under conditions of erratic precipitation are obvious; a secure water source reduces one of the most unpredictable and uncontrollable variables in farming. The cost in terms of scheduling and person-hours of labor can be considerable. We might therefore expect evidence for irrigation to be high when farming is important and/or when human population densities are relatively high. In a region with a predictably dry summer, the cultivation of crops that require irrigation at that time of year has the added benefit of using available labor to the fullest in an otherwise slow agricultural season.

Geomorphological studies archaeological surveys show that regional occupation was oriented towards springs and surface streams, but over time, the water table dropped (Kealhofer 2005: 144–145; Marsh 2005). Maximum regional population as well as maximum size of Gordion itself occurs in the middle Phrygian, and indeed, there is a small peak in indicators of irrigation at that time (Figure. 5.20). There do not appear to be many summer-irrigated crops, but irrigating staple crops would have reduced the risk of crop failure at Middle Phrygian Gordion. By Late Phrygian times, regional and local population densities had declined, reducing the labor supply available for maintaining the irrigation works. Subsequently, the summer irrigated crop, millet, shows a fairly steady increase relative to other cereals, reaching its maximum at the end of the sequence (Figure. 5.5). Rice and cotton first appear in the Medieval period.

The first peak in the proportion of wet-habitat plants occur during the periods when crop acreage is presumed to be the greatest and the population could support the labor requirements of irrigation (YHSS 5). The second peak occurs after the introduction of several summer crops (YHSS 1) whose cultivation would make the available labor force more productive by lengthening the agricultural year.

Integrated Economies and Archaeobiological Data

One of the reasons it has been very difficult to reconcile interpretations of plant and animal data is taphonomic. Insofar as charred macrobotanical remains are the remains of fuel, and uncharred animal bones the remains of food refuse, there is no particular reason to suppose them to be correlated within deposits. That correlations are discoverable at the level of site and time period is surely a result of the integrated functioning of the agropastoral economy. At Kurban Höyük along the Euphrates, high wild:cereal ratios were associated with a more pastoral orientation expressed in higher percentages of sheep and goat bone relative to cattle and pig (see Miller 1997b).

If one assumes that the Gordion wild seed:cereal ratios reflect animal diet, higher values would reflect animals sent out to pasture and lower ratios reflect crop-foddering. And indeed, our initial results bear this out (Tables 6.1, 6.2; Miller and Zeder in prep.). Patterning of the plant and animal remains could be interpreted along a continuum that can be thought of as an economic orientation away from or toward the settlement, which roughly reflects emphasis on pastoralism vs. emphasis on farming (Table 6.3). The numerical values of the various economic indicators is not stable, in the sense that additional samples could easily change the details. It will be seen, however, that for most of the measures calculated here, the Middle Phrygian period (YHSS 5) stands out for its emphasis on farming.

Zooarchaeologists quantify animal remains in several ways in developing interpretations of ancient diet: counts of identifiable bone, minimum number of individuals, available meat equivalent. I use percent bone counts by time period as an relative indicator of animal taxa consumed, because this measure most directly quantifies the archaeological materials with the fewest additional assumptions. For purposes of this analysis, I compare the percentages of the food animals: caprid (sheep/goat), cattle, pig, deer, and hare (Figure. 6.1) (Miller and Zeder in prep. consider deer and hare separately).

I exclude unlikely food mammals (equid, many of which are donkeys or horses; canid, which includes domestic dog; commensal rodents). I also exclude birds, fish, amphibians, because the way they are used and the number of bones for the various taxa are not comparable to those of mammals. Typical of most sites in west Asia, caprids constitute the bulk of the food bone assemblage, never less than 55%. The percentage bone counts for cattle and pig roughly follow each other.(Miller and Zeder in prep.). Deer and hare combined do not exceed 6% of the assemblage, yet a pattern emerges: deer bone count percentages tend to rise and fall with sheep-goat, and rabbit with cattle and with pig. Although we cannot assume that all dogs and equids worked with shepherds, there does appear to be some association of caprids with canids and equids (Figure. 6.2), as well as with the primary plant indicator of herding, the wild:cereal ratio.

It is in this context that the fuel economy can be best understood. First, throughout the sequence the seed:charcoal ratios are similar to those of sites in steppe-forest or open woodland (Table 5.12), so although people altered the forest composition, mainly by removing juniper, fuel wood within 50 km of Gordion was always available. Even at Gordion's maximum population, not only was wood fuel available (renewable oak was most prominent), the use of dung appears to be at a nadir. During the other periods, when pastoral production prevailed, dung fuel appears to have been more convenient to use. In the later part of the sequence, pine appears to be associated with the indicators of pastoralism and orientation away from the settlement; the proximity of juniper in YHSS 8-9 and 7 may explain the comparatively low pine percentages early on (Figure 4.1).

Cultural Affiliation

Crop choice could speak to questions raised by ancient histories about population movements of Phrygians, and later Galatians, to Anatolia. In particular, einkorn wheat was probably first domesticated in Anatolia or adjacent regions of west Asia. Over time, its popularity declined, and by the end of the Bronze Age, einkorn is relatively more important in southeastern Europe than in Anatolia (Hubbard 1976), and we might expect that Phrygian immigrants would have brought this taste of home. Einkorn grains and rachis fragments are never very numerous, so the data are weak. Einkorn does, however, show a small increase in ubiquity in YHSS 7 (Figure. 5.6), and so is consistent with the other lines of evidence for this population movement (Voigt and Henrickson 2000a: 42).

In the absence of a positive culinary hypothesis to test, the other key ethnic change, i.e., the arrival of the Galatians at Gordion, does not appear to have direct archaeobotanical correlates. On the other hand, if the Galatian element was primarily military, non-farming mercenaries granted land might well have deferred to the agricultural choices of their local wives and farmers. For the Hellenistic deposits, the differences in the various indicators of economic activity generally show a continuation of trends that began during the Late Phrygian period (i.e., a shift in the agropastoral balance toward the pastoral).

Summary of Results

Analysis of the Gordion archaeobotanical assemblage remains provisional. The flotation samples are unevenly distributed over the periods represented in the 1988 and 1989 deep soundings, and the diversity of the seed assemblage makes generalizations difficult. In earlier chapters I have provided alternative ways to calculate the data, partly to provide comparability with other reports, and partly to demonstrate that some variables are more reliable or stable than others. For many variables, the numerical values are less interpretable than the direction of change between periods. For most of the variables considered, values for the Middle Phrygian period (YHSS 5) stand out as being at the extreme end of the range for the sequence (lowest mean and median seed:charcoal mean, wild seed:charcoal, and wild:cereal; lowest percent wheat; highest indicators of disturbance). Some variables show overall temporal trends over the sequence (decline in juniper, increase in successional trees, increase in millet). And some variables have a more complex distribution that might due to chance or might have some significance (for example, irrigation in the Middle Phrygian period vs. the Medieval period, the distribution of pine and oak). A key finding has been that the faunal data share the Middle Phyrgian anomaly, and both inform and strengthen the archaeobotanical analysis.

A narrative summary would begin during the Middle Bronze Age (YHSS 10), when Hittite influence was highest, settlement in the region was relatively high, with subsistence dependent on farming (Kealhofer and Graves 2005), but there are too few botanical remains for useful interpretation. By the Late Bronze Age (Hittite empire, YHSS 8-9), settled population declined. The pithouse dwellers of the Early Iron Age (YHSS 7) are thought to represent an new immigrant nomadic element (i.e., the earliest Phrygians; Voigt and Henrickson 2000: 42), and the uptick in einkorn could reflect that. The Early Phrygian YHSS 6) descendents of the pithouse dwellers established Gordion as the Phrygian capital. Economic indicators for YHSS 8-9 to YHSS 6 are similar to one another: they share high proportions of caprids and somewhat high wild:cereal ratios, low indicators of irrigation, decreasing indicators of pasture quality, and increasing indicators of disturbance. The Middle Phrygian (YHSS 5) period stands out as a time when farming was the predominant strategy; archaeological settlement survey reached the same conclusion with that independent data set (Kealhofer 2005:148). Cereals, especially barley, was important for fodder; cattle and pig, both dependent on the river for surface water were husbanded; and hare was trapped or tended close to home. With the shrinking of the Middle Phrygian city, pastoral production again became increasingly important (Late Phrygian, YHSS 4), a trend that continued into the Hellenistic period (YHSS 3), when subsistence acquisition was again more oriented toward the steppe and woodland; herding, with sheep and goat grazing in uncultivated tracts, and deer-hunting characterize the assemblage. The Medieval (YHSS 1) shows continuing reliance on pastoral production, but the introduction of new crops requiring irrigation in the summer enabled the relatively small population to increase their productivity by farming year-round.

Fig. 6.1 Major food mammals (see Zeder, and Table 6.1 for data)

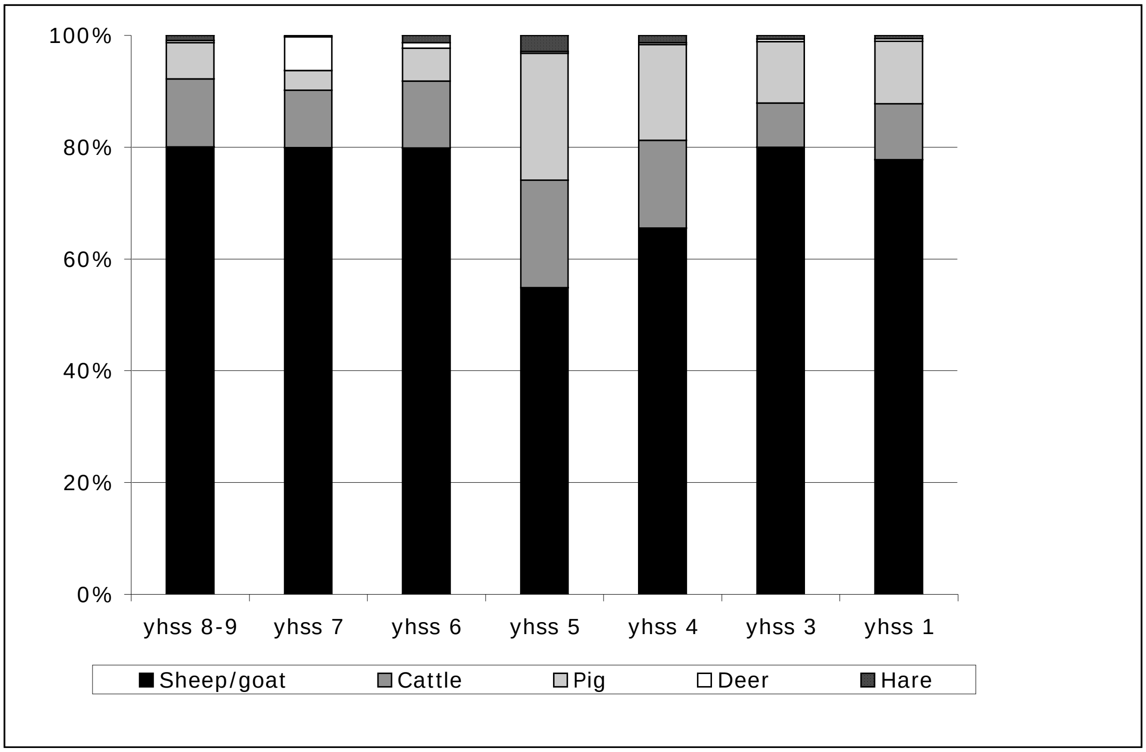
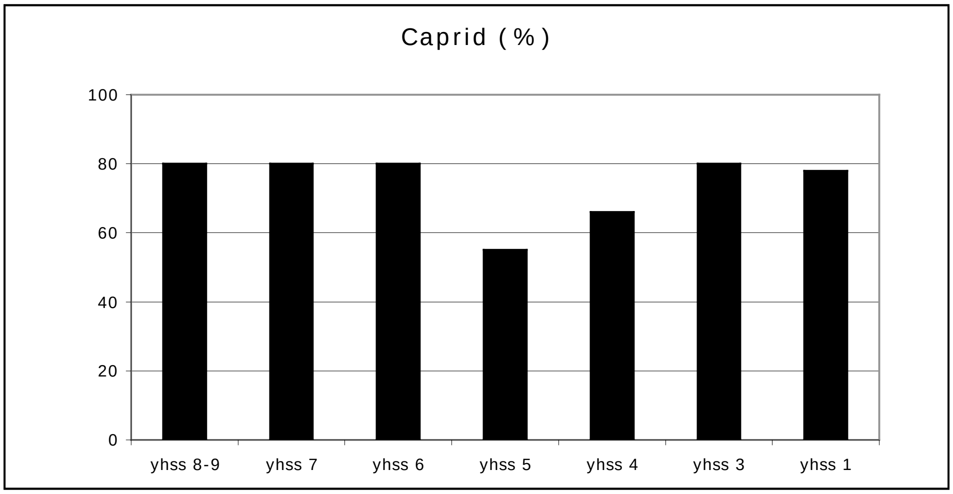
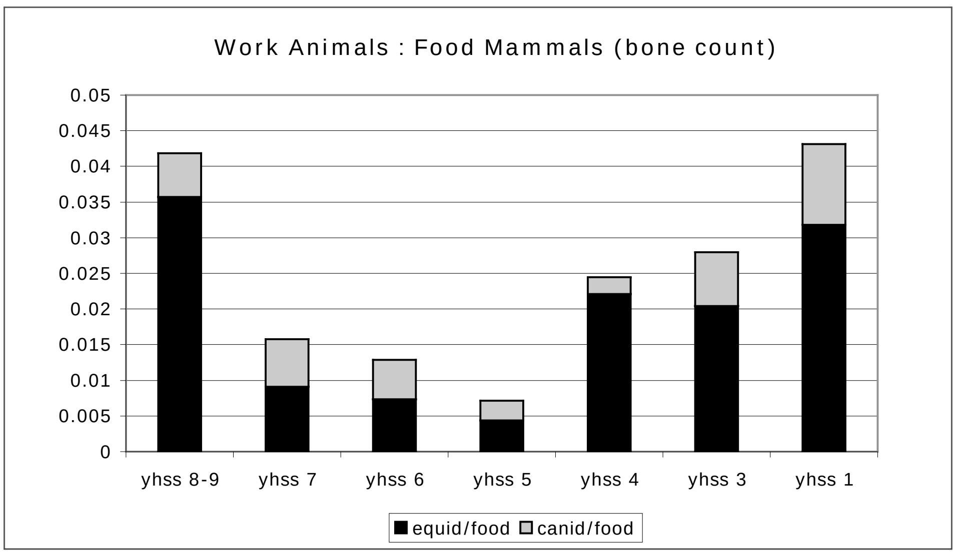


Fig. 6.2 Caprids, herder animals, and wild:cereal





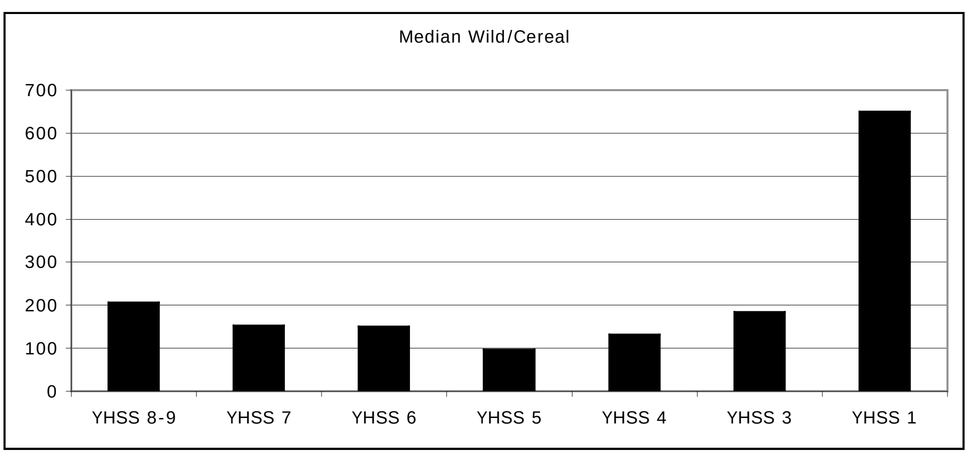


Table 6.1 Bone counts (Zeder...)

	yhss 8-9	yhss 7	yhss 6	yhss 5	yhss 4	yhss 3	yhss 1
caprid	1816	2639	1300	1002	1421	1057	685
bos	277	339	195	352	341	105	88
pig	146	118	96	414	371	145	99
deer	9	198	16	6	7	6	4
hare	21	9	21	53	29	9	5
equid	81	30	12	8	48	27	28
fish	17	17	6	13	13	22	3
bird	9	13	22	37	70	37	45
canid	14	22	9	5	5	10	10
rodent	1	0	3	2	1	1	6
reptile	6	43	7	0	6	1	6

Table 6.2 Percent of food animals

	yhss 8-9	yhss 7	yhss 6	yhss 5	yhss 4	yhss 3	yhss 1
Sheep/goat	80.0	79.9	79.9	54.8	65.5	80.0	77.8
Cattle	12.2	10.3	12.0	19.3	15.7	7.9	10.0
Pig	6.4	3.6	5.9	22.7	17.1	11.0	11.2
Deer	0.4	6.0	1.0	0.3	0.3	0.5	0.5
Hare	0.9	0.3	1.3	2.9	1.3	0.7	0.6

Table 6.3. Economic indicators (independent of time)

Location	Distant	Close
Activity (wild:cereal ratio)	Pastoralism	Farming
Domestic food mammals (bone count)	Sheep and goat	Cattle and pig
Wild food mammals (bone count)	Deer	Hare
Work animals (bone count)	Dog, equid higher	Dog, equid lower

Table 6.4 Other indicators of plant use. Summary chart based on totals:

YHSS	8&9	7	6	5	4	3	1
No. samples	32	66	8	15	53	32	15
Wheat sum (includes einkorn)	6.32	24.07	0.11	0.81	11.44	5.34	0.70
Einkorn sum	0.17	1.79	0.01	0	0.13	0.03	0
Barley sum	7.90	12.42	0.13	1.53	18.33	6.31	0.68

Cereal sum	21.28	50.00	0.44	4.07	40.63	23.18	1.95
Einkorn rachis (includes einkorn)	8	103	0	1	35	5	0
Wheat rachis	390	1000	7	15	3605	863	22
Bitter vetch sum	1.02	1.10	0	0.03	0.36	0.25	0.20
Pulse sum (includes bitter vetch)	1.43	1.38	1.00	2.18	0.73	0.99	0.38
Wheat/(wheat + barley) - %	44	66	44	35	38	29	51
Wheat/cereal-%	30	48	25	20	28	23	36
Barley/cereal-%	37	25	32	38	45	57	35
Einkorn/Wheat-%	2.7	7.4	9.1	0	1.1	0.6	0
Einkorn rachis/wheat rachis-%	8	43	43	27	8	1	0
Bitter vetch/Pulse-%	71	80	0	1	49	13	53

Comparison of average seed:charcoal ratios, southeast Turkey and northwest Syria*

Site	Samples (no.)	Period	Vegetation inference	Ratio
Gritille	18	Medieval-later	depleted oak woodland	2.40
Gritille	14	Medieval-early	open oak woodland	0.12
Hacınebi	26	Chalcolithic	steppe-forest	0.24
Sweyhat	17	Early/Middle Bronze	steppe	1.13

Source: Gritille (Miller 1998); Hacinebi: Stein et al. (1996); Sweyhat: Miller (1997b)

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Appendix A
Flotation Samples: Laboratory Protocol for Gordion

Procedures for Sorting and Recording of Light Fractions (see sample data sheet):

• Fill in YH data sheet provenience information

• If sample is larger than about 1 film cannister full, weigh entire sample. Otherwise, use sample splitter to obtain about one film cannister of material, and weigh the material to be sorted. (For each halving, put in separate containers so that it will be possible later to do additional fractions of approximately equal size).

• For portion to be identified, sift into >2 mm (4 mm and 2 mm sieves), <2 mm, <1 mm, and <0.5 mm. Material that passes through the 0.5 mm mesh should be scanned occasionally. If no seeds are seen, this dust fraction can be discarded.

• Sorting
1. >2 mm fraction: totally sort into charcoal, seed, straw and chaff, other charred, bone/shell, other.

a. weigh charcoal and record
b. weigh seeds and seed fragments as a group and record
c. weigh other charred plant parts as a group and record
c. put bone/shell, identifiable and unidentifiable carbonized material in separate containers with labels (YH # and substance; for bone and shell put full provenience). Put any other residue in a container.
d. identify the seeds, identifiable seed fragments (mainly cereal), and culm nodes, rachis internodes, other plant parts and put in separate piles.
e. record counts and weights as appropriate (see "Recording" below)

2. for material between 2 and 1 mm:
a. separate whole seeds, identifiable seed fragments (mainly cereal), and rachis internodes; put the bits of gravel, sand, etc. in the residue container.
b. record counts and weights as appropriate (see "Recording" below)

3. For material between 1 and 0.5 mm:
a. separate whole seeds and identifiable plant parts
b. record counts as appropriate (see "Recording" below)

4. For material smaller than 0.5 mm
a. separate whole seeds; this size fraction has few identifiable seeds.
b. record counts as appropriate (see "Recording" below)

• Seed identification

Use standard seed atlases, illustrations in archaeobotanical reports, and material in my comparative collection housed in MASCA, which includes seeds and voucher specimens collected in the Gordion area since 1988.

• Recording

1. Taxa that are frequently found in identifiable fragments include cereals (wheat, barley, cereal indet.), pulses (grass pea, bitter vetch, lentil, et al.), grape, nutshell. Whole items should be recorded by count and weight , and weight of identifiable fragments larger than 2 mm and larger than 1 mm should also be recorded

a. for >1 mm: counts and weights of the larger taxa

b. for <1 mm: counts only; if a seed has a unique part, record unique fragment as MNI (minimum number of individuals). For example, the proximal end of a grass may be counted as 1 MNI of Poaceaeeae.

2. Plant parts should be recorded separately--by count if the item is or breaks up into a recognizable unit, like rachis internode or culm node, and by weight if the item breaks up into irregular fragments, like fruit rinds; only weigh items that are larger than 1 mm.

3. Obviously modern seeds and not so obviously modern seeds should be counted and recorded as such. This applies to most boraginaceous seeds (unless they are charred). The most common seeds in this category that are mineralized (sometimes silicified) that may well be ancient include *Lithospermum* and *Arnebia* (but not *Heliotropium* and *Asperugo*), sedges (notably *Eleocharis* and *Carex*), *Ficus*.

Procedures for Picking, Sorting, and Recording of Heavy Fractions:

The heavy fraction is caught in 1-mm mesh in the flotation tank; after it dries, it is stored in plastic bags until it is picked. Heavy fractions were picked in the field without a microscope by local girls under the supervision of the archaeobotanist or by the archaeobotanist herself. In 1988, material between 1 and 2 mm was scanned under a low-power microscope; occasional identifiable seeds were encountered (e.g., *Galium*, *Bromus*), but the numbers did not warrant the time spent sorting to such a small size. In subsequent years, only botanical material larger than 2 mm was picked.

To pick:

1.Pour heavy fraction a little at a time throught nested sieves (4.75 and 2 mm). Put the >4.75 mm fraction on a tray, the fraction between 2 and 4.75 mm in a bag, and throw away the material less than 2 mm.

2. Material > 4.75 mm: remove botanical materials, bone, sherds, metal, other artifacts, and other interesting items and return to the unpicked portion of the sample.

3. Material > 2mm: the archaeobotanist herself examined the smaller fraction and removed only seeds, whole bones, eggshell, fishscales, and beads or other small artifacts.

4. The archaeobotanist distributed the non-botanical materials to the appropriate experts and packed the botanical remains for examination with a microscope in the U.S.

To sort botanical remains from heavy fraction:
1. totally sort material >4.75 mm into charcoal, seed, straw and chaff, and remove seeds from >2mm fraction

2. weigh charcoal and record

3. weigh seeds and seed fragments as a group and record

4. weigh other charred plant parts as a group and record

5. identify the seeds, identifiable seed fragments (mainly cereal), and culm nodes, rachis internodes, other plant parts and put in separate piles.

6. record counts and weights as appropriate (see "Recording" for light fractions, above)

Appendix B
Wood Charcoal Identification Criteria

The Taxa

Identifications are based on comparison with an incomplete comparative collection housed at MASCA, and illustrations and descriptions of woods in Panshin and de Zeeuw (1970), Fahn et al. (1986), and Schweingruber (1982, 1990). It is difficult, and frequently impossible, to determine a wood sample to the species level. If there are distinguishing characteristics, they may not be preserved in charred specimens, due to size or color changes, or the destruction of delicate features. Even between genera, some types are easily confused. Some of the previously published specific determinations of wood from Gordion seem to be based on features apparent in uncharred wood but not in charcoal; others are inferred on geographical grounds. I have found no anatomical grounds for giving determinations to species, although occasionally one might use a phytogeographical argument to go beyond the genus level. To enable interested wood anatomists to assess my reasons for assigning items to a given taxon, the features I have used to distinguish the taxa are listed. Features indicated with an asterisk are ones that were loooked for on all pieces. Features without an asterisk were used to check, confirm or delimit an identification.

CONIFERS

Two types of conifers were distinguished, pine (Pinus) and juniper (Juniperus). A few small or distorted peices remain indeterminate and are referred to as "conifer," though they are more likely to be juniper than pine or any other type. Kayacık and Aytug (1968) report several conifers from the Tumulus MM and its furnishings: Pinus sylvestris, Juniperus foetidissima, Cedrus libani, and Taxus baccata; the pieces originally thought to be yew (T. baccata) are now understood to be pine and Lebanon cedar (Blanchette and Simpson 1992). Criteria for the specific indentification of pine and juniper could not be developed with the charred specimens available from the City Mound, and cedar and yew were not seen.

Pinus (pine)
Low magnification
x-section *resin ducts, usually in later half of growth ring
High magnification
x-section intercellular spaces not seen
r-section pinoid cross-field pits, ray tracheids on margins of rays

Juniperus (juniper)
Low magnification
x-section *resin ducts absent
High magnification
x-section *intercellular spaces frequent
r-section pits cupressoid/taxodioid, no ray tracheids on margins of rays (and rays relative low height), tangential walls of ray cells thin and finely nodular

t-section ray height less than 12 cells, and usually less than 6

Possible confusions:
Abies (fir): like juniper, fir does not have resin ducts. Anatomy manuals and a comparative piece (Abies alba) do not have intercellular space, ray height seems to be over 10 cells, and tangential walls of ray cells dentate.
Taxus (yew): like juniper, yew does not have resin ducts, but it does have spiral thickenings, absent from all coniferous wood examined for this report.
Cedrus libani (Lebanon cedar): like juniper, Lebanon cedar does not have resin ducts, but it does have marginal ray tracheids, absent from all non-pine coniferous charcoal examined for this report.

DICOTS

Alnus cf. viridis (formerly Unknown 5; YH 30419, "planks") (Alder)
Low magnification
x-section Diffuse porous, *vessels solitary to radial multiples of 4 or more, as many as 9 seen, and some pore groups, distributed throughout growth ring. Rays thin, but visible at low power, pores not particularly small. Note that rings are fairly wide.
High magnification
x-section same as above, *scalariform perforation plates visible
r-section *scalariform perforation plates, ca. 8–9 bars
t-section rays 1-seriate, vessels with densely alternate pits

Possible confusions:
Maple and boxwood are two of the woods, identified from the Midas tumulus furnishings, that were not seen in these samples. They do not correspond to any of the unknowns; they seem closest to Unknown 5, but are not. (The third wood known from the tomb furnishings but not from the 1988/89 excavations is walnut, Juglans regia.)
Acer: Alder is reminiscent of maple, except that maple does not have scalariform perforation plates.
Note: scalariform perforation plates are fairly unusual. Except for the scalariform perforation plates, this wood does not resemble other wood types with scalariform perforation plates, namely birch (Betula), Viburnum, holly (Ilex), plane (Platanus) cornelian cherry (Cornus) beech (Fagus). Boxwood, hazel and alder still need to be considered.
Buxus: boxwood pores are small and solitary
Corylus: has aggregate rays
Alnus orientalis, A. glutinosa, and A. viridis: This wood looks like alder at low magnification, and alder has the densely alternate pits characteristic of this type. Unfortunately, only the first two species are reported for Turkey, but both have aggregate rays. A. viridis does not have aggregate rays, but is not mentioned in the Flora of Turkey (Davis 1982).

Fraxinus (Ash)
Low magnification
x-section *ring porous, *growth rings distinct, *large early wood vessels, solitary or radial multiples, tyloses common, *small, sparse latewood vessels, usually in radial pairs
High magnification
x-section same as above, vessels smaller than "Morus"
r-section *homocelllar, no spiral thickenings
t-section *rays biseriate, no spiral thickenings

Populus (Poplar)
Low magnification
x-section *Diffuse porous, growth ring usually distinct, *pores rounded in cross-section, solitary or radial multiples or small groups, *frequently with occluded vessels, *fine rays
High magnification
x-section as above, fibers thin-walled
r-section *homocellular (Populus), *heterocellular (Salix), large pits in vessels congregate just outside ray margins
t-section *1-seriate

Possible confusions:
Salix (willow): except for one piece from YH phase 0 (YH 20801), all these were poplar.
Pyrus/Crataegus: At first, I erred in the identification, but poplar pores are more likely to be rounded than angular, and the large pits in vessels congregating on the ray margins are also distinctive.

Prunus (persica/armenaica/communis-type) (peach/apricott/almond)
Low magnification
x-section *Ring porous, growth rings distinct. *Early wood vessels one deep, occluded/tyloses. *Late wood pores fairly evenly distributed in growth ring, not sparse, seem to have crystals, rays wide
High magnification
x-section same as above
r-section rays average 6–7-seriate, up to 8-. Spiral thickenings in vessels, probably homocellular (hard to see in specimen)
t-section 1-seriate and multiseriate rays

Pyrus/Crataegus (formerly unknown 2) (Pear/Hawthorn)
Low magnification
x-section *Diffuse porous to semi-diffuse porous, growth ring ±distinct, *vessels mostly solitary and evenly distributed across growth ring, *frequently angular cross-section
High magnification

x-section same as above, vessels 2+ -seriate, fibers may be relatively thick-walled compared to Populus/Salix

r-section heterocellular and homocellular, vessels usually with thin spiral thickenings

t-section rays upt to 6 or so-seriate, though usually 2–3-seriate

Possible confusion:
Populus: But thinner-walled fibers, pores more rounded, more likely (but not necessarily) to be in small groups or radial multiples, *uniseriate, no spiral thickenings

Note: According to Schweingruber (1982), it is not possible ot distinguish the woods of wild pear and hawthorn. Either are possible at Gordion.

Quercus (oak)

Low magnification

x-section * ring porous, *growth rings distinct, *wide rays and narrow ones, tyloses in most samples, tangential parenchyma in late wood, flame-like arrangement of vessels in late wood (usually rings were so narrow that only large, early-wood pores were present)

High magnification

x-section not checked

r-section not checked

t-section not checked

Rhamnus (Buckthorn)

Low magnification

x-section *diffuse porous, *growth rings distinct, *vessels in oblique, flame-like groups, *no vessels interspersed among fibers. Looks identical to Rhamnus cathartica depicted by Schweingruber (1982)

High magnification

x-section not checked

r-section not checked

t-section not checked

Ulmus (Elm)

Low magnification

x-section *Early vessels mostly large, but sometimes associated with narrow ones, *late wood vessels clustered in oblique bands, frequently continuing across rays, ± tyloses

High magnification

x-section same as above

r-section *rays homocellular or heterogeneous type I (i.e., cells mostly procumbent, with marginal row of square cells), *spiral thickenings, especially in narrow vessels t-section rays 1- and 2-seriate, frequently 3–5-seriate (one piece 7–8-seriate), up to >20 cells high

Possible confusion:
Celtis: At first, Ulmus was identified as Celtis, but even though many of the rays were heterogeneous, they had square rather than upright marginal cells, and the type seemed to have mostly homocellular rays with procumbent cells.

Ulmus/Morus (Elm/Mulberry)
Low magnification
x-section *ring porous, *growth rings distinct, *early wood vessels large, solitary or radial multiples, tyloses common, *late wood vessels in small isolated clusters, oblique arrangement, but not continuous bands
High magnification
x-section same as above
r-section *heterocellular (heterogeneous type I?), *distinct, fine spiral thickenings, widely spaced in examples seen, especially in smaller vessels
t-section *rays wide (4-–5-seriate), *spiral thickenings

Possible confusion:
The verbal distinction between the elm and mulberry is small. It is possible that I have incorrectly identified the rays as heterocellular. Even so, these pieces do not seem to be Celtis or Ulmus, because the late wood pore groups are isolated, not arranged in continuous or near continuous bands.

Unknown 1 (YH 22895 #6)
Low magnification
x-section *Ring porous, *growth rings distinct, early wood pores solitary but closely packed, late wood pores mostly solitary and round, very occasionally pairs
High magnification
x-section same as above
r-section heterocellular (otherwise, would be reminiscent of ash)
t-section very fine rays (check)

Unknown 3 (YH 25660 #1)
Low magnification
x-section Ring porous, growth rings distinct, early wood pores single, tyloses, late wood pores radial twos and clusters, but sparse, seems like ash but not
High magnification
x-section same as above
r-section rays heterocellular: 1–3 rows of uprights on margins of procumbents, no spiral thickenings
t-section rays several seriate

Unknown 4 (check Tamarix!; YH 25748 #3, 5; YH 31330 #9)
Low magnification

x-section	*Ring porous, *growth ring distinct, *early wood vessels solitary or in group, *rays wide, clear at low magnification, *late wood pores sparse, solitary, radial files of 2, and small groups, *±tyloses

High magnification

x-section	same as above
r-section	no spiral thickenings, seems to be heterocellular (rows of procumbent with square cells interspersed?)
t-section	rays wide, 5–6-seriate, vessels with many minute pits

Appendix C
Vegetation Survey

During 16 field seasons between 1988 and 2007, I informally surveyed the vegetation growing within about 2 kilometers of the site of Gordion and village of Yassıhöyük. Although it is easy to recognize some vegetation patterns, it is hard to identify taxa that are uniquely associated with a particular environmental niche (Davis's Flora of Turkey, pers. obs.); not only are most of the plants tolerant of a range of conditions, most of the terrain I examined was adjacent to irrigated fields or overgrazed pasture. There are, however, a few plant taxa that stand out as potentially useful for tracing changes in land use patterns because they generally grow on the grassy steppe, the degraded steppe, fields, or, in the case of the tree taxa, in the forest. Unfortunately, their charred seeds are generally not distinctive beyond the level of genus or family.

Botanical fieldwork took place concurrently with the excavation and archaeological conservation seasons, between the beginning of June at the earliest and the middle of August at the latest; most botanizing was done in June. Therefore, early spring and fall-flowering plants are absent from this discussion. A variety of habitats occurs within the surveyed area: degraded pasture, irrigated gardens and fields, the former bed of the Sakarya river, the banks of the river, and roadsides, many of which are field edges. Most intensive and systematic botanical survey was on Tumulus MM, 1997–2007. Whenever I had occasion to leave the valley bottom, there were always at least a few plants I had not seen before, but I did not have time for collecting more than a few specimens.

In 1993, I was able to work on voucher specimens to date at the Royal Botanic Garden in Edinburgh, where several staff members helped make the determinations; other plants were less securely determined at the botanical laboratory of the British Institute of Archaeology in Ankara (sometimes with Mac Marston) and with the help of P.H. Davis' Flora of Turkey and various field guides. Mecit Vural and other botanists visiting Gordion have also suggested identifications for present-day plants. Even so, it is not a simple matter to identify plants in the field, since their distinquishing characteristics are not always present or obvious (i.e., the list of plant taxa should not be taken too literally). In addition to voucher specimens, I have collected seeds and wood from the area when available; the identifications of the ancient material are based on these specimens, illustrations in books and articles (especially Schewingruber 1990 for the wood and W. van Zeists many publications in the journal Palaeohistoria), and the comparative collection housed in the ethnobotanical laboratory at the University of Pennsylvania Museum.

See Excel file: YH App C plant list

Appendix D
Wild and Weedy Taxa: Seed Identification and Ecological Information

Description of the taxa. The taxa of wild and weedy plants found in the Gordion samples are listed below in alphabetical order by family. Identification was based on illustrations on comparison with the comparative collection housed in the University of Pennsylvania Museum, which includes many types collected in the spring in the environs of Gordion. Seed atlases and archaeobotanical reports were also consulted. General comments based on personal observation around Gordion and published information about the taxa follow the seed descriptions. Tumulus MM--relatively undisturbed pasture

Apiaceae (Umbelliferae—carrot family)
In fresh specimens, members of the Apiaceae are distinguished by general morphology, specific variations in shape, and surface. Charring destroys or distorts many features, so many of the seeds cannot be determined even to genus. Generally, members of this large, diverse family are plants of open ground.

cf. Anthriscus. Long drop-shaped seed; surface eroded (YH 28338: L 3.5, B 1.8, T 1.4). Not seen growing today.

Artedia. [seed ill. D.1] Distinctive, flat seed in only one sample. Not seen growing today.

Bifora. Distinctive round seed with heart-shaped hilum. Bifora radians seen at the edge of an irrigated wheat field.

Bupleurum. Size, shape, and surface texture (rugose, but with no hint of spines) consistent with Bupleurum. YH Apiaceae 6 may be Bupleurum based on general size and shape, but seed coat absent. Bupleurum turcicum and B. flavum seen in uncultivated steppe.

cf. Daucus. [cf. seed ill. D.2] Size and shape (roughly parallel sides, hint of spines) consistent with Daucus carota, which is common along roadsides, irrigated field edges, and the bank of the Sakarya.

Eryngium. [seed ill. D.3] Five distinctive flat seeds occur in a single sample. Both Eryngium campestre and E. creticum grow in the area today. Their leaves and inflorescences have have spiny tips, and they grow in overgrazed pasture as well as on Tumulus MM.

Torilis. [seed illus. D.3.5]

Torilis cf. leptophylla. [seed ill. D.4] Similar to cf. Daucus, but in examples where spines have been abraded away, wavy longitudinal ridges visible (YH 30664: L 6.1, B 2.0, T 1.0).

cf. Turgenia. [seed ill. D.5] Seed wider and thicker at base than at apex; base of some spines visible. Seen on Tumulus MM.

Apiaceae, various. Several members of the family occur throughout the sequence in small numbers. Some are illustrated and described. Given the inherent variability of charred seeds, I have not described and illustrated all these types; the reader would be advised to lump them as miscellaneous Apiaceae, which tend to be plants of open ground.

YH Apiaceae 2. [seed ill. D.6; Table D.1] A small seed, ridged; may not have spines. Seven measurable seeds from four samples average length 2.3 mm, breadth 1.1 mm, and thickness 0.9 mm.

Table D.1. YH-Apiaceae 2 measurements.

n = 7	Range (mm)	Mean (mm)	Standard Deviation
L	1.6–2.7	2.3	0.4
B	0.8–1.3	1.1	0.2
T	0.6–1.1	0.9	0.2
L/B	2.00–2.25	2.06	0.09
T/B	0.73–0.92	0.82	0.17

YH Apiaceae 3. A small seed, relatively flat and ridges not prominent (YH 22096: L 1.9 mm, B 1.2 mm, T 0.7 mm). The single examplar has remains of fine spines.

YH Apiaceae 4/8 [see illus. D.7.5b; Table D.2] A plump seed; surface texture may be shiny or dull, with or without bumps indicative of spines. Designation based primarily on length and plumpness. There were 13 measurable seeds from 13 different samples, with length averaging 2.8 mm, length:breadth about 1.65 and thickness:breadth about 0.90.

Table D.2. YH-Apiaceae 4/8 measurements.

n = 13	Range (mm)	Mean (mm)	Standard Deviation
L	2.3 – 3.2	2.8	0.3
B	1.3 – 2.2	1.7	0.3
T	1.3 – 2.1	1.5	0.3
L/B	1.38 – 1.94	1.65	0.21
T/B	0.86 – 1.00	0.90	0.04

YH Apiaceae 6. May be Bupleurum without its seedcoat.

YH Apiaceae 7. [see ill. D.7]. See seed illustration.

YH Apiaceae 9. A whole fruit (i.e., two attached carpels) in one sample.

YH Apiaceae 10/Unknown 31. [seed ill. D.8a,b; Table D.3]. Similar to YH Apiaceae 4/8, but larger and longer. surface texture may be shiny or dull, with or without bumps indicative of spines. Identification primarily on length and plumpness, with length being about 3.5 mm, length:breadth about 1.87 and thickness:breadth 0.88.

Table D.3. YH Apiaceae 10/Unknown 13 measurements.

n = 20	Range (mm)	Mean (mm)	Standard Deviation
L	3.1 – 4.3	3.5	0.3
B	1.5 – 2.3	1.9	0.2
T	1.3 – 2.2	1.7	0.3
L/B	1.60 – 2. 25	1.87	0.19
T/B	0.76 – 0.96	0.88	0.06

Asteraceae (Compositae; daisy family). The Asteraceae is one of the largest plant families in Turkey with diverse genera, though they tend to be plants of open ground. In both ancient seed samples and modern vegetation survey, they can be difficult to identify. I have been unable to collect seeds of several common genera because they ripen in the late summer or fall (notably Cousinia halysensis, Xeranthemum inapertum); perhaps some of the unidentified seeds belong to these uncollected genera.

cf. Anthemis/Matricaria. [seed ill. D.9]. Differs from YH Asteraceae 1 because it is slightly bigger. Both of these genera are common in lightly grazed steppe.

Artemisia. Along with wild thyme (Thymus sp.) Artemisia cf. fragrans is one of the most common shrubs in the overgrazed environs of Gordion.

Carthamus. [seed ill. D.10]. Carthamus is a large seed; one seed (YH 26472) measures 4.3 x 2.5 mm. Not seen growing today.

Centaurea. [seed ill. D.11]. Centaurea achenes in the Gordion assemblage are very variable in size. One sample had a Centaurea head (capitulum). In and around Gordion today I have seen many different species of Centaurea. (In addition to C. calcitrapa, C. patula, C. pseudoreflexa, C. pulchella, C. solstitialis, C.virgata, there are six that I have been unable to determine.) Some have spiny leaves and calyces and some not, and seed size is quite variable. For that reason, it was not possible to categorize the seeds by size or shape, with the exception of a particularly large one with an oval hilum that is similar to C. cyanus or C. depressa.

Cirsium. [seed ill. D.12]. The single Cirsium is smooth and relatively flat with an umbo (raised part of achene apex, characteristic of the Cardueae (Davis V:5). Cirsium sp. is seen at roadsides and other disturbed ground.

cf. Koelpinia. [seed ill. D.13]. Curved with the bases of stiff bristles on the outer side. Koelpinia linearis is seen on Tumulus MM.

Onopordum. [seed ill. D.14]. A large achene; a separable ring of connate (fused) pappus hairs (see Davis, vol. 5, p. 356) is also encountered in some samples. Onopordum anatolicum is a prominent thistle, seen on Tumulus MM and also in some poorly drained terrain.

cf. Senecio. [seed ill. D.15]. See illustration. Senecio sp. is seen on Tumulus MM.

Taraxacum. [seed ill. D.16]. A single Taraxacum achene has been identified. Taraxacum sp. (dandelion) has been noticed in the Gordion City Mound.

Asteraceae, various. Several members of the family occur throughout the sequence, some in large numbers. In addition to the seeds (actually, achenes), other parts of the flower head (capitulum) have been seen: Carduae involucres and phyllaries and several forms of receptacles. Some seeds are illustrated and described. Given the inherent variability of charred seeds, I have not described and illustrated all these types; many could be lumped as miscellaneous Asteraceae, which tend to be plants of open ground. In view of the complexity and wide distribution of this family, no further interpretations are provided.

YH-Asteraceae 1. [seed ill. D.17]. A small, smooth achene; narrow ridge follows the edge of the seed, and it has a slightly rounded cross-section. It may be an Achillea. There are several Achillea species growing near Gordion (most common in overgrazed pasture is an annual A. wilhelmsii, but on Tumulus MM and lightly grazed areas several perennial Achillea species are seen.

YH-Asteraceae . [seed ill. D.18]. Unlike YH-Asteraceae 1, YH-Asteraceae 2 has small bumps arranged in longitudinal ribs and a rounder cross-section.

YH-Asteraceae 5. [seed ill. D.19]. A tiny seed, most probably a member of the family based on shape and apparent apex.

YH-Asteraceae 7. [seed ill. D.20]. Slight ridge on anterior side. See illustration.

YH-Asteraceae 9 Similar to YH-Asteraceae 3. Tubercles more pronounced in general, especially on slightly ridged anterior side.

YH-Asteraceae 10. [seed ill. D.21]. Tubercles on longitudinal ribs, rounded cross-section.

YH-Asteraceae 11. [seed ill. D.22]. Only one distinctive exemplar, reminiscent of Taraxacum or Sonchus.

YH-Asteraceae 12. Only 3 examples; low ribs, smooth, rounded cross-section, about 1.5 mm long and about 0.6 mm in diameter.

YH-Asteraceae 13. [see ill. D.22.5]. A flattish Asteraceae with shallow ribs, with only 6 designated in 3 samples.

Phyllaries (136) and tips (142) in one sample, YH 27718, that also has 14 Centaurea seeds (achenes), 1 Centaurea capitulum, 16 Onopordum seeds, 4 fragments of an Onopordum capitulum, 24 Onopordum "connate ring" of pappus hairs [seed illus. D.14]. Centaurea and Onopordum are both in the tribe Carduae, and members of both genera could have spiny phyllaries like the ones in this sample.

Receptacles. One sample, YH 23307, has two receptacles. YH-Asteraceae plant part 1 is about 5 mm in diameter with ephemeral palea and is reminiscent of Matricaria. YH-Asteraceae plant part 2 is conical, about 2 mm in diameter and 4 mm long, with paleas "cuneate" at the base; it is consistent with Anthemis/Matricaria. Other capitula occur occasionally.

Boraginaceae (borage family)

It is now well-known that many members of the Boraginaceae preserve well in uncarbonized form, and when they do char, they sometimes turn white or gray rather than black. Distinguishing modern from ancient examples presents problems. I have incorporated gray and black seeds in the main analysis (reported with other charred seeds), and am assuming that white and tan ones, if not modern, arrived uncharred in the samples (reported with mineralized and uncharred seeds). All types identified here are herbaceous plants.

Anchusa cf. azurea. A single charred seed, YH 33246, YHSS 620; consistent with this species as shown in Davis 6, 247 fig. 8b.

Arnebia/Lithospermum. All but 5 of the seeds classified as Arnebia or Lithospermum are uncharred (white, gray, tan).

Asperugo. There is no reason to think these tan seeds are ancient; Asperugo procumbens has been seen growing within the excavated area of the Citadel Mound.

Heliotropium (158). Only dark gray, charred seeds are included in charred seed data tables Heliotropium is a common ruderal (plant of disturbed ground) near Gordion today.

cf. Buglossoides. Some of the nutlets are clearly charred, and some are white or tan; only the dark gray ones are included in charred seed data tables. Buglossoides arvensis has been seen at Gordion.

Moltkia. A few uncharred seeds of this type were encountered. Moltkia coerulea has been seen in disturbed steppe.

Nonea. A single uncharred seed of this type was seen. Nonea caspica grows on Tumulus MM.

Brassicaceae (mustard family)

Seeds of members of the mustard family are distinguished by general morphology. Some have relatively distinctive shape and surface texture, but more often than one would prefer, one must be satisfied to identifcation at the family level. Some of the Brassicaceae siliques (seed pods) in the assemblage are distinctive. Generally, members of this large, diverse family are plants of open ground.

cf. Alyssum. A few tentatively identified Alyssum seeds occur in the samples. The plant Alyssum, however, is quite widespread on Tumulus MM as well as waste areas. At least four species have been recognized, though not identified, growing in the area today.

Boreava orientalis. A single silique of this species occurs in Hellenistic deposit (YH 28338, 370.05); the wavy margin distinguishes it from the other Turkish species, B. aptera. B. orientalis has been seen in irrigated fields near the site.

cf. <u>Camelina rumelica</u> (was YH-Brassicaceae 14). [see illus. D.24a]. Three seeds from Early Iron Age context, YHSS 7, compare well to <u>C. rumelica</u> collected at Gordion in size, shape (the boundary between the radicle and the rest of the seed is pronounced), and overall surface distribution of small tubercles. Though not common today, the plant has been seen on Tumulus MM, on the City Mound, and uncultivated field edge.

cf. <u>Camelina sativa</u>. The four seeds identified as cf. <u>Camelina sativa</u> are somewhat bigger than those of <u>C. rumelica</u>.

<u>Cardaria draba</u>. [see illus. D.25]. A single example of the distinctive silique (flat inverted heart shape) occurs in YH 22192, which also has a lot of YH-Brassicaceae 3/5). Cardaria grows on Tumulus MM, but is widespread in ruderal habitats. <u>C. draba</u> is the only Cardaria species in Turkey.

<u>Conringia</u> (was YH Brassicaceae 9). [see illus. D.26]. <u>Conringia</u> seeds are a bit more common earlier in the sequence (Early Iron Age 8&7). They have a distinctive surface texture that compares will with seeds of <u>Conringia orientalis</u>, which was collected in irrigated fields near Gordion.

<u>Euclidium syriacum</u>. [see illus. D.27]. A silique type identified as <u>Euclidium syriacum</u> makes a sporadic appearance. There is only one species in Turkey, but I have not seen it in the area.

cf. <u>Lepidium</u>. [see illus. D.28]. One hundred of the 107 tentatively identified <u>Lepidium</u> seeds come from a single sample (YH 27461-YHSS 705).A typical one is about 1.8 mm long and 0.8 mm wide, lies flat with radicle to one side, and radicle curves along the edge of the seed.

<u>Sisymbrium altissimum</u>-type. [see illus. D.29B]. This is a rather blocky seed. The radicle is pronounced. These specimens compare most closely to <u>S. altissimum</u>-type in the comparative collection. <u>S. altissimum</u> is a very common plant of disturbed ground.

Brassicaeae, various. A variety of Brassicaceae seeds and some silique fragments have been separated out. Identifications for some are suggested, but at this point it it would be better to be more cautious.

YH-Brassicaceae 2. [see illus. D.30]. This small, blocky Brassicaceae (about 1 mm long) is a morphological category that might include more than one genus.

YH-Brass 3/5. [see illus. D.31]. This seed type is fairly numerous. Fine cell structure is visible at 30x magnification. The shape and size is consistent with <u>Cardaria draba</u>, and it is perhaps not an accident that the one sample with a C. draba silique also has a lot of this seed tpe.

YH-Brassicaceae 7. [see illus. D.32]. This type compares well with <u>Lepidium perfoliatum</u> in the comparative collection. There is a flat rim around the edge; fine cell structure is visible at 30x magnification; the seed is about 1.4 to 1.6 mm long, and is flatter than cf. <u>Lepidium</u> above.

YH-Brassicaceae 10. [see illus. D.33] Another blocky Brassicaceae with fairly large tubercles.

YH-Brassicaceae 11. [see illus. D.34] Narrower than YH-Brassicaceae 2, this numerous type is a morphological category that might include more than one genus.

YH-Brassicaceae 12. Not illustrated, this type has the same general shape as YH-Brassicaceae 11, but is well under 1 mm in length. It is a morphological category that might include more than one genus.

YH-Brassicaceae silique 3. This appears to be the pedicle of a completely dehisced silique.

YH-Brassicaceae silique 4. This is consistent with Sinapis arvensis.

YH-Brassicaceae silique 5. [see illus. D.35] Almost spherical silique with wavy margin at line of dehiscence; some surface texture; flat beak-like projection.

Caryophyllaceae (pink family)

Bufonia. [see illus. D.36]. The seeds are a bit over 1 mm in length. The hilum is on one of the narrow sides of the relatively flat oval seed, which has nearly linear arrangement of tubercles following the perimeter. Bufonia virgata, a small (ca. 10 cm) delicate plant has been seen on Tumulus MM as well as in unprotected areas.

Cerastium? [see illus. D.37] A seed type tentatively identified as Cerastium based on size and relatively sparse (compared to other Caryophyllaceae) distribution of tubercles. Cerastium dichotomum has been seen in fields around Gordion.

Gypsophila. One of the more common genera (415 seeds), Gypsophila is found throughout the sequence. At least four species grow in the area today: . G. eriocalyx, a small steppe shrub that is abundant on Tumulus MM and also in unprotected steppe; two other perennials—cf. G. lepidioides, similar to G. eriocalyx, and G. perfoliata; and two annuals, G. viscosa, common on tumulus MM and G. pilosa, which has been seen in fields.

Silene/Allochrusa. Seeds identified as Silene/Allochrusa are scattered throughout the sequence. I am unable to distinguish modern examples of Silene and Allochrusa seeds. I have seen at least two kinds of Silene—Silene conoidea, in an irrigated field, and another small herbaceous one on Tumulus MM; the genus is sufficiently varied that one cannot specify its requirements and habits. The two species of Allochrusa that grow in Turkey, A. versicolor and A. bungei, are small shrubs; one or both grow on Tumulus MM.

Vaccaria pyramidata. Seeds of this monotypic genus are scattered throughout the sequence. The seed is spherical with small bumps; the archaeological specimens are split open on the equatorial plane. V. pyramidata is a field weed.

Caryophyllaceae, various. Many in this indeterminate category includes seeds that are likely to be Gypsophila (beaked) or Silene/Allochrusa (unbeaked). In addition, the form of several unknowns are small, flattish sees with hilum on concave side; convex side may have parallel ridges (YH-unknowns 14, 16, 29) or ridges not noticeably parallel (YH-unknown 38); genera that have been considered include Dianthus in the Caryophyllaceae and Veronica in the Scrophulariaceae.

YH-Caryophyllaceae 1. [see illus. D.37.5] A smooth, flattish seed with hilum on concave side.

Chenopodiaceae (goosefoot family)

Members of the Chenopodiaceae are an important component of the vegetation of the central Anatolian steppe; many are salt tolerant. Others are common weeds of irrigated fields and gardens.

Atriplex. [see illus-bract D.38] Atriplex seeds, recognized by the embryo curled around the perimeter occur in a few samples. In addition, the distinctive bract-enclosed fruit has been recognized. Atriplex cf. leucoclada grows on the unprotected part of the City Mound and it is an early colonizer of the steep baulks within the fenced part. A. laevis was seen in an irrigated field.

Chenopodium. The seeds designated Chenopodium compare well in size and surface to modern specimens. Chenopodium album has been seen on waste areas and in gardens and irrigated fields. Complete ancient charred seeds are sometimes difficult to distinguish from the modern black ones.

Salsola kali-type. [see illus. D.39a] Seeds tentatively identified as Salsola kali occur in the early and later parts of the sequence. The curled embryo is visible in the seeds.

Salsola soda-type. [see illus. D.40] In contrast to Salsola kali-type seeds, the embryos of S. soda-type seeds can be coiled.

Salsola sp. S. kali-type seeds are relatively flat, and S. soda-type look like little coiled mounds; intermediate forms (or incomplete seeds) that could be either are designated Salsola sp. I have not seen Salsola around Gordion.

Salsola/Kochia. fruits. [see illus. D.41] The fruits compare well with those of S. kali and S. salsola as well as Kochia. Kochia seeds and enclosing fruits are more elongated than those of Salsola. The specimens here are pentamerous, but bilaterally symetrical, which would suggest Kochia. Seeds of Kochia have not been identified, however, and other Chenopodiaceous fruits may be similar, too.

Suaeda. Suaeda is relatively easy to identify (see illustration, van Zeist and Bakker-Heeres 1985:fig. 4.1). It has been seen growing as a weed in gardens and irrigated fields around Gordion. One modern specimen is Suaeda altimissima.

Chenopodiaceae, various. The many small, lenticular seeds (ca. 1 mm diam.), seeds listed under the family taxon have not been determined further.

YH-Chenopodiaceae 2. [see illus. D.42] This seed looks like a tiny Chenopodium. It has a tendency to burst on an equatorial plane.

Cistaceae (rock-rose family)

Helianthemum. Thirteen Helianthemum seeds from Gordion are similar in shape to those from, e.g., Sweyhat (Miller 1997:fig. 6.1a). Helianthemum salicifolium is a small annual herb that is very common on the lower, drier slopes of Tumulus MM.

Conolvulaceae (morning glory family)

Convolvulus. Eleven Convolvulus seeds have been identified. The most common species in the area tody is C. arvensis (bindweed), an invasive perennial plant of disturbed ground, but there are at least three other perennial species that have been seen at Gordion: C. galaticus and C. scammonia, near the river, and an as yet unidentified one that compares well with C. aucheri on Tumulus MM.

Cyperaceae (sedge family)

Sedges occur mainly as seeds, but a few stem fragments, recognized by a triangular cross-section, are also encountered. Sedges show an interesting distribution through time. In the earlier part of the sequence, sedges comprise less than 10% of the wild and weedy assemblage. They are somewhat more prominent in Middle Phrygian and later deposits, with an apparent steep increase in the latest deposits (33% in the YHSS 1). Since sedges grow in moist lowlying areas, along the river, on the old flood plain, and along irrigation ditches, it is conceivable that higher proportions of sedges relative to other wild and weedy plants are an indication of expansion of these moist habitats during the Medieval occupation. The possibility that the Phrygians, and almost definitely the later Hellenistic and Medieval populations, were expanding or instituting some irrigation system can at least be considered. Sedges are underrepresented in the modern botanical collections around Gordion.

cf. Carex. Seeds identified as Carex are among the more numerous sedges (1154). They are relatively flat, about 1.5 mm long, and the linear cell structure is commonly visible at low magnification.

YH Carex-3, of which only 11 exemplars were seen, is relatively flat and has the surface texture of Carex, but is about 2 mm long and 1 mm wide.

Eleocharis. [see illus. D.44] The seed of Eleocharis was identified by comparison with fresh examples. It has a flat side and a rounded side; the rounded side has two shallow furrows. Some specimens havev a cap-like structure at the apex. Some are charred black, but a greater number are gray or white. Eleocharis mitrocarpa/palustris has been seen in a ditch on the valley bottom.

Fimbristylis. [see illus. D.45] The seed has a distinctive surface texture. All come from a single sample dated to YHSS 1 (YH 21728).

Cyperaceae, various.

YH-Cyperaceae 1. The most numerous identified sedge (1478) is most probably Scirpus/Cyperus [as illustrated by van Zeist and Bakker-Heeres (1982:fig. 24.1) and others]. Instead of Scirpus maritimus L., some archaeobotanists use the synonym Bolboschoenus maritimus Palla.

YH-Cyperaceae 2. This seed type is round in cross-section except for three seams at one end, where the seed has a tendency to burst. (See also YH Cyperaceae-6.)

YH-Cyperaceae 3. [see illus. D.46] This type has a rounded triangular cross-section (i.e., it is trigonous). Reticulate surface texture is visible at low magnification; it compares with, for example, Cyperus fuscus illustrated in Schoch et al. (1988:77).

YH-Cyperaceae 5. [see illus. D.47] This type, about 1.8 mm long has a rounded triangular cross-section. The seed is reminiscent of Carex flava.

YH-Cyperaceae 6. [see illus. D.48] This type, about 1.5 mm long and 1.2 mm wide is round in cross-section for most of its length. One end has 3 seams; the seeds could be an unburst examples of YH Cyperaceae-2.

YH-Cyperaceae 7. [see illus. D.49] This type is small triquetrous seed.

YH-Cyperaceae 8. This type compares well with Fimbristylis bisumbellata illustrated in Townsend and Guest (1985:pl. 84); like Fimbristylis, all in YHSS 1

Dipsacaceae

cf. Cephalaria. Some seeds identified as Cephalaria are spindle-shaped. Sometimes, the outer surface, similar to that of Dipsacus, is preserved, but the point that extends beyond the [outer surface] is more obvious.

cf. Dipsacus (was YH-unknown 9, 9.1). [see illus. D.51a, b] Most of the seeds in this category occur in a single Medieval sample., and all but one of the remainder occur in Hellenistic or Medieval contexts. The seed is roughly four sided, with ribs at the corners and middles of each side.

Scabiosa. [see illus. D.52] A small number of this distinctive seed were seen. Two or three types grow on Tumulus MM, at the edges of the old Gordion excavations, and on the gypsum hills north and south of Yassıhöyük.

Euphorbiaceae

Euphorbia cf. falcata. [see illus. D.53] The seed in sample YH 22491 is similar to E. falcata. Several Euphorbia species grow in the area today, in a variety of habitats.

Fabaceae (pea family)

Alhagi (camelthorn). [see illus. D.118, D.119] The samples contain both pod fragments and seeds. It is most prevalent in deposits from phases 4 and 3, and is common but less numerous in the Medieval deposits. Camelthorn is a plant of the steppe, but particularly of disturbed soil. It has a deep taproot that is not destroyed by plowing. Today it grows primarily out in the middle of the plain and in fallow fields; it also may be regarded as an indicator of degraded pasture. Animals avoid eating it because of its spine-tipped branches, though ethnographically it is known as a fuel.

Astragalus. One of the most wide-spread and varied genera in the Middle East, Astragalus grows in a wide variety of habitats, from steppe to cultivated fields, so no ecological generalizations can be made. Some are perennial and some annual, and spiny types have been removed from the genus, now called Astracantha, also grow in the area. In addition to Astragalus hamosus, A. lydius, A. odoratus, A. triaradiatus, at least five or six other species have been seen.

Coronilla. Only two of this small cylindrical seed were seen. Sometimes there is a bump at the area around the hilum.

Medicago. Small kidney-shaped legumes are identified as Medicago. In the area today, Medicago constricta is common recently disturbed ungrazed areas and M. minima has been seen on the conglomerate outcrop across the Sakarya from Gordion.

Medicago radiata. The distinctive seed of identified as Medicago radiata compares well with the type illustrated by van Zeist ?and Bakker-Heeres (1982[1985])

Onobrychis. When the seed can be seen throught the easily recognized reticulate pod it is easy to identify. In addition. Othere seeds have been only tentatively assigned to Onobrychis.

Trifolium/Melilotus. This small, rounded legume has not been further determined. Modern members of the two genera, clover and melilot, have been seen growing in relatively moist habitats near river banks and irrigated gardens and fields.

Trigonella. Trigonella is the single most numerous genus of wild plant seed at Gordion. It is one of the endemics of the central Anatolian steppe, and today is common on Tumulus MM; in 1988 it was also common withing the fenced area of the City Mound. At least 7 species have been seen growing around Gordion, including: Trigonella astroites, T. capitata, T. coerulescens, T. crassipes, T. monantha, T. cf. pycnocephalus. Like clover, Trigonella would be a prime fodder plant, and would probably be sensitive to grazing. For that reason, I think it is an indicator of relatively undisturbed steppe. Using this somewhat circular reasoning, it is interesting to note that there is a gradual decline in the proportion of Trigonella relative to the seeds of other wild and weedy plants between the Late Bronze Age and Middle Phrygian periods, with a temporary upswing in the Late Phrygian and Hellenistic deposits.

Trigonella cf. astroites. Trigonella seeds with tuberculate surface are assigned a morphological species, though other species cannot be excluded.

Trigonella capitata. [see illus. D.54] This type is recgonized by its pod, which compares well with that of T. capitata. With only one seed per pod, it appears in the tables under "seed" rather than "plant part."

Vicia. Three spherical members of the Fabaceae have been identified as Vicia. Other wild vetches may be part of the category unidentified pulse.

Fabaceae, various. There are a number of seeds of small and medium sized legumes.

Geraniaceae (geranium family)

cf. Erodium. [see illus. D.121] Today, Erodium cicutarium is a common plant on waste areas and at the base of Tumulus MM.

cf. Geranium. [see illus. D.120] A seed type tentatively identified as Geranium occurs almost entirely in one Hellenistic sample, YH 28338. Two species of Geranium have been seen at the Gordion dighouse, G. lucidum/rotundifolium and G. cf. pusillum.

Hypericaceae

Hypericum. A single Hypericum seed occurs in a Medieval sample. H. origanifolium has been seen on the conglomerate outcrop.

Juncaceae

cf. Juncus. [see illus. D.55] A capsule filled with seeds compares well with Juncus. Not only is it the right size and shape, but the tiny seeds with longitudinal striations also fit. Today Juncus grows in some of the poorly drained parts of the valley.

Lamiaceae (mint family)

Ajuga chamaepitys. [see illus. D.56] A single seed identified to species occurs in a Late Bronze Age sample, YH 31836. Today, it was once seen on Tumulus MM.

cf. Lamium amplexicaule. Five seeds from a Late Phrygian deposit (YH 22109) are consistent with L. amplexicaule, seen in the City Mound of Gordion.

Mentha. [see illus. D.57] Two tiny mints with cell structure visible at low magnification have been identified as Mentha. They come from Late Phrygian levels. Mentha aquatica has been seen on the banks of the Sakarya.

Teucrium. A distinctive type. Sparsely distributed in the flotation samples. It is fairly common on the overgrazed gypsum steppe around Gordion and Teucrium polium grows on Tumulus MM.

Ziziphora. Ziziphora is the most numerous member of the mint family in the samples. Today it is a component of the steppe vegetation, and it is quite common on the lower east and south slopes of Tumulus MM.

Lamiaceae, various. Many mints have tiny seeds that are difficult to distinguish.

YH-Lamiaceae 1. [see illus. D.58] The distal end is relatively flat.

YH-Lamiaceae 2. [see illus. D.122] Small mint seeds, some of which were enclosed in the calyces (4 per flower). They measure about 0.7 mm long and 0.3 mm wide; The seeds are angular with flat sides; the distal end is flat.

YH-Lamiaceae 3. [see illus. D.59] Based on size and surface, this type is consistent with <u>Nepeta congesta</u>, which grows on undisturbed steppe in the region.

YH-Lamiaceae 4. [see illus. D.60] A long seed. The surface is distinctive, but seems to flake off. Nearly all of this type come from an Early Iron Age sample, YHSS (YH27461).

YH-Lamiaceae 5. [see illus. D.61] <u>Marrubium</u> was considered but discarded as a possible identification for this seed. Unlike YH-Lamiaceae 1, the distal end is rounded. Cell structure is visible at low magnification, and sometimes the seeds is encrusted with a white substance.

YH-Lamiaceae 6. [see illus. D.62] There are only a few of these small rounded seeds.

YH-Lamiaceae 7. [see illus. D.63] There are only a few of these seeds, but their surface is distinctive and four are still attached to each other.

Liliaceae (lily family)

A few seeds considered to be in this family are thin walled and have a hole at one end.

Linaceae (flax family)

<u>Linum</u>. Two seeds tentatively identified as wild flax were seen. <u>Linum bienne</u> has been seen on the north upper slopes of Tumulus MM.

Malvaceae

cf. <u>Malva</u>. The wedge-shaped seed of <u>Malva</u> is similar to other members of the family (e.g., <u>Alcea</u>, <u>Lavatera</u>). <u>Lavatera bryonifolia</u> grows by the river.

Papaveraceae (poppy family)

<u>Glaucium</u>. <u>Glaucium</u> seeds have a distinctive reticulate surface and in contrast to reniform <u>Papaver</u>, the hilum area is straight. <u>Glaucium corniculatum</u> and/or <u>G. hausknechtii</u> grow on the drier slopes of Tumulus MM, the gypsum ridge, the conglomerate outcrop, and field edges.

<u>Hypecoum</u>. [seed ill. .23]. The scimitar-shaped fruit of <u>Hypecoum</u> breaks cleanly into segments when dry. The species seen growing in Yassıhöyük is <u>H. imberbe</u>.

<u>Papaver</u>. [see illus. 64a, b] The poppy seeds are small, presumably from uncultivated plants. The seeds occur charred, but gray and white mineralized examples are fairly common. In addition, one sample had part of the disk that tops the poppy capsule [see

illus. D64.5]. I cannot distinguish Papaver seeds from those of Roemeria (though unlike poppy, the fruit is an elongated capsule, more like Glaucium). Several poppy species grow today in uncultivated steppe as well as fields and field edges: Papaver rhoeas, which has a large prominent flower, and the smaller P. hybridum and P. lateritium/dubium. Much less common, Roemeria hybrida has been seen in protected places on overgrazed land.

Fumaria. Fumaria, sometimes put in a separate family, has a very distinctive seed: it is small, lens shaped, with sharply defined circumference, irregular surface texture, and the hilum is a double hole (one one either side of the circumference). Fumaria vaillantii has been seen in the protected excavation area on the City Mound as well as in the watered garden at the dighouse.

Plantaginaceae

Plantago. Plantago is not particularly common in these samples. In Europe, Plantago pollen is considered an indicator of agriclutural disturbance. At Gordion, it is more likely to indicate relatively moist, grazed conditions: Plantago lanceolata, P. major, and P. media have all been seen growing along the Sakarya.

Poaceae (grass family)

Aegilops. Aegilops is a minor component that occurs both as seed and glume base. Aegilops cf. triuncialis grows at the base of Tumulus MM as does a second type, and Aegilops cylindrica is common near ditches and fields.

Avena (24). [see illus. D127]. There are only a few oat grains. Like today, oat was probably growing as a weed in grain fields.

Bromus. One of the most numerous identified grass genera, there are at least two morphological types in the assemblage: a long, narrow one, and a short, broad one. Bromus fragments are frequently recognizable, however, but cannot be distinguished further. The annuals Bromus tectorum and B. japonicus grow both in steppe and waste areas; the perennials Bromus cappadocicus and B. tomentellus are common on Tumulus MM, but are also seen on overgrazed gypsum slopes; the seeds of B. cappadocicus are long and relatively broad; on phytogeographical grounds it seems likely that some of the Bromus are of this type.

Bromus cf. japonicus. This morphological type, equivalent to van Zeist's Bromus danthoniae type, is relatively broad and flat.

Bromus cf. tectorum. This morphological type, equivalent to van Zeist's Bromus sterilis, is long and thin.

Eremopyrum. Eremopyrum is one of the most common identified grasses in the samples. It is particularly plentiful in the grassy steppe and in steppe vegetation at the edges of fields, as well as on Tumulus MM and in the fenced excavation area of Gordion.

Hordeum. Seeds of wild barley have been identified. A few could be be underdeveloped H. vulgare. In addition, a few rachises of wild barley (i.e., with smooth dehiscion scar) occur in some of the samples. Today, the ubiquitous annual weedy Hordeum murinum and less common perennial Hordeum bulbosum both grow in the area, so there is no reason to doubt the presence of wild barley in the samples.

Hordeum cf. murinum. [see illus. D.65] Archaeologically examples assigned to this type are much smaller than the domesticated type. Nowadays, Hordeum murinum, with its spiky-awned seed-dispersal unit, is one of the most common plants on roadsides and overgrazed areas. Once the awns form, herbivores avoid eating it.

Hordeum cf. spontaneum. Examples of a large-seeded wild barley resemble H. spontaneum. They are more likely to be undeveloped H. vulgare than the locally available large-seeded wild barley, the perennial H. bulbosum, which tends to be quite flat on the distal half.

cf. Lolium. Lolium seeds have a distinctive glume folds; identification is tentative because the plant is not that common today and there are few archaeological examples.

cf. Phalaris. Like Lolium, Phalaris is usually distinctive; identification is tentative because the plant is not that common today and there are few archaeological examples.

cf. Phleum pratense. [see illus. D.66] Seven of the 8 drop shaped seeds that compare well with modern examples of Phleum pratense come from a Hellenistic deposit. The seeds have a wrinkled appearance. Today, this species grows in and near irrigated fields.

Phragmites. One Hellenistic sample (YH 20825, YHSS 320) had some grass stem fragments of such great diameter that they are most probably from Phragmites, a plant which today grows along the river, the former riverbed, and in irrigated fields near the river.

cf. Poa bulbosa or P. timeolontis. [see illus. D.67] No complete (i.e., unbroken) one has been seen. If these are the bulbets, the parallel ridges support an identification as a monocot, and the general size and shape are consistent with P. bulbosa or P. timeolontis, both of which may exhibit vivipary. Technically not a seed, the bulblets are formed in the inflorescence.

Setaria. [see illus. D.68] The Medieval level at Gordion have cultivated Setaria italica. Smaller wild examples are scattered through most of the sequence.

Stipa. [see illus. D. 69–71, fig. D.a; Table D.4] Stipa seeds are distinctively round in cross-section with parallel sides. There is a tendency in the archaeological specimens length and width to be roughly correlated (i.e., longer seeds tend to be broader,too), but the larger seeds tend to have a smaller length to breadth ratio than the smaller ones (i.e., their overall appearance is less slender). A range of shapes is illustrated here: small slender (fig. D.69), medium (fig. D.70), and large broad (fig. D.71). Further study may enable us to confirm two or three overlapping morphological types. Today, Stipa is an important component of Tumulus MM vegetation, and is also present in overgrazed steppe. There are at least two species on Tumulus MM. The seeds are about 1 mm wide, but are generally longer than the archaeological specimens: Stipa arabica (seeds smaller, more slender) and S. holosericea (seeds larger, broader).

Table D.4. Archaeological Stipa measurements
a. Treated as a single population:

Stipa	N	Width (mm) mean (range)	Length (mm) mean (range)	L/W mean (range)
Total	58	1.0 (0.6 – 1.4) SD = 0.2	4.8 (3.2 – 5.9) SD = 0.5	4.8 (3.7 – 6.7) SD = 0.7

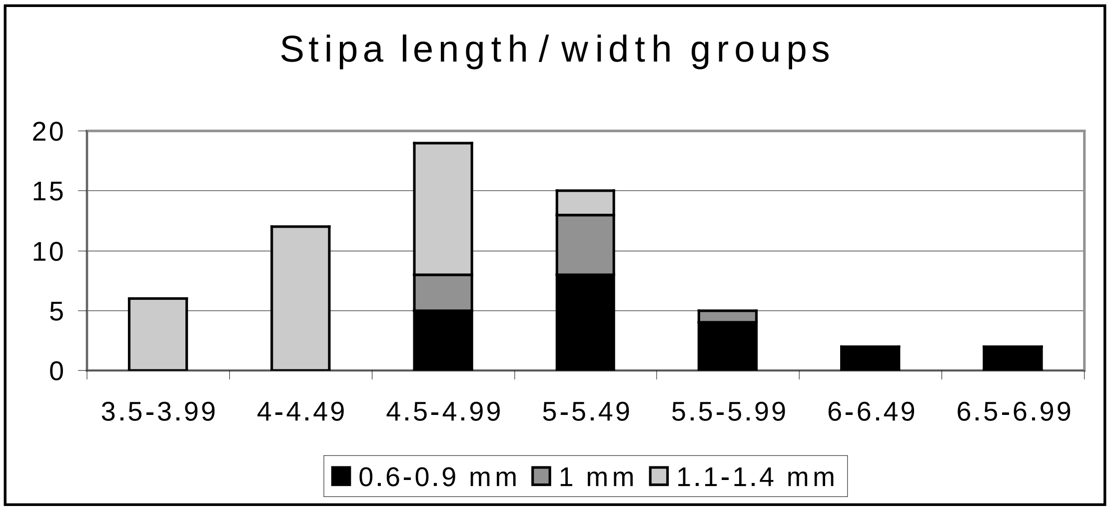
b. Treated as three populations, widths 0.6 –0.9, 1.0, and 1.1-1.4 mm

Stipa	N	Width (mm) mean (range)	Length (mm) mean (range)	L/W mean (range)
Total	18	8 (0.6 –0.9) SD = 0.1	4.4 (3.2–5.5) SD = 0.1	5.49 (4.50–6.71) SD = 0.6

Stipa	N	Width (mm) mean (range)	Length (mm) mean (range)	L/W mean (range)
Total	9	1.0 (1.0) SD = 0	5.0 (4.5–5.5) SD = 0.35	5.0 (4.5–5.5) SD = 0.35

Stipa	N	Width (mm) mean (range)	Length (mm) mean (range)	L/W mean (range)
Total	31	1.2 (1.1-1.4) SD = 0.1	5.0 (4.2–5.9) SD = 0.4	4.4 (3.75–5.39) SD = 0.4

Figure D.a. Frequency of widths of Stipa seeds according to shape



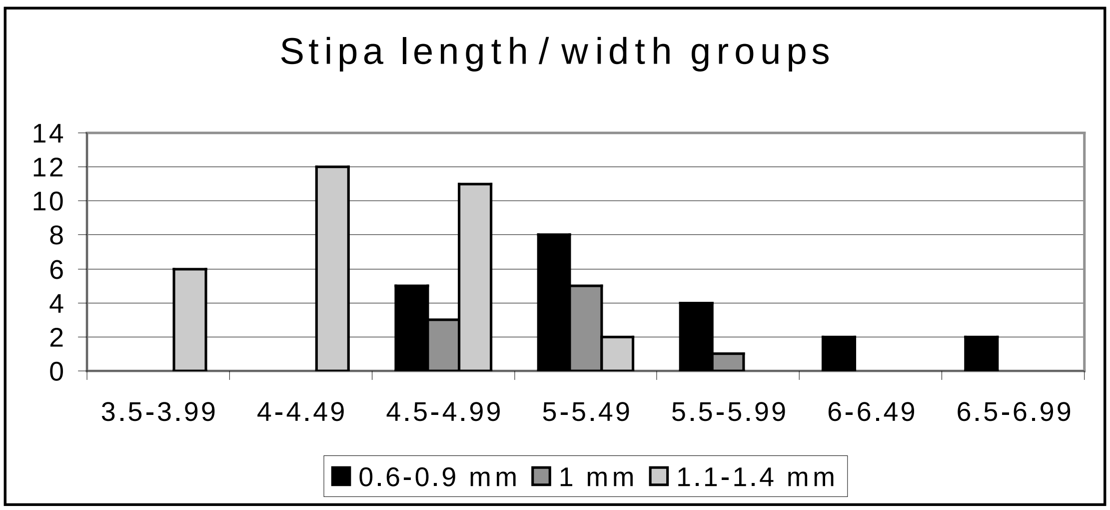


chart for values of <u>Stipa</u> length/width

	w=0.6-0.9	w=1	w=1.1-1.4
3.5-3.99			6
4-4.49			12
4.5-4.99	5	3	11
5-5.49	8	5	2
5.5-5.99	4	1	
6-6.49	2		
6.5-6.99	2		

<u>Taeniatherum</u> (was YH Poaceae-7). [see illus. D.72] Taeniatherum is a relatively large seed. In cross-section, the glumes create a fold on either side and towards the ventral side. The ventral side flattens out toward the tip. In addition to seeds, a few rachis fragments

have also been seen. Taeniatherum caput-medusae is an annual grass characteristic of relatively undisturbed areas (along the railroad tracks, on the conglomerate outcrop).

"Triticoid." There are few seeds that are reminiscent of Triticum but quite a bit smaller.

Triticum boeoticum. Wild einkorn comprises a minor part of the material. Triticum boeoticum (the single-seeded variety) grows at the base of Çile Dagı, which has a basalt substrate, about 7 km from the site.

Poaceae (small grasses), various.

Grasses are generally plants of open ground, and at least when green tend to be fodder plants. They are difficult to identify, and even the numbered types mentioned below may not be true scientific taxa. If a type is consistent with a known taxon growing in the area, I mention it.

YH-Poaceae 1, cf. Eragrostis. This is a small, round seed (commonly less than 1 mm). [see illus. D.123]. It is numerous and widely distributed in the samples.

YH-Poaceae 2. [see illus. D.73] See seed illustration; similar to YH-Poaceae 5.

YH-Poaceae 3. [see illus. D.74] See seed illustration; longer than Y-Poaceae 2 and 5.

YH-Poaceae 4. [see illus. D.75] Germ takes up about one-half the length of the seed, which is relatively broad.

YH-Poaceae 5. [see illus. D.76] See seed illustration; similar to YH-Poaceae 2.

YH-Poaceae 7 [see illus. D.77a, b] See seed illustration. Nearly all of these seeds come from a single Hellenistic sample, YH 28338 (59 of 62). They are reminiscent of Taeniatherum caput-medusae.

YH-Poaceae 7.1 [see illus. 77.5]

YH-Poaceae 8. [see illus. D.78] Germ is not quite one-half the length of the seed, and is thinner than YH-Poaceae 4. It occurs throughout the sequence. It is consistent with Cynodon dactylon, which is an aggressive perennial that propagates by deep underground stems and is not particularly good forage.

YH-Poaceae 10/15. [see illus. D.79] The glumes of this tiny (less than 0.4 mm long) seed are sometimes visible as a fold along the edge. It is consistent with Aeluropus littoralis, which grows on the poorly drained plain.

YH-Poaceae 11. [ILLUSTRATE PAGE 60?]?

YH-Poaceae 12. [see illus. D.80] Only a single one of this distinctive large, plump grass was seen.

YH-Poaceae 13. [see illus. D.81] These seeds compare well in size and positiion of embryo (i.e., dorsal side relatively flat, ventral side bulged toward base) with Phleum paniculatum, which, though not collected at Gordion, is in its range (Davis, vol. 9).

YH-Poaceae 14. [see illus. D.82] This is a distinctive seed. If it is a grass, the embryo extends almost the entire length of the seed.

YH-Poaceae 16. [see illus. D.83] A small nondescript grass; see illustration.

YH-Poaceae 17/18. [see illus. D.84] Some of these seeds retain the impression of the glume on the ventral side. They are plump, but flatten towards the tip.

YH-Poaceae 19. [see illus. D.85] The germ, which extends about 3/4 of the length of the seed, is similar to the seed of Bothriochloa ischaemum, a perennial grass that has been seen near Çekerdeksiz.

YH-Poaceae 20/21. Most of these come from a single sample, YH 29312 [YHSS 705]. Similar in size to YH-Poaceae 17/18, they do not have a fold on the ventral side. YH-Poaceae 19 is slightly concave at the tip and bulges at the basee of the ventral side, where YH-Poacae 20 is slightly concave toward the base and bulges at the tip; they appear to come from a two-seeded floret, with the growth of the first one constraining that of the second.

YH-Poaceae rachis 1. [see illus. D.85.5].

Polygonaceae

cf. Polygonum. Polygonum may be underrepresented (misidentified as sedge); unlike sedge, its cell structure is not clearly visible at low magnification. Seeds tentatively identified as Polygonum are wider towards the base than the tip. Some seeds with a rounded triangular cross-section that could not be oriented (i.e., it is impossible to tell whether the seed is wider at the base or the end) are designated Polygonum/Cyperaceae. I have seen Polygonum arenarium and P. cf. pulchellum in gardens, irrigated fields, and along the Sakarya near Gordion.

Rumex. The tetrahedral shape with sharp edges make Rumex easily recognized. It occurs in low numbers throughout the sequence. I have seen Rumex gracilescens and R. pulcher growing on the edges of irrigated fields near Gordion.

Portulaceae

Portulaca. It is not always easy to determine whether a Portulaca seed is ancient or modern, since both are black. I have seen Portulaca in gardens and moist areas near Gordion.

Primulaceae

Androsace. This type is roughly triangular in cross section, and the surface has broad shallow ridges perpendicular to the side edges. Sometime a hilum is visible at the center of one edge. Androsace maxima, a small (ca. 10 cm high) annual, is fairly common in uncultivated steppe around Gordion, including Tumulus MM.

Primulaceae, various

YH-Primulaceae 1. [see illus. D.86] This seed type has tentatively assigned to the Primulaceae because of its triangular cross section. In contrast to Andrsace, the surface is relatively smooth.

YH-Primulaceae 2. [see illus. D.87] This seed type has tentatively assigned to the Primulaceae because the hilum is on the center of one side.

Ranunculaceae

cf. Aconitum/Consolida. [see illus. D.88] This seed is quite distinctive, pointed at one end with thin wavy ridges perpendicular to the sides. It most resembles three Ranunculaceae genera, all of which grow on uncultivated ground in the area today. Consolida is common; Aconitum cf. nasutum is only in protected contexts.

Adonis. The distinctive seeds of Adonis occur in low numbers throughout the sequence. Adonis is fairly ubiquitous, and is seen on low-lying overgrazed areas.

Ceratocephalus. [see illus. D.89] A few seeds of Ceratocephalus occur; identification is based on comparison with fresh C. falcatus. The plant is inconspicuous (about 10 cm high), seen growing on Tumulus MM.

Ranunculus. [see illus. D.90] This flat asymmetrical seed has a shape reminiscent of Ranunculus repens but the surface is characterized by low irregular ridges roughly parallel to the edges. The two Ranunculus species seen at Gordion today, both of which grow along ditches, are not under consideration; R. cornutus has large (ca. 2 mm) seeds with bumps, and R. muricatus seeds have spines on the surface, similar to R. arvensis (which was not noticed).

Ranunculus arvensis-type. [see illus. D.91] Nine large (> 2mm) seeds with remnants of the spines were seen. Ranunculus muricatus, which has been seen along ditches, has spiny seeds, too.

Resedaceae

Reseda. [see illus. D.92] Today, two types of Reseda have been seen: The seeds of R. lutea are more than 1 mm long (typically between 1.2 and 1.5 mm), and those of R. microcarpa are under 1 mm. The ancient seeds are probably R. lutea. R. lutea grows on Tumulus MM and lightly grazed areas; R. micocarpa has been seen in low areas and roadside ditches.

Rhamnaceae

Paliurus spina-christi, formerly YH-unknown 10. [see illus. D.99] Twenty-five of this type occurs in only one Hellenistic sample (YH 21719, YHSS 380.18). It is most probably the fruit of Paliurus spina-christi, a spiny, shrubby tree that is a minor component of open juniper woodland within 20 km of Gordion.

Rosaceae

The Rosaceae family is well-represented in the wood charcoal by Pyrus/Crataegus (whose wood cannot be distinguished; both types occur in the area) and Prunus (various wild almonds, plums, cherries, and other stone fruits). The seeds of these woody types are less common.

Potentilla. Of four seeds identified as Potentilla in YH22074 (YHSS 1), one measureable one is 0.9 mm long and 0.6 mm wide; asymmetrically drop shaped with low ridged relief similar to Potentilla recta. Today, P. erecta has been seen on the conglerate ridge and P. reptans grows along the Sakarya.

Rubiaceae

cf. Asperula (was YH-Rubiaceae 2). Following Riehl 1999:108, hollow globose seeds internally divided by a septum visible because there is a hole at the hilum are assigned to the genus Asperula. It resembles Galium, except the latter is undivided inside. Today, on grazed and ungrazed steppe, yellow-flowered A. stricta subsp. grandiflora grows, as does a white-flowered type.

Galium. Galium is one of the most common and numerous seeds in the assemblage. When charred, the globose seed has an undivided hollow interior visible through a hole at the hilum. On fresh material, the same pedicel may have a tiny seed and a large one. The genus has many species with a wide range of habitats, both disturbed and undisturbed, and may have a perennial or annual habit. Galium verum, though not common, grows in roadside ditches and in the poorly drained Roman road excavation just inside the Tumulus MM fence.

YH-Rubiaceae 1. [see illus. D.93] This type is most likely a member of the Rubiaceae. Unlike the more globular Galium and Asperula, it is longer than it is wide. The central depression is divided, like Asperula, but the charred seed is not hollow. Note that species of both Galium and Asperula are not necessarily globose, and not all are hollow. I.e., YH-Rubiaceae 1 may belong to one of these genera.

Scrophulariaceae

Veronica. Only three seeds identified as Veronica were encountered. One of them (YH 23637) compares well with V. persica, with ridges on the dorsal side; that seed is about 1.4 mm long. One species of this genus, cf. Veronica multifida, has been seen on Tumulus MM and in juniper scrub near Ahırozu. See also discussion of unknowns in Caryophyllaceae.

Verbascum. Only three seeds identified as Verbascum were encountered. In contrast to YH-Scrophulariaceae 1 (see next entry), the depressions are very sharply delineated. Otherwise, they are similar in size and shape.

YH-Scrophulariaceae 1. [see illus. D.94] This seed is very similar to Verbascum and Scrophularia, with irregulary blocky shape and short horizontal depressions aligned in vertical rows along the length. The seed is typically about 0.8 mm in length. Verbascum, with its candelabra-shaped inflorescence, is prominent in the summer landscape along roadsides around Gordion and towards Polatlı, and in Turkey generally, and seems a likely identification for this seed.

Solanaceae

Hyoscyamus (was YH-Solanaceae 1). [see illus. D.95] The surface of the seed has the wavy-edged ridges typical of the Solanaceae, and the irregular shape, flattish, but thicker at one end, supports an identification of Hyoscyamus. I have not seen Hyoscyamus growing, but there is no reason members of this widespread genus could not have been part of the local flora.

Solanum (was YH-Solanaceae 3). [see illus. D.96] A single flat Solanaceous seed is designated Solanum. Solanum dulcamera grows along the Sakarya today.

YH-Solanaceae 2. One flat seed is relatively smooth on surface, except low sculpting is visible on the rim at high magnification; the identification as Solanaceae is a best guess.

Thymeleaceae

Thymelaea. The distinctive seed of Thymelaea is pointed at one end rounded at the other [van Zeist and Bakker-Heeres 1984:fig. 7.12 for illustration]. Thymelaea passerina, though fairly common on Tumulus MM, is actually quite inconspicuous thanks to its very slender green branches.

Valerianaceae

Valerianella. In several publications, Willem van Zeist has distinguished three morphologically distinct types of Valerianella, all of which occur in the Gordion samples: V. coronata, V. dentata,and V. vesicaria. At Gordion, Valerianella coronata is the most numerous type (105 seeds), followed by V. vesicaria (14) and V. dentata (3), with 18 indeterminate Valerianella. I have not recognized it

Verbenaceae
Verbena officinalis. [see illus. D.97] Two Verbena officinalis occur in Late Phrygian contexts. I have not seen it growing, but there is no reason this plant could not have been part of the local flora. There is only one other Verbena species listed in the Flora of Turkey.

Zygophyllaceae

Peganum harmala. Despite the presence of only a few intact seeds, a number of seeds with traces of the surface and a shiny endosperm are identified as wild rue. A native shrubby steppe, plant, wild rue has hallucinogenic alkaloids that make it unpalatable to livestock. With overgrazing, it would tend to increase through time. Today, it is most common on the uncultivated tumuli and archaeological mounds in the valley. It is not common on the degraded steppe areas where thyme predominates. Although nowadays people do not take advantage of its psychotropic properties, belief in its magical effects is widespread in the Middle East; in some places, its seeds are tossed into fires for general good fortune, and even today women make charms (nazarlık) against the evil eye from its seed pods.

Zygophyllum fabago (was YH-unknown 11/13). [see illus. D.100] This asymmetrical seed sometimes looks mineralized rather than charred. Well-preserved exemplars look like Zygophyllum fabago (a ruderal that has been seen along the railroad tracks near Gordion; the only other Turkish Zygophyllum, Z. album, grows on dunes and salt flats [Davis, vol. 2, p. 492]).

Recognizable unknowns

Many seeds remain unidentified because they are poorly preserved, are are non-descript (for example, the ubiquitous catgory small round seed), or occur in such small numbers or fragmentary state that there is no point trying to describe them. Sometimes, a seed type is so distinctive or occurs in sufficient quantity so that it is possible to get a sense of the range of variation that someday, when the comparative collection is extensive enough or a fellow archaeobotanist passes by the laboratory, it will be identified.

YH-unknown 7. [see illus. D.98] This seed is likely to be in the Rubiaceae. The linear white flecks are similar to those seen on fresh Sherardia arvensis.

YH-unknown 12. [see illus.D101] The outer coat of this unidentified seed/fruit is thin; see also Carex divisa.

YH-unknown 14. [see illus. D.102] This seed is similar to members of the Caryophyllaceae in form, as well as Veronica (Scrophulariaceae) but did not match illustrations or seeds in the comparative collection. The Caryophyllaceae with similar seeds that have been collected near Gordion are Petrorhagia/Dianthus, which has smooth seeds, as does Veronica.

YH-unknown 16. [see illus. D.103] Only two of this type occur. The central ridge on the ventral side is reminiscent of Plantago, but he ridges are not.

YH-Unknown 17. [see illus. D 104] This large, irregular seed is reminiscent of Crataegus (hawthorn).

YH-unknown 18. [see illus. D. 105] This large irregular seed remains unidentified; may be the same as YH-Unknown 17.

YH-unknown 19 [see illus. D. 124] A small seed with a fine cell structure visible at high magnification and warty surface (small rounded bumps) was found in YH33270.

YH-unknown 21 [see illus. D. 125] This small item is probably the endosperm of a flat round seed.

YH-unknown 23. [see illus. D.106] A small wedge-shaped seed with rounded edges.

YH-unknown 26) [see illus. D.107] A few of these sedge-like seeds occur. The type has a series of ridges on the rounded side. A possible identification not yet ruled out is Carex divisa (or C. muricata). Despite superficial similarity in the drawings, this is unlikely to be the same as YH-unknown 12, which is considerably larger.

YH-unknown 27. [see illus. D.108] Irregularly shaped and very variable in size, this form remains unidentified; it may not be a seed. Brassicaceae (Myagrum in particular) has been considered, but the distal end is not smooth. Some kind of small animal fecal pellet has also been considered, but at high magnification some cell structure is visible, and one broken specimen had a 0.2 mm thick seed coat.

YH-unknown 28. [see illus. D.109] Two of this type occur in a single Hellenistic sample (YH28338).

YH-unknown 29. [see illus. D.110] This seed is similar to YH-unknowns14 and 16. The central rise is wider than that of 14 and the ridges are narrower than those of 16.

YH-unknown 30. [see illus. D.111] This small item, if it is a seed, looks a bit like a member of the Asteraceae.

YH-unknown 32. [see illus. D.111.5] Small lens-shaped seed with tiny tubercles visible around the edge. At first was thought to be in the Brassicaceae.

YH-unknown 35. [see illus. D. 126] (16) The surface of this rounded seed is smooth and shiny.

YH-unknown 36.   Fairly large (> 1 mm diameter) globose seed with low tubercles. (7) Brassicaceae is under consideration.

YH-unknown 37. [see illus. D.112] A unique, but distinctive item, this may be a seed capsule rather than a seed.

YH-unknown 38 (4) similar to 14, 16, and 29, but not ridged; entire sample (YH22706) sent to P. I. Kuniholm for radiocarbon dating.

YH-unknown 40 (1) Check

Plant parts
YH-plant part 16 [see illus. D.116]
YH-unknown 25. [see illus. D.117]

Notes on cultivated plants

Triticum aestivum/durum rachis fragments. One type which has a stem with a square cross section occurs primarily in Late Phrygian (YHSS 4) samples [see illus. D.115]

YH-unknown 34--MOVEd TO UNKNOWNS
YH-unknown 24. moved to unk general

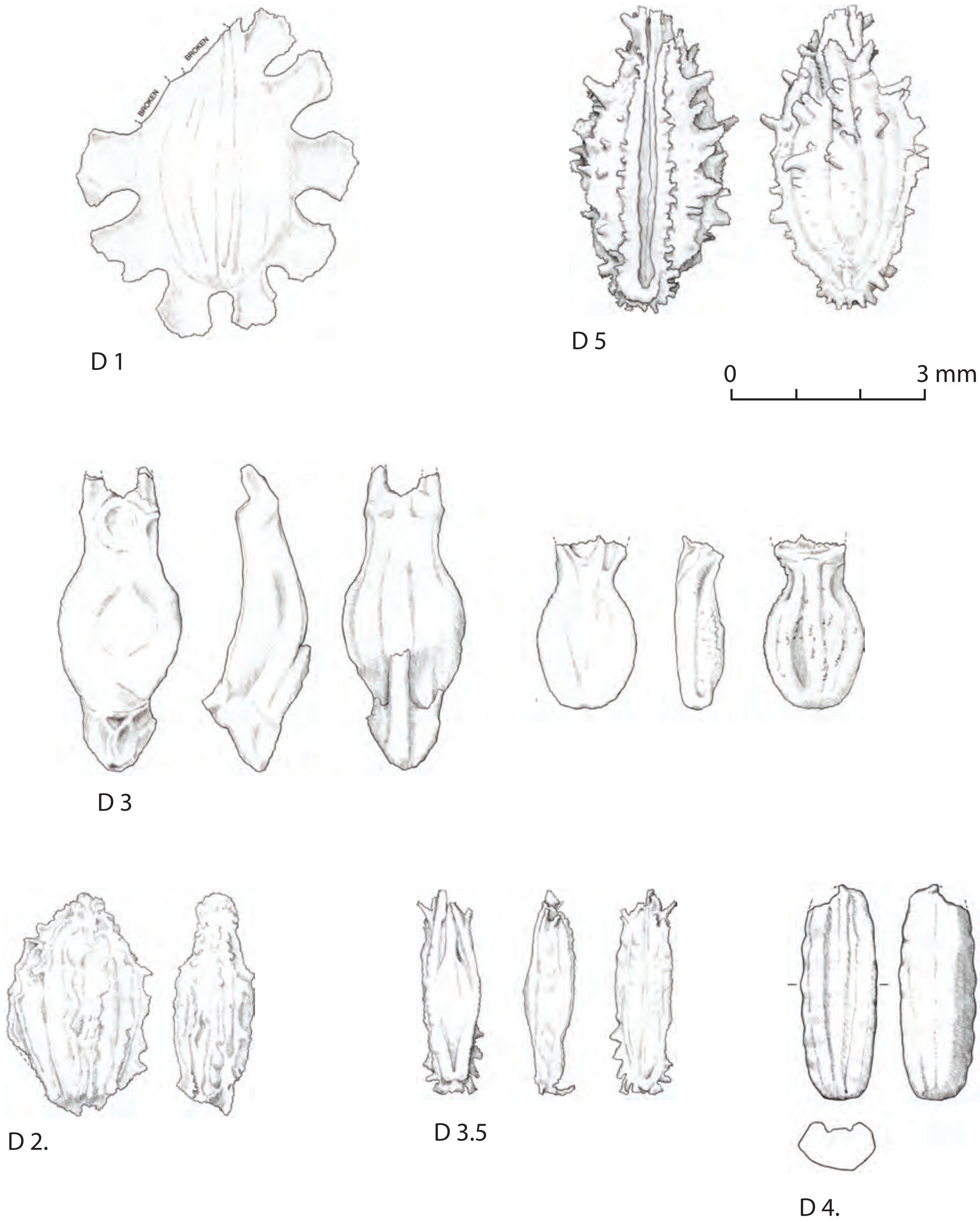


plate 1. D1 Artedia, D5 cf. Turgenia; D3 Eryngium; D2 cf. Daucus carota; D3.5 Torilis; D 4 Torilis leptophylla

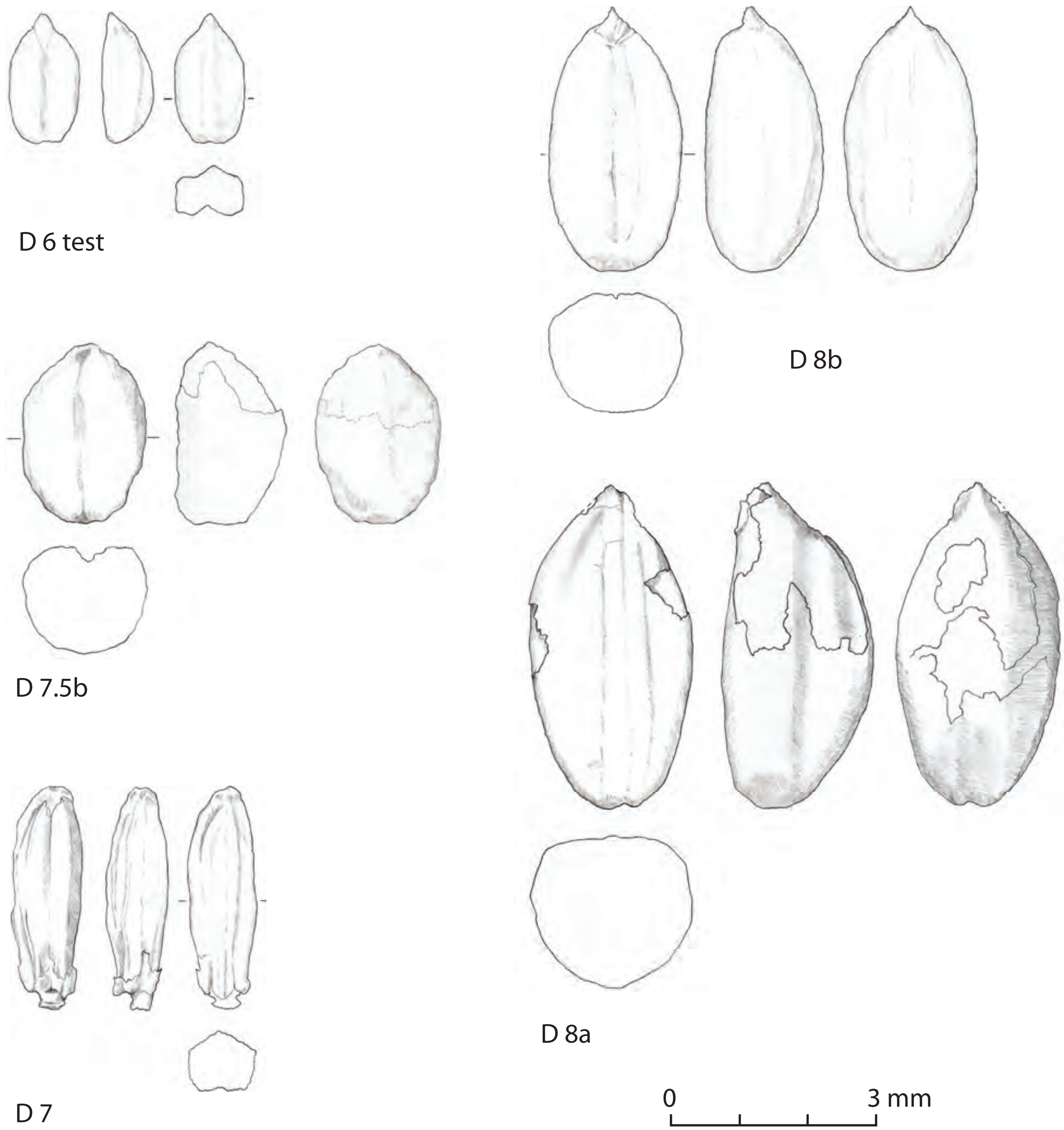


Plate 2. D 6 YH-Apiaceae 2; D7.5 YH-Apiaceae 4/8; D7 YH Apiaceae 7;
D8 YH-Apieaceae 10/Unknown 31

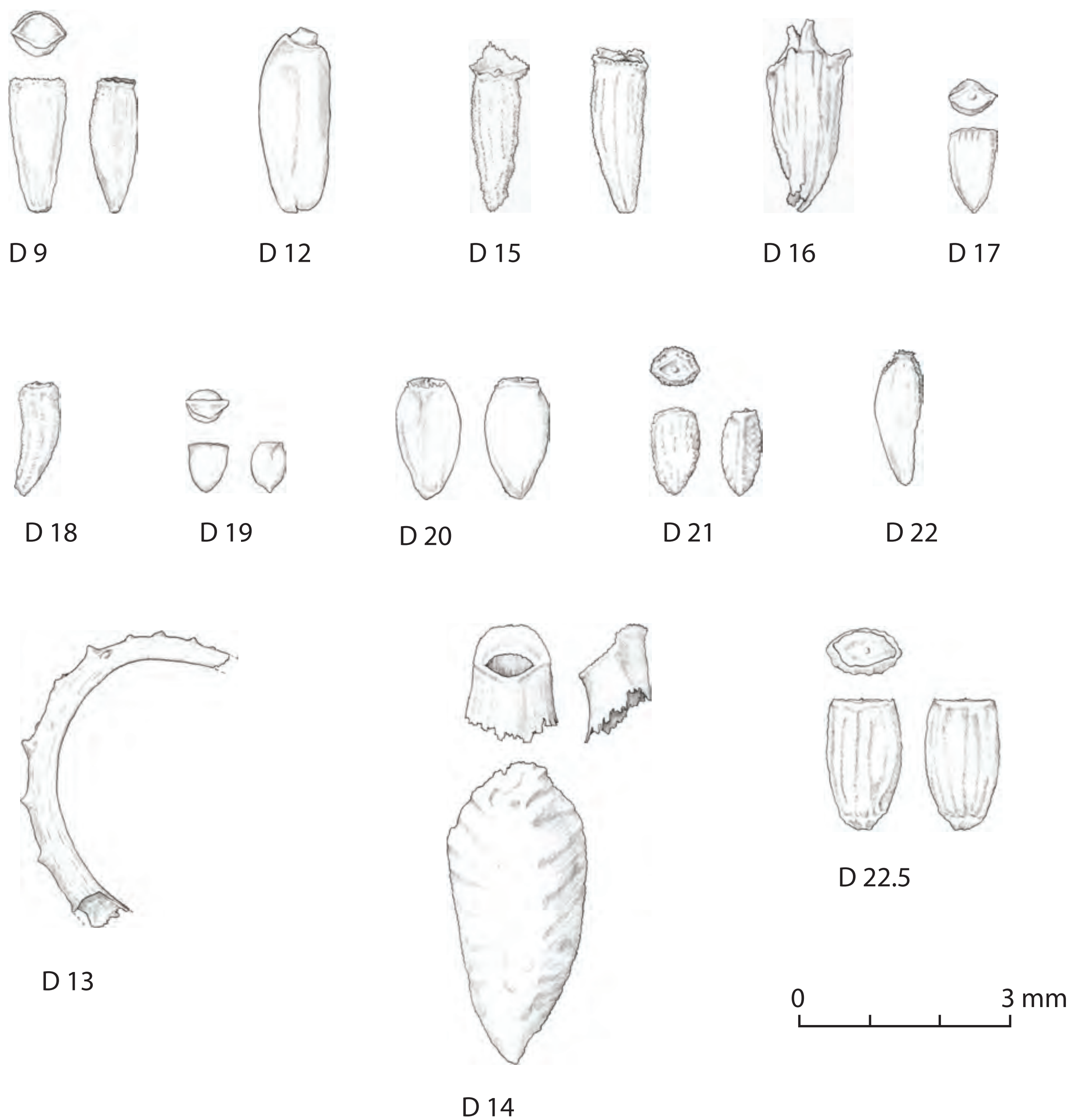
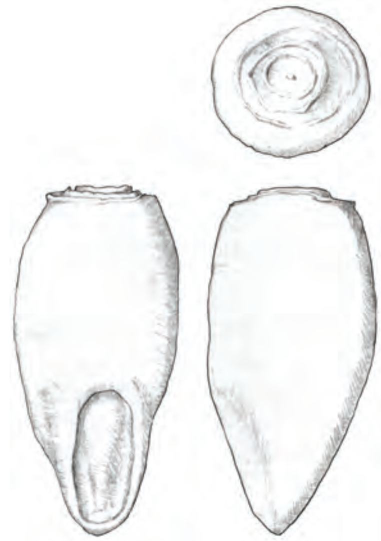


Plate 3. D9 Anthemis/Matricaria; D12 Cirsium; D 15 cf. Senecia; D16 Taraxacum;
D17 YH-Asteraceae 1; D18 YH-Asteraceae 2; D19 YH-Asteraceae 5; D20 YH-Asteraceae 7;
D21 YH-Asteraceae 10; D22 YH-Asteraceae 11; D13 Koelpinea; D14; Onopordum;
D22 YH-Asteracee 11; D22.5 YH-Asteraceae 13

D 10



D 11

Plate 4. D10 Carthamus; D 11 Centaurea

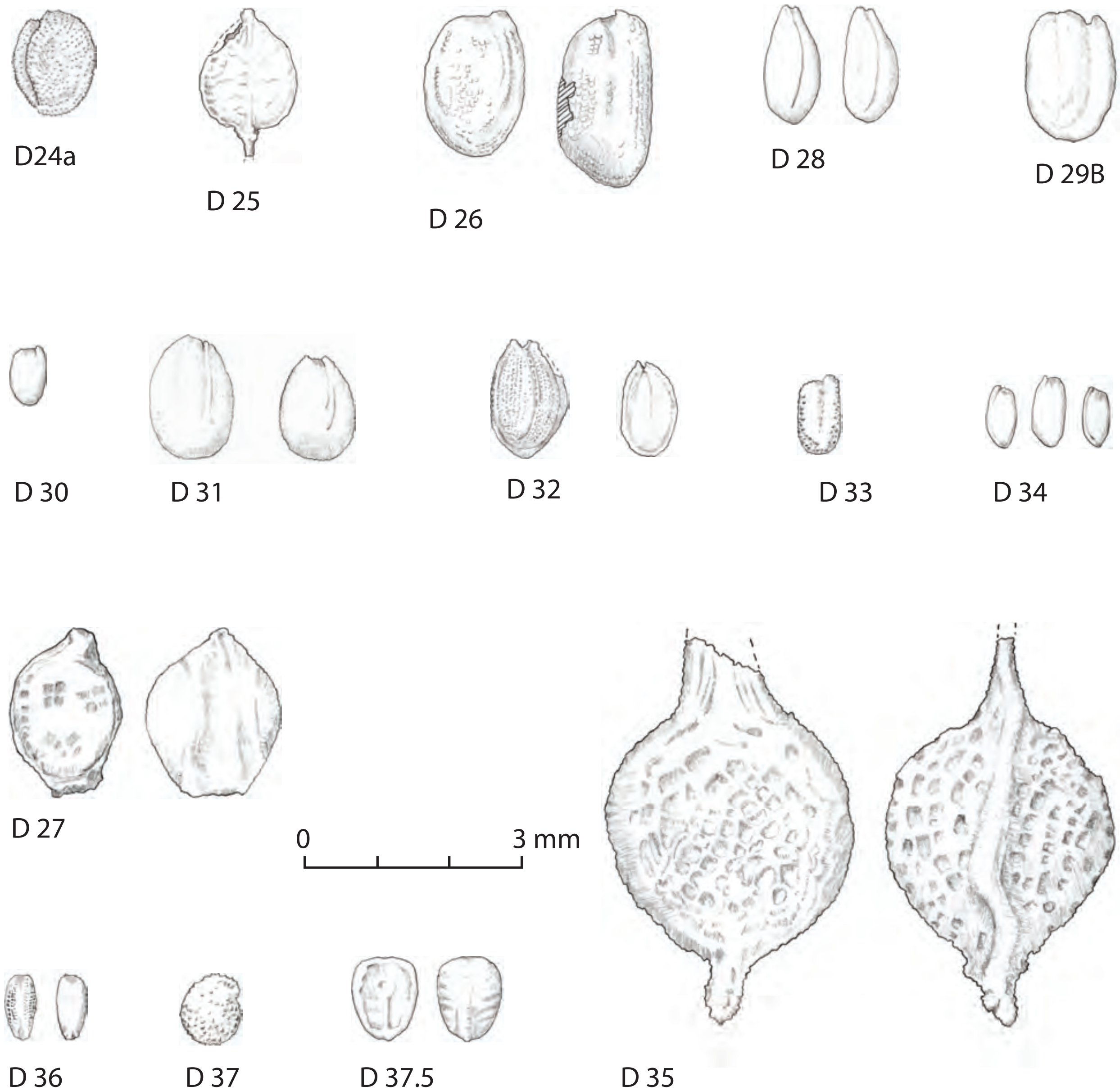


Plate 5. D24a cf. Camelina rumelica; D25 Cardaria draba silique; D26 Conringia; D28 cf. Lepidium; D29B Sisymbrium altissimum-type; D30 YH-Brassicaceae 2; D31 YH-Brassicaceae 3/5; D32 YH-Brassicaceae 7; D33 YH-Brassicaceae 10; D34 YH-Brassicaceae 11; D27 Euclidium syriacum silique; D35 YH-Brassicaceae silique 5; D36 Bufonia; D 37 cf. Cerastium; D37.5 YH-Caryophyllaceae 1

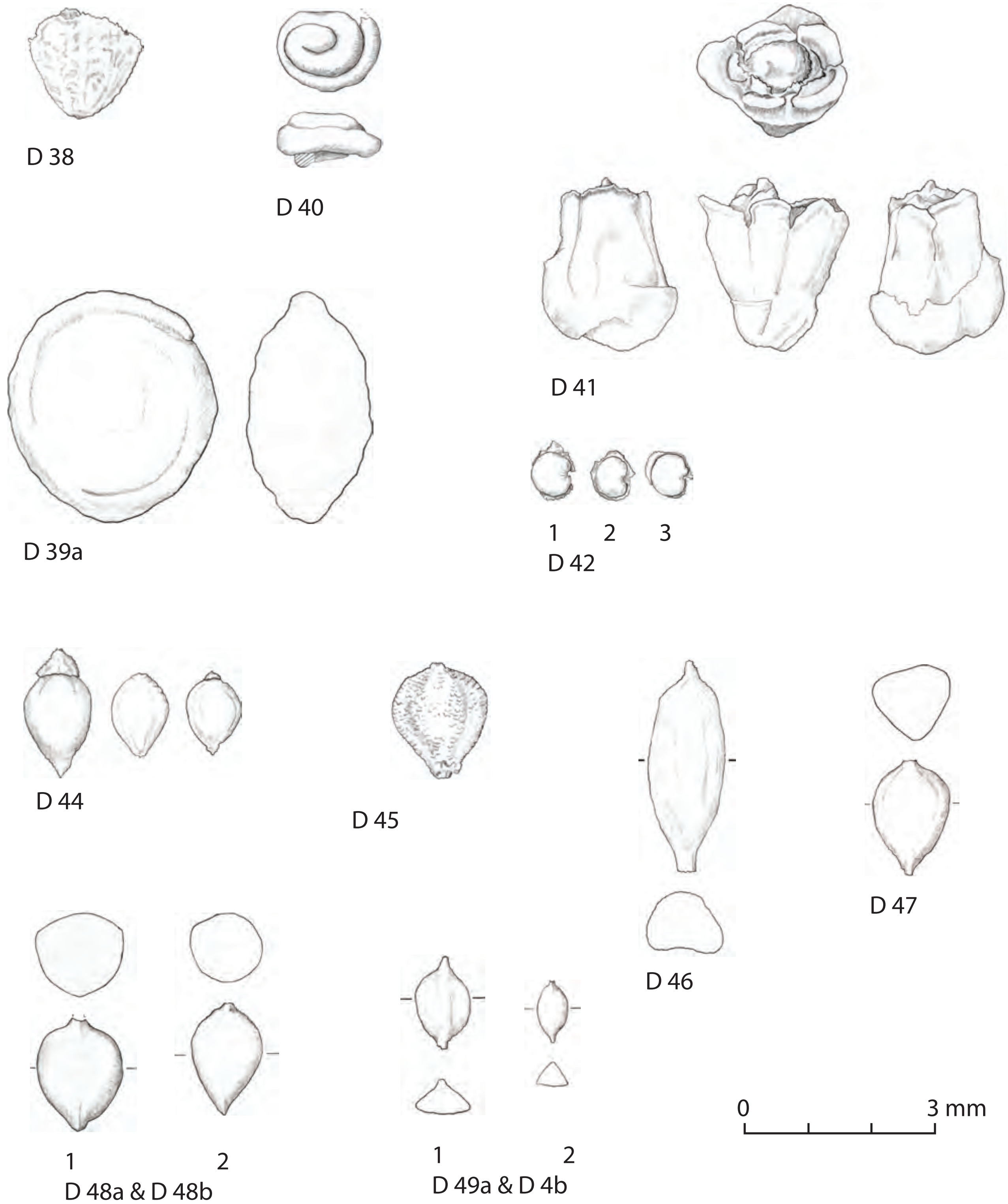


Plate 6. D38 Atriplex bract; D40 Salsola kali-type; D41 Salsola/Kochia fruit; D39a cf. Atriplex; D42 YH-Chenopodiaceae 2; D44 Eleocharis; D45 Fimbristylis; D46 YH-Cyperaceae 3; D47 YH-Cyperaceae 5; D48 YH-Cyperaceae 6; D49 YH-Cyperaceae 7

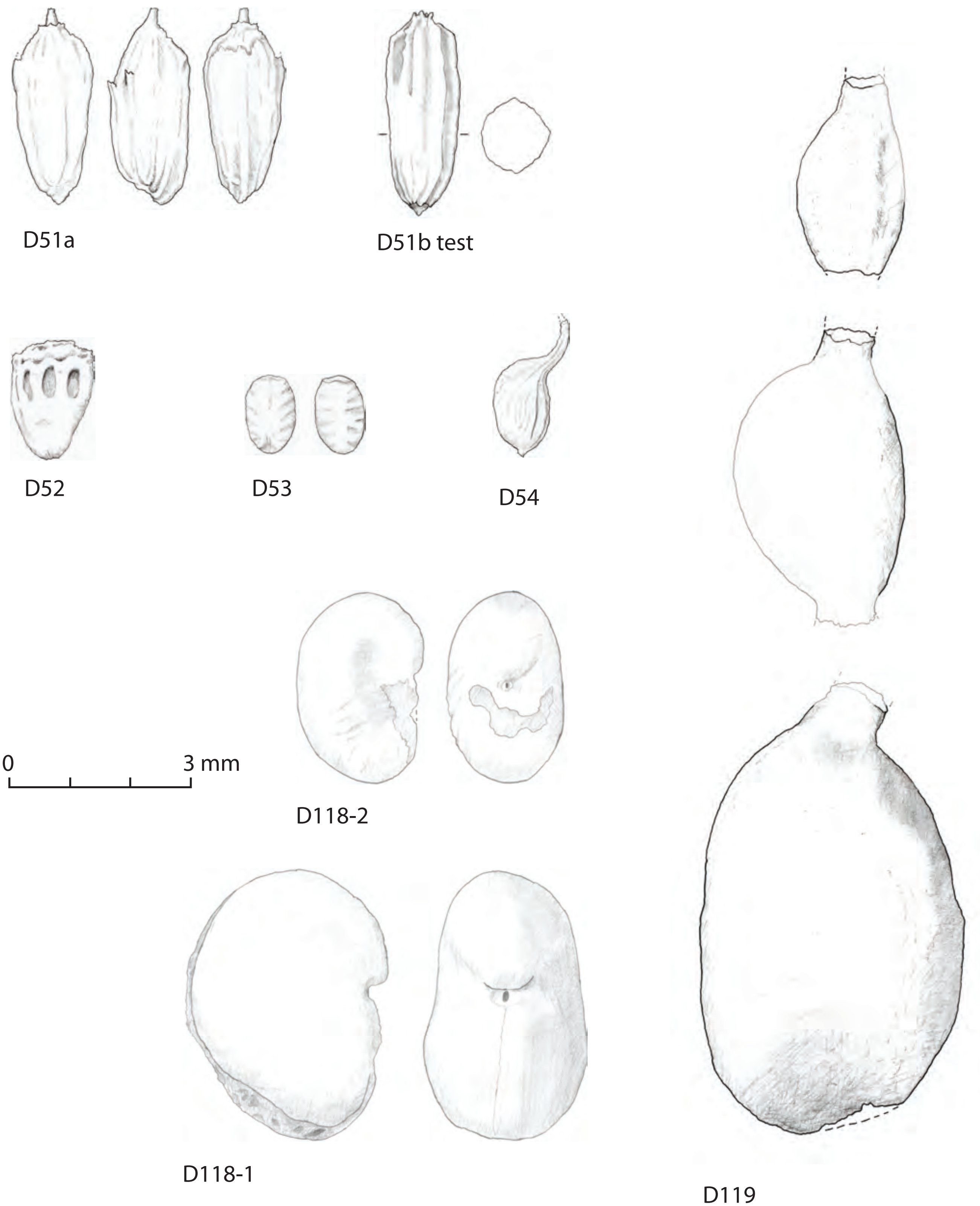


Plate 7. D51a&B cf. Dipsacus; D52 Scabiosa; D53 Euphorbia; D 118 Alhagi seeds; D 54 Trigonella capitata pod; D 119 Alhagi podss

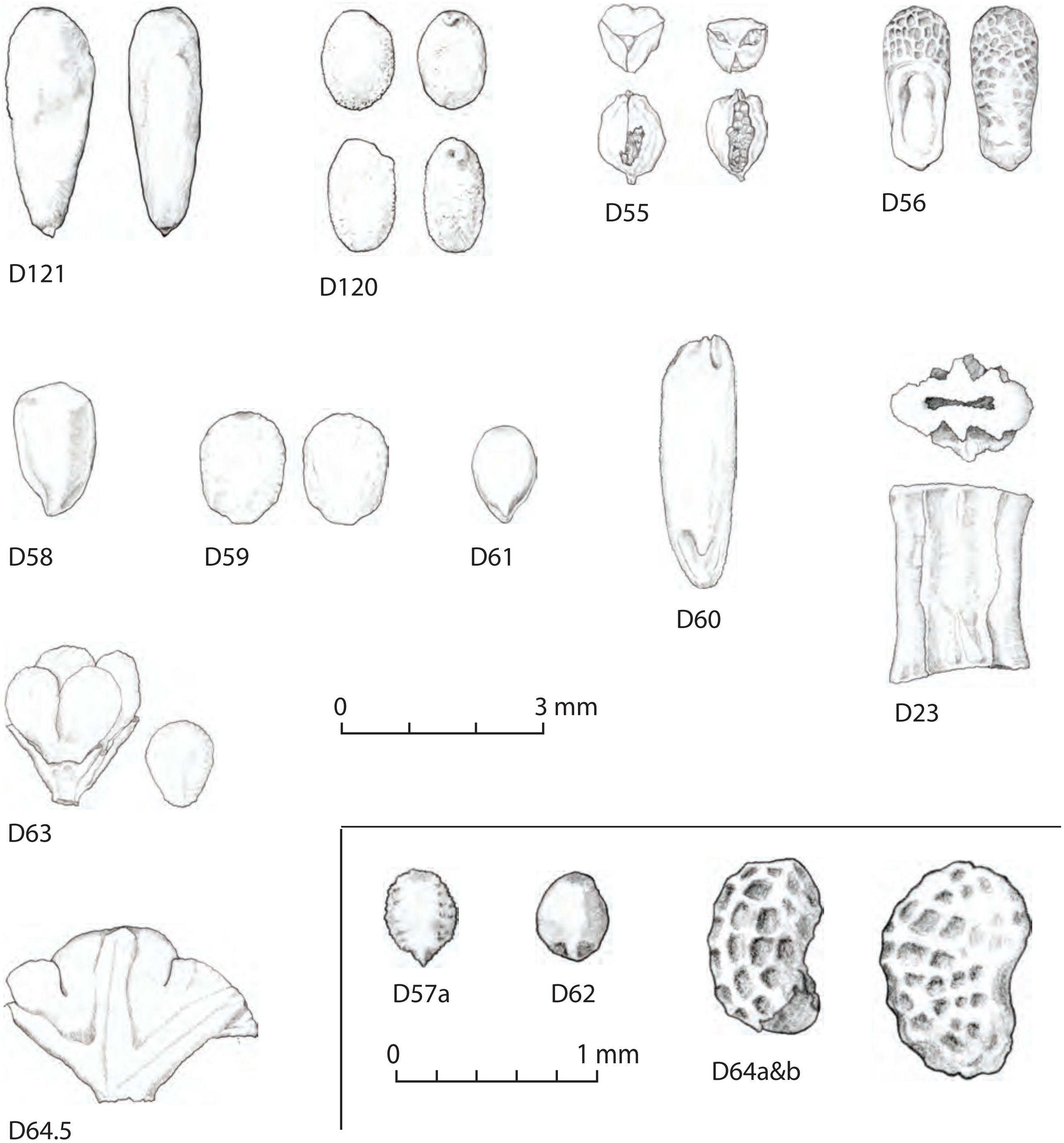


Plate 7.5. D121 Erodium; D120 Geranium; D55 Juncus capsules with seeds; D56 Ajuga chaemypitys; D58 YH-Lamiaceae 1; D59 YH-Lamiaceae 3; D61YH-Lamiaceae 5; D60 YH-Lamiaceae 4; D23 Hypecoum fruit segment; D63 YH-Lamiaceae 7; D64.5 Papaver capsule top; D57a Mentha; D62 YH-Lamiaceae 6; D64 Papaver

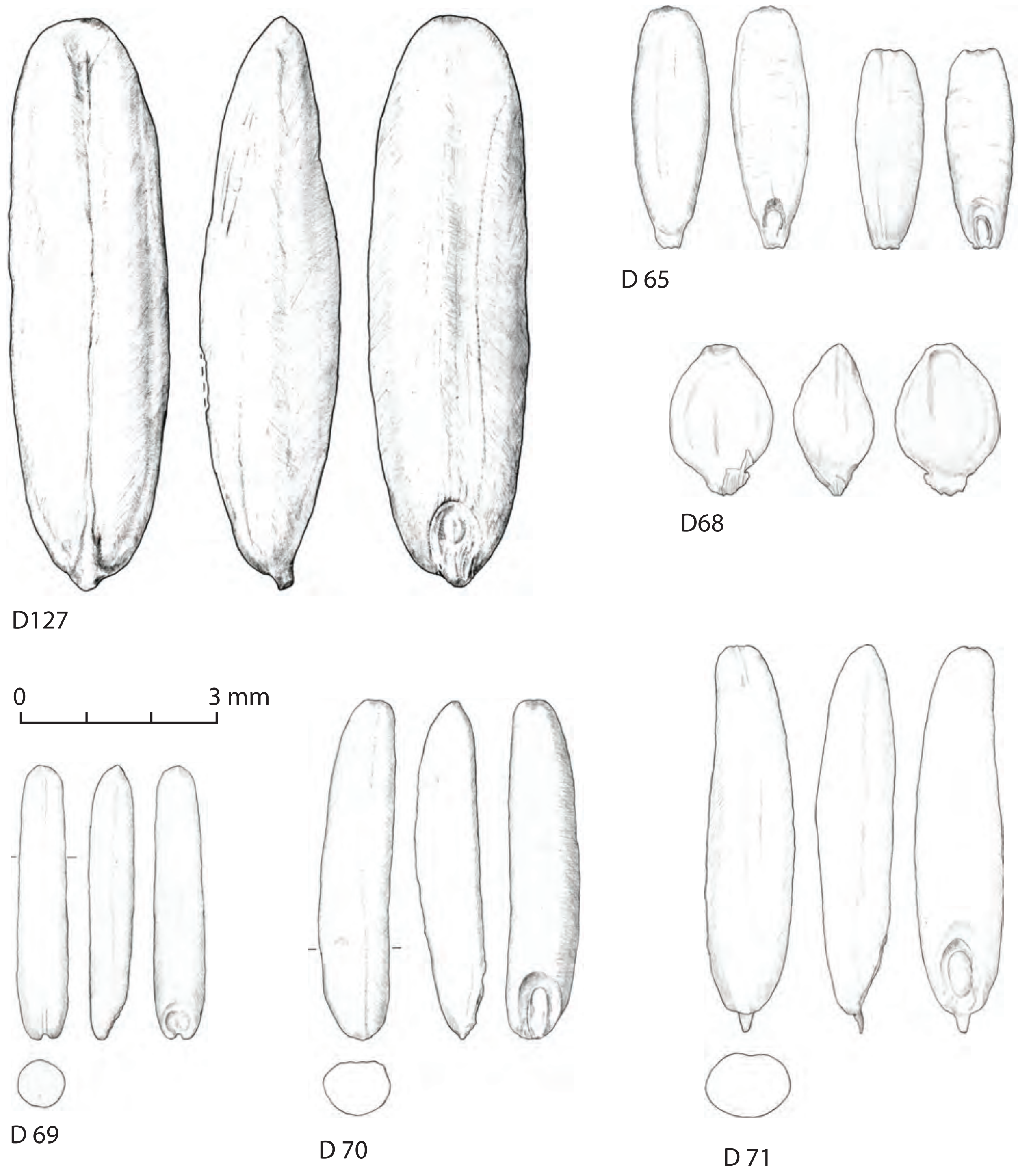


Plate 8. D 127 Avena; D65 Hordeum murinum-type; 68 Setaria; D69 Stipa (small); D70 Stipa (medium); D71 Stipa (large); D 72 Taeniatherum rachis fragment

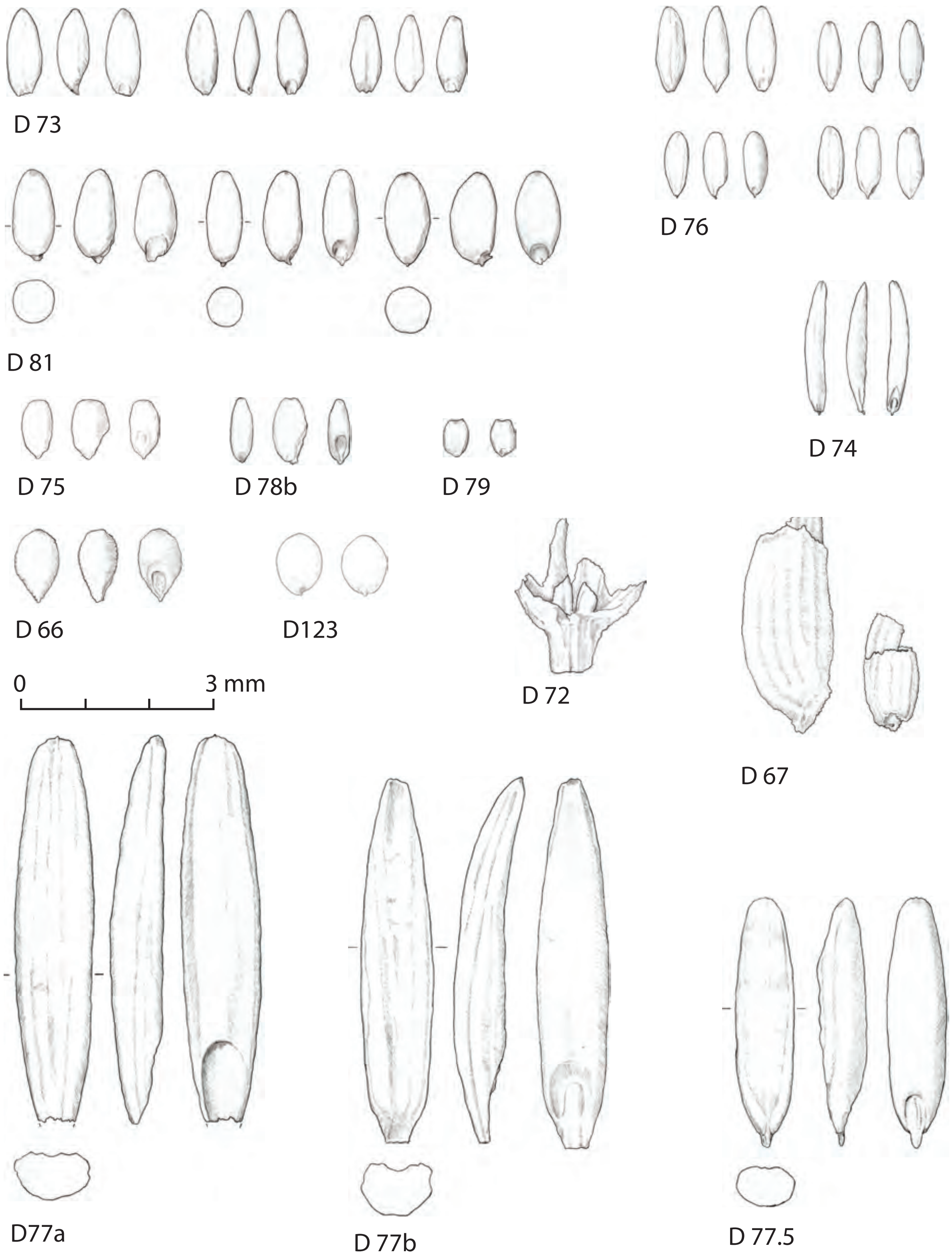


Plate 9. D73 YH-Poaceae 2; D74 YH-Poaceae 3; D75 YH-Poaceae 4; D76 YH-Poaceae 5; D81 YH-Poaceae 13; D75 YH-Poaceae 4; D78b YH-Poaceae 8; D79 YH-Poaceae 10/15; D77 YH-Poaceae 7 (cf. Taeniatherum); D 77.5 YH-Poaceae 7.1; D 66 cf. Phleum pratense; D123 YH-Poaceae 1; D74 YH-Poaceae 3; D72 Taeniatherum caput-medusae glume base D 67 Poa bulbosa; D77a, b YH-Poaceae 7; D77.5 YH-Poaceae 7.1

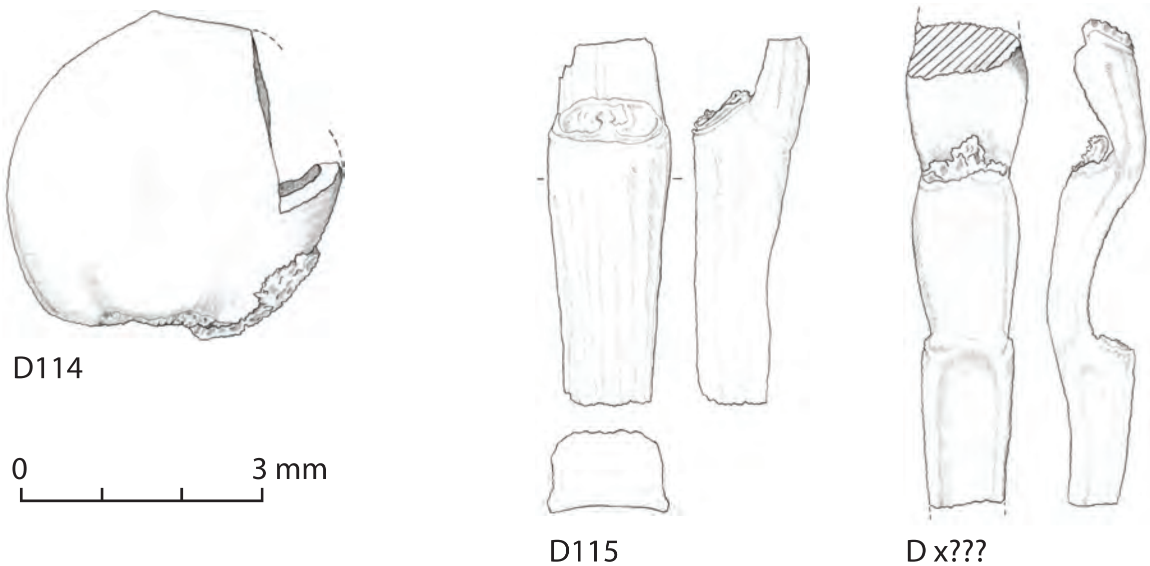


Plate cultivated/food. D114 Pistacia; D 115, D x??? Triticum rachis (square cross-section)

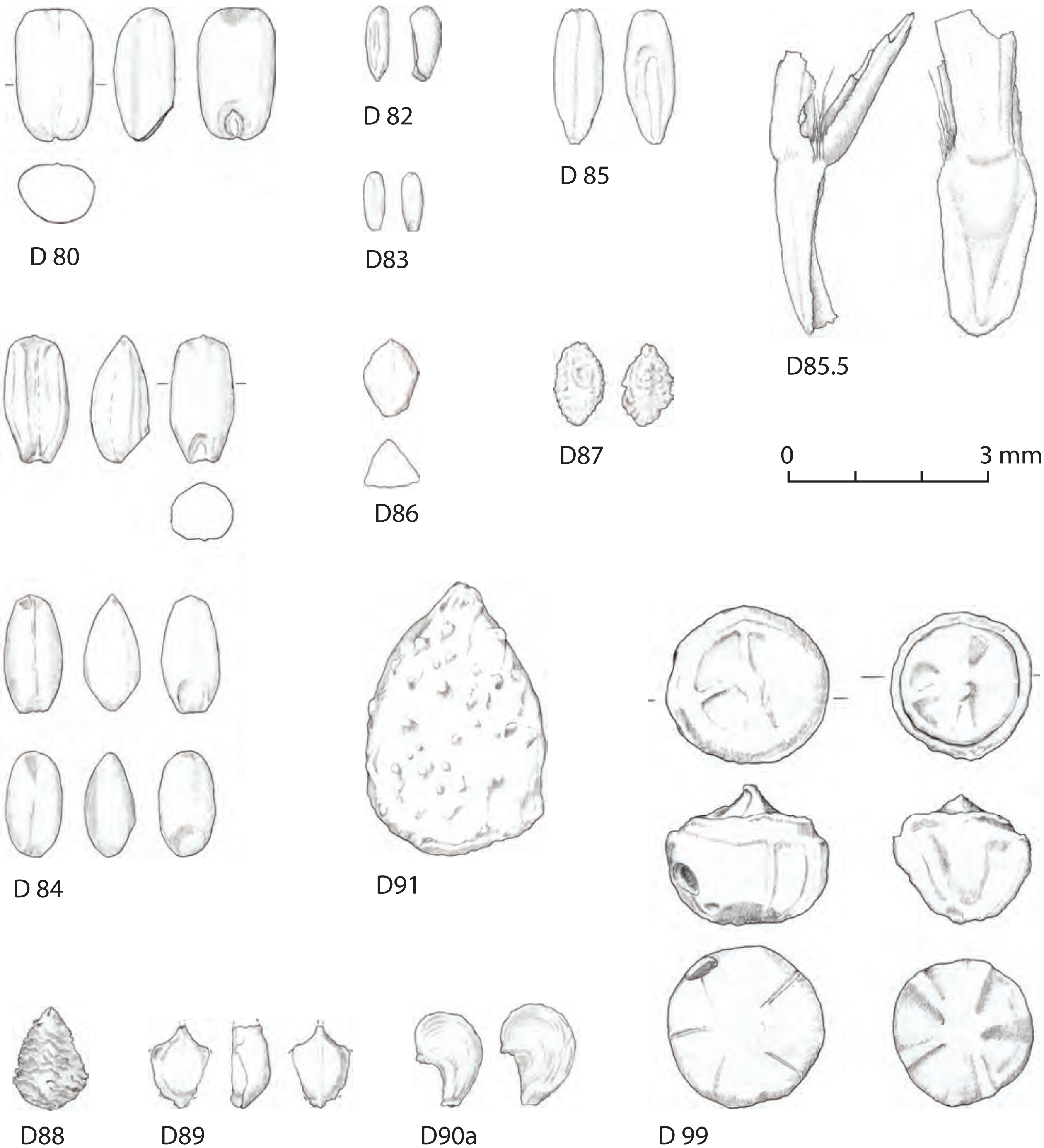


Plate 10. D80 YH-Poaceae 12; D82 YH-Poaceae 14; D83 YH-Poaceae 16; D85 YH-Poaceae 19; D85.5 YH-Poaceae rachis 1; D84 YH-Poaceae 17/18; D86 YH-Primulaceae 1; D87 YH-Primulaceae 2; D91 Ranunculus arvensis-type; D88 Aconitum/Consolida; D89 Ceratocephalus; D 90a Ranunculus; D99 Paliurus (was unk 10)

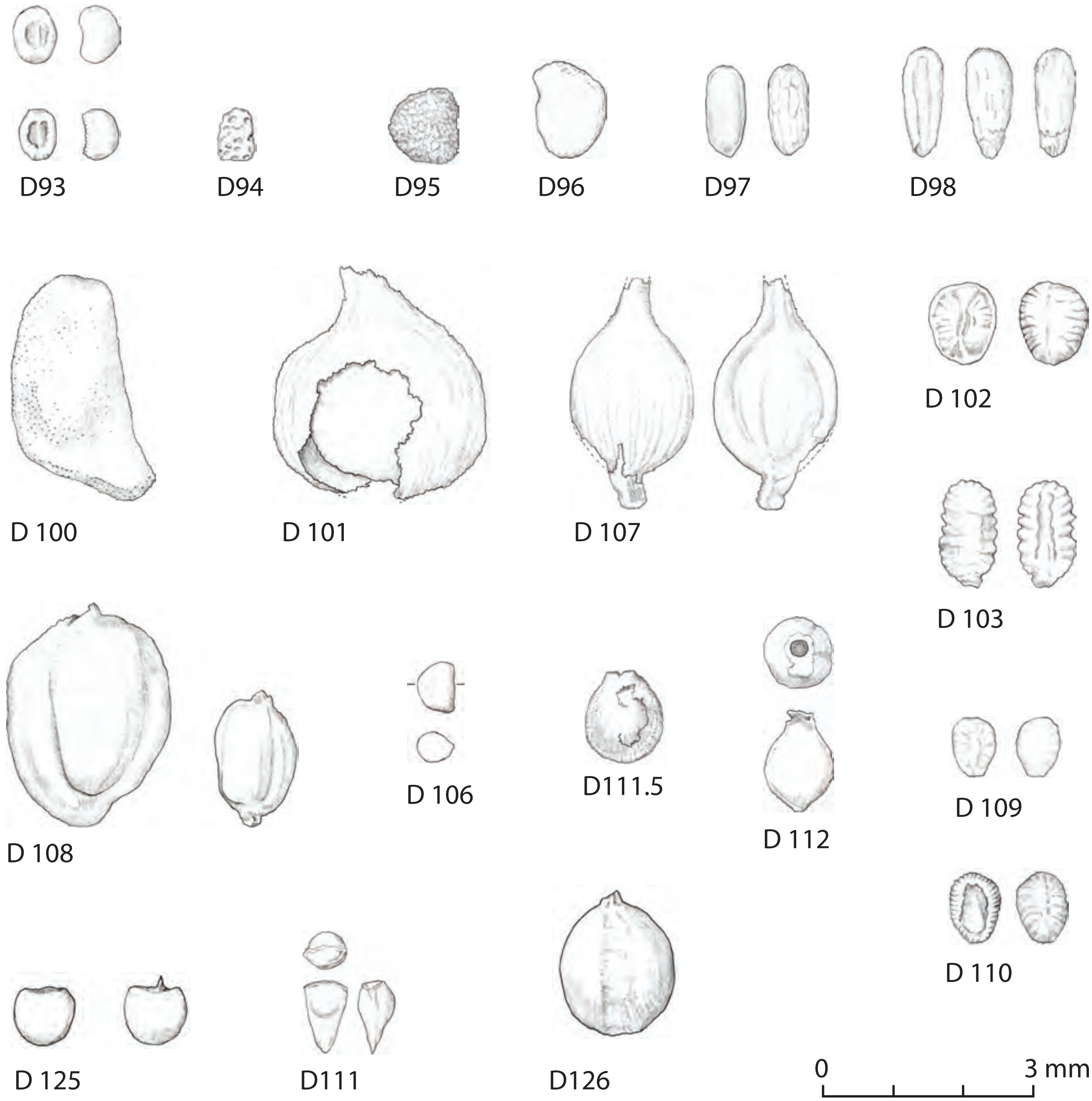
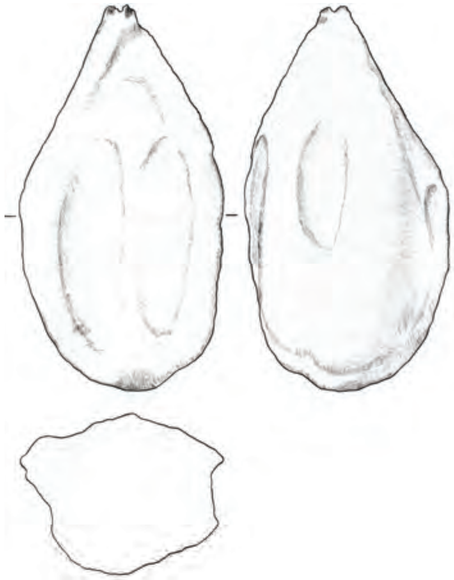
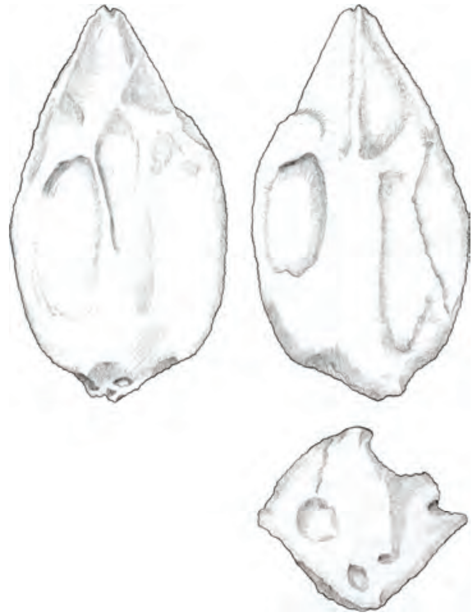


Plate 11. D93 YH-Rubiaceae 1; D94 Scrophulariaceae 1; D95 Hyoscyamus; D96 Solanum; D97 Verbena officinalis; D98 YH-unknown 7 (cf. Sherardia); D100 Zygophyllum; D101 YH-unknown 12; D 107 YH-unknown 26; D108 YH-unknown 27; D106 YH-unknown 23; D111.5 YH-unknown 32; D112 YH-unknown 37; D 102 YH-unknown 14; D103 YH-unknown 16; D109 YH-unknown 28; D110 YH Unknown 29; D125 YH-unknown 21; D111 YH-unknown 30; D126 YH-unknown 35



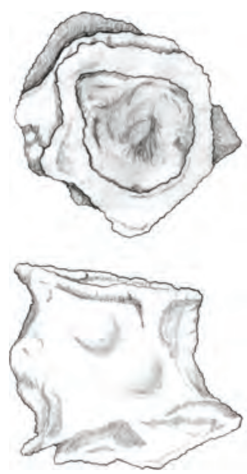
D 104



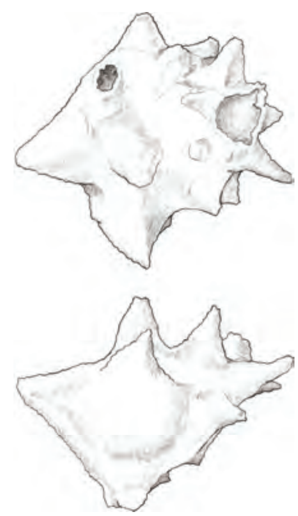
D 105 alt.

D124

0 3 mm



D 116



D 117

Plate 12. D104 YH-unknown 17; D105 alt. YH-unknown 18; D124 YH-unknown 19
D116 YH-plant part 16; D117 YH-plant part 25;

Appendix E
Charcoal Samples

The tables in Appendix E include the inventory of samples analyzed and their contents; see Excel chart YH App E char data.xls.

Table E.1. Inventory of samples
Table E.2a. Debris (weight)
Table E.2b. Debris (count)
Table E.3a. Buildings (weight)
Table E.3b. Buildings (count)

Table E.1. Inventory of samples

YH	op	locus	lot	stratum	description	# id'd	wt. id'd	tot.wt
25745	89.07	9	21	100	plow zone	6	1.75	1.75
26092	89.02	42	58	100	plow furrows?	2	0.39	0.43
27094	89.07	10	53	110.01	pit	4	1.50	4.87
27397	89.07	10	68	110.01	pit	3	0.76	0.95
20510	88.02	17	23	110.02	pit	7	3.71	3.91
21089	88.02	17	23	110.02	pit	6	1.24	1.42
26262	89.02	42	77	110.04	pit	10	2.09	3.10
26478	89.02	42	88	110.04	pit	15	4.94	4.96
26506	89.07	8	23	110.07	pit	10	2.29	4.70
20500	88.01	11	21	120	pit	2	0.43	0.43
20781	88.01	12	37	140	trash, collapse	1	0.62	0.62
20946	88.01	24	47	150	wall collapse	1	0.66	0.66
20833	88.02	21	36	300	Coll./floor dep.	15	11.16	21.44
21086	88.02	21	45	300	collapse w/ rodent burrows	10	12.84	15.48
22696	88.01	90	179	315	pit in robber trench	1	1.15	1.15
26114	89.01	13.2	42	315	pit	1	3.11	3.11
22077	88.01	28	123	345.01	pit & storage jar	10	1.92	4.75
23580	88.02	27	60	355	floor dep.	1	0.95	0.95
26540	89.07	13	31	360	mixed in exc	10	4.53	15.94
28066	89.07	24	94	360.03	wall	3	12.75	13.33
25712	89.07	7	17	360.05	ash lens	14	1.35	2.75
26534	89.07	8	29	360.05	pit	10	1.08	2.98
25731	89.07	8	20	360.06	floor deps	9	1.93	2.03
26204	89.07	13	33	360.06	floor dep	7	1.04	1.52
27055	89.07	13	47	360.06	floor matrix	10	4.48	10.44
26225	89.07	13	38	360.09	basin hearth	3	0.45	0.69
26230	89.07	15	40	360.10	pyrotechnic fea, floor	6	1.97	2.87
25748	89.07	8	22	360.13	floor	9	2.10	2.26
26502	89.07	8	22	360.13	floor	3	2.41	2.68
26525	89.07	8	26	360.13	floor	2	1.06	1.06
26526	89.07	8	26	360.13	floor	5	1.03	1.33
26209	89.07	12	34	365	trash	4	0.81	0.87
26529	89.07	12	28	365	trash	10	2.39	3.22
27070	89.07	20	50	370	ext surf	10	5.55	16.09

27372	89.07	20	57	370	ext surf	10	3.57	4.35
28306	89.07	29	102	370.02	brick-lined bin/pit	10	11.36	46.36
23397	88.07	37	56	370.03	pit	1	2.36	2.36
28657	89.07	30	110	370.05	pyrotechnic fea.	4	0.63	0.63
31276	89.07	45	219	370.13	pit	10	2.55	2.55
23603	88.07	29	41	375.02	floor deps	1	2.73	2.73
22021	88.02	42	114	380.01	basin	5	10.40	12.89
22358	88.02	47	121	380.06	posthole	6	1.21	2.04
21971	88.01	38	73	380.15	hearth	10	2.37	5.04
21586	88.01	50	93	380.17	pit	5	1.66	1.98
22059	88.01	62	119	380.19	shallow pit	8	0.91	0.93
22364	88.02	46	120	380.24	pit	2	0.62	0.64
23120	88.02	71	169	380.26	basin pit	6	0.77	0.88
25613	89.01	10	23	390	surfaces	1	1.36	1.36
22852	88.02	64	155	400	pits	3	1.54	1.54
25226	89.01	5	7	400	mixed	4	2.27	2.27
25515	89.01	5	7	400	mixed	1	0.47	0.47
26900	89.02	55	119	400	test trench	1	2.57	2.57
27226	89.02	57	134	400	pit?	10	1.34	4.06
27900	89.07	26	91	400	mixed in exc	5	0.61	1.14
28542	89.01	45	120	400	pits	5	4.08	4.08
29251	89.07	26	136	400	mixed	1	0.66	0.66
29261	89.07	26	127	400	?	10	3.93	9.96
29423	89.07	26	93	400		10	1.83	4.51
30141	89.01	53	156	400	robber trench	1	7.24	7.24
30503	89.07	36	178	400	mixed in exc	1	1.64	1.64
31045	89.07	39	209	400	mixed in exc	1	0.10	0.10
31259	89.07	39	214	400	mixed in exc	7	1.62	1.62
31260	89.07	41	213	400	mixed in exc	4	0.83	0.83
31290	89.07	46	221	400	floors	7	4.68	4.72
31547	89.07	53	242	400	surfaces	10	1.85	2.23
31960	89.07	54	244	400	mixed in exc	15	8.18	10.00
22406	88.01	71	139	410.07	pit	4	1.08	1.24
22895	88.02	65	166	410.15	pit	10	1.59	2.22
26966	89.01	15	44	410.17	pit	5	4.80	5.46
25544	89.01	7	14	410.18	pit, metallurgical	1	1.20	1.20
25661	89.01	7	14	410.18	pit, metallurgical	10	5.82	6.94
25679	89.01	7	16	410.18	pit, metallurgical	3	0.64	0.64
30522	89.07	38	177	415	bricky collapse	10	3.09	4.71
30824	89.07	39	191	415	pit?	1	0.14	0.14
30846	89.07	38	200	415	ext surfs	7	1.57	1.61
31003	89.07	39	199	415	lensed coll & trash, hearth	8	0.93	0.95
31040	89.07	43	210	415	robber trench	4	1.41	2.67
31305	89.07	47	225	415	collapse	10	3.84	4.40
31330	89.07	48	232	415	collapse	15	6.75	13.14
31340	89.07	39	230	415	lensed coll & trash	10	1.94	3.74
31342	89.07	39	227	415	mixed in exc	5	0.07	0.11

31995	89.07	57	251	415	mixed in exc?	10	3.38	5.23
31998	89.07	58	258	415	mixed in exc	11	5.29	5.95
29737	89.07	31	160	415.03	pit	5	0.77	1.10
31546	89.07	51	240	415.04	pit	15	18.82	25.07
31966	89.07	55	245	415.05	pit	6	15.18	15.18
31339	89.07	49	233	415.08	pit	10	3.75	11.39
31523	89.07	50	237	415.10	pit	10	1.33	1.71
22440	88.01	75	149	420	ash lens	20	12.53	33.64
23138	88.02	73	173	420	trash	10	2.31	2.71
28934	89.01	51	129	420.01	pit	2	2.87	2.87
23043	88.01	93	187	420.02	pit	10	3.86	4.20
25660	89.01	8	15	420.03	pit	3	0.58	0.64
25664	89.01	8	15	420.03	pit	10	6.10	9.32
22507	88.02	55	129	430	pits mixed in exc	1	2.23	2.23
22894	88.02	69	165	430	pits mixed in exc	2	4.96	2.38
22987	88.02	67	162	430	trash	2	0.56	0.56
23118	88.02	58	168	430	trash, pit?	10	4.74	6.10
23305	88.02	69	176	430	pits mixed in exc	10	3.42	5.12
23311	88.02	64	175	430	pits?	15	4.27	6.37
23505	88.02	55	180	430	pits mixed in exc	8	2.35	3.25
27510	89.01	25	75	430	trash, collapse	1	1.95	1.95
28429	89.02	64	177	430	pit	10	2.39	7.55
26781	89.01	2.3	62	430.02	yellow clay	1	1.05	1.05
27624	89.01	2.3	62	430.02	yellow clay	1	0.77	0.77
25522	89.01	5	10	430.03	furnace?	2	0.74	0.77
25524	89.01	5	10	430.03	furnace?	1	4.99	4.99
26624	89.02	53	96	430.12	pit	10	4.18	7.00
25588	89.02	28	36	430.15	pit	20	7.88	10.35
25282	89.02	10	14	430.17	pit w/ clay column	10	12.01	53.86
26185	89.02	48	70	435	mixed in exc	7	2.78	3.27
26802	89.02	6	118	435	ext. surfs	7	0.86	0.89
27432	89.02	60	146	435.05	pit	3	2.43	2.43
25247	89.01	3	6	450.01	pit/cellar collapse	7	2.99	3.64
23459	88.01	97	204	460	pit in robber trench	15	3.21	5.05
26646	89.02	30	98	470	collapse	2	1.98	2.15
27820	89.01	33	98	470	trash	7	2.61	2.61
28769	89.02	11	182	470	lensed trash	1	1.30	1.30
29529	89.01	52	133	495.06	floor dep.	1	2.13	2.13
31938	89.12	33	46	500	test trench	1	1.20	1.20
30694	89.02	78	243	510.05	pit	10	5.44	6.48
31438	89.02	88	287	515	pit?	10	2.17	6.29
32620	89.12	25	56	540.03	pit	1	10.82	10.82
32634	89.12	38	60	550.01	pit	1	2.97	2.97
32636	89.12	39	61	550.02	jar contents	10	5.30	13.65
32683	89.12	42	71	550.04	jar contents	20	25.52	131.31
32801	89.02	87	330	570.11	pit in cellar floor	1	0.31	0.31
20083	88.04	10	16	640	ctyd fill	4	1.40	1.76

20098	88.06	2	1	640	ctyd fill	10	2.94	3.71
25123	89.08	2	3	640	ctyd fill/chipping debris	2	0.32	0.32
20233	88.06	10	12	660	Occup deb. & Ext Surfs	2	0.39	0.75
20342	88.05	10	10	660	Occup deb. & Ext Surfs	7	2.34	2.54
25067	89.11	4	9	660	occup deb & ext surfs	10	2.78	3.35
25069	89.11	4	9	660	occup deb & ext surfs	1	5.23	5.23
25087	89.11	4	16	660	occup deb & ext surfs	1	0.60	0.60
25111	89.08	1	2	660	occup debris & ext surfs	10	1.54	2.80
25137	89.08	3	7	660	occup deb. & ext surfs	6	1.87	2.03
25171	89.09	2	6	660	occup deb. & ext. surfs	2	2.06	2.06
25858	89.08	3	12	660	occup deb. & ext surfs	7	1.35	1.74
25865	89.08	3	14	660	occup deb. & ext surfs	2	0.29	0.29
25129	89.08	2	6	670	ctyd surf/constr. debris	8	2.59	2.78
25178	89.09	2	8	670	ctyd surface	4	2.87	2.90
25879	89.08	5	17	670	ctyd surf/constr debris	10	5.48	9.66
20577	88.05	17	19	700	mixed in exc.	4	1.15	1.15
21280	88.05	26	30	700	mixed in exc.	1	1.03	1.03
27189	89.11	15	45	700	mixed in exc.	1	0.78	0.78
28118	89.09	21	73	700	mixed in exc.	10	0.27	0.81
28725	89.11	21	67	700	mixed in exc.	1	0.23	0.50
28745	89.11	21	73	700	mixed in exc.	1	1.21	1.21
28967	89.08	10	91	700	mixed in exc.	1	0.66	0.66
29236	89.11	20	83	700	mixed in exc.	6	1.85	1.93
29339	89.09	23	103	700	mixed in exc.?	10	7.49	16.94
31118	89.10	11	21	700	mixed in exc	1	0.90	0.90
31777	89.10	3	37	700	mixed in exc.	5	3.26	4.13
31897	89.10	25	54	700	mixed in exc.	10	41.29	148.14
29815	89.08	10	100	700.01	depression/pit top	5	0.77	1.53
20865	88.04	18	33	705	Ext Surf, pit tops	1	1.94	1.94
25909	89.09	5	19	705	ext. surf	16	5.72	5.72
28252	89.11	16	47	705	pit?	1	1.97	1.97
28459	89.14	31	60	705	pit	5	2.76	3.45
26701	89.09	12	39	705.01	pit	3	0.73	1.59
26703	89.09	12	39	705.01	pit	8	1.79	2.50
26719	89.09	12	42	705.01	pit	1	5.92	5.92
26720	89.09	12	42	705.01	pit	4	1.96	3.28
28733	89.11	14	70	705.01	bldg coll	5	0.70	0.70
30580	89.10	4	11	705.05	pit/hearth	2	1.66	1.66
27039	89.08	9.4	44	705.10	pit	2	0.82	1.19
28982	89.08	10	95	705.12	pit	1	1.00	1.00
31465	89.08	30	149	705.12	pit	6	11.00	11.13
30495	89.11	31	119	705.23	pit	3	3.81	3.81
27474	89.09	16	63	720	ext surf	1	1.33	1.33
27481	89.09	16	62	720	ext surf	10	12.84	16.88
29064	89.09	21	89	720	ext. surf.	1	2.42	2.42
29334	89.09	23	101	720	ext surf, burned bldg coll	10	4.91	8.69
29348	89.09	21	102	720	ext. surf.	5	6.51	6.87

33321	89.10	25	76	720	burned bldg coll	10	18.92	55.58
22756	88.03	45	81	730.02	pit	3	1.40	1.40
23242	88.05	39	73	730.04	pit	12	4.46	7.48
21279	88.03	23	45	735	ext. surface	1	0.95	0.95
31796	89.10	16	41	740	bldgcollapse	4	0.96	0.96
31876	89.10	16	51	740	collapse/floor dep.	1	1.23	1.23
32487	89.10	29	67	745	floor dep.	11	3.00	8.08
28710	89.11	19	58	750.02	bldg collapse	1	0.27	0.27
28734	89.11	20	71	750.02	bldg collapse	1	0.97	0.97
29216	89.11	21	77	755.02	floor dep.	5	2.16	2.55
30460	89.11	14	110	755.03	bin	1	1.33	1.33
30395	89.11	25	105	755.05	bin	10	1.22	1.50
27033	89.08	9	42	760	bldg coll	4	0.60	0.84
27979	89.08	9	53	760	floor dep./coll.	3	1.59	2.06
28952	89.08	9	84	760	wall coll.	2	0.46	1.07
28154	89.14	19	44	770	bldg coll	10	3.42	4.43
21482	88.06	27	39	795	wall coll. & floor dep.?	10	2.28	4.79
22704	88.06	30	46	795.02	floor dep.	5	0.85	3.49
21545	88.03	23	50	798	ext. surface	5	0.50	0.77
29202	89.11	21	73	798	floor dep.?	1	1.07	1.07
22162	88.03	37	62	800	trash	1	3.42	3.42
32736	89.11	44	184	840	wall coll.	2	5.31	5.31
23151	88.03	40	91	850	floor dep.	1	0.78	0.78
23178	88.03	40	96	850	floor dep.	10	8.73	12.77
23199	88.03	40	98	850	floor dep.	10	8.33	22.82
23213	88.03	40	100	850	floor dep.	10	16.21	23.67
23220	88.03	40	101	850	floor dep.	2	1.05	1.93
33156	89.11	46	189	850.01	hearth	4	7.51	7.52
29978	89.14	39	85	870.01	pit	7	4.74	5.08
33143	89.14	60	167	900	mixed in exc	10	8.82	22.66
33252	89.14	60	168	900	mixed in exc	10	6.65	7.93
28836	89.14	10	72	970	lensed trash	1	0.22	0.22
29371	89.14	10	75	970	lensed trash	2	3.84	3.85
33263	89.14	61	170	1030	erosion surf.	1	3.22	3.22
PROVENIENCE NO GOOD								
20038	88.01	6	11	0	mixed			
20260	88.02	7	12	0	mixed in exc.		4.88	5.30
20263	88.02	7	12	0	mixed in exc.		3.10	3.25
20801	88.02	22	30	0	mixed in exc.		0.79	0.79
20818	88.02	17	33	0	pit		5.85	8.00
20847	88.02	17	33	0	pit		9.61	11.26
21071	88.02	17	43	0	pit		2.62	2.70
21281	88.01	51	96	0	area of RSY ramp			
22127	88.01	66	135	0	mixed in exc			
22157	88.05	27	47	0	mixed in exc.			
22217	88.07	5	8	0	pit			
22370	88.02	49	123	0	pit(s)		14.07	45.88

22733	88.07	18	23	0	pit			1.47	1.47
22873	88.02	64	161	0	pit?			3.08	3.18
23228	88.03	45	103	0	mixed in exc.			0.87	1.88
23579	88.02	21	64	0	mixed in exc.			1.02	1.02
23586	88.02	27	48	0	mixed in exc.			1.25	1.25
25303	89.07	1	5	0	pit				
25311	89.07	2	6	0	collapse, burrow				
25341	89.07	5	12	0	mixed in exc				
25346	89.07	5	13	0	mixed in exc				
25482	89.12	10	12	0	mixed				
25486	89.12	13	16	0	floor dep				
25487	89.12	10	17	0	lime kiln				
25704	89.07	5	14	0	mixed in exc				
25705	89.07	5	13	0	mixed in exc				
27075	89.07	21	51	0	pit?				
27378	89.07	16	64	0	pit?				
27395	89.07	16	67	0	pit?				
27764	89.12	17	24	0	dump				
27770	89.12	18	26	0	?				
27774	89.12	13	39	0	?				
27793	89.12	18	38	0	Roman house section				
27798	89.12	28	37	0	Roman house section				
27859	89.07	16	85	0	?				
27890	89.07	16	90	0	mixed in exc				
27895	89.07	16	92	0	mixed in exc				
28094	89.07	26	99	0	mixed in exc			3.63	5.62
28157	89.14	23	46	0	ext surf, bldg coll			3.67	5.98
28207	89.02	42	106	0	mixed in exc			1.60	1.82
28900	89.07	27	127	0	pit?				
29703	89.07	34	155	0	baulk cutting				
29714	89.07	34	158	0	test trench, RSY ramp				
29721	89.07	27	159	0	pit?				
29738	89.07	34	164	0	baulk cleaning				
30488	89.11	30	117	0	mixed in exc.				
30502	89.07	37	176	0	pit				
31066	89.14	17	111	0	mixed in exc			1.11	1.81
31587	89.01	63	184	0				1.17	1.17
25104	89.08	1	1	630	topsoil			1.85	2.16
NO CHARCOAL ANALYZED:									
20770	88.01	18	35	100	mixed in exc				
26221	89.07	17	37	110.10	pit				
21774	88.01	60	115	300	ash lens				
26141	89.01	13	48	300	mixed in excavation				
21174	88.02	21	59	320	wall collapse				
21057	88.02	21	40	350	floor dep.				
21087	88.02	21	42	350	floor dep.				
22735	88.07	20	25	365	trash				

22983	88.01	95	197	410	sandy lens			
25808	89.02	37	44	430	pit or lens			
26271	89.02	29	78	430.11	pit			
26601	89.02	29	94	430.11	?			
30284	89.02	75	232	435.02	pit			
32688	89.12	42	71	550.04	jar contents			
32385	89.01	100	203	620	floor dep.			
32957	89.01	100	194	620	floor dep.			
33230	89.01	100	203	620	floor dep.			
33234	89.01	100	203	620	floor dep.			
33243	89.01	100	205	620	floor dep.			
33245	89.01	100	205	620	floor dep.			
33246	89.01	100	205	620	floor dep.			
33521	89.01	100	205	620	floor dep.			
33522	89.01	100	205	620	floor dep.			
33524	89.01	100	205	620	floor dep.			
33525	89.01	100	205	620	floor dep.			
33528	89.01	100	208	620	floor dep.			
33529	89.01	100	208	620	floor dep.			
33530	89.01	100	208	620	floor dep.			
33555	89.01	100	205	620	floor dep.			
33568	89.01	100	205	620	floor dep.			
33579	89.01	100	205	620	floor dep.			
33580	89.01	100	205	620	floor dep.			
33590	89.01	100	205	620	floor dep.			
33725	89.01	100	216	620	floor dep.			
25917	89.09	5	21	705	ashy lens			
27454	89.09	12	58	705.01	pit			
33444	89.10	4	107	705.05	pit/hearth			
28609	89.08	9.7	77	705.12	pit			
31902	89.08	30	154	705.12	pit			
27276	89.09	18	54	705.18	hearth			
27497	89.09	21	70	720	ext. surf.			
28554	89.09	21	81	720	ext. surf.			
28562	89.09	21	82	720	ext. surf.			
29462	89.09	23	106	725	burned bldg coll/floor dep.			
29463	89.09	23	106	725	burned bldg coll/floor dep.			
29464	89.09	23	106	725	burned bldg coll/floor dep.			
29905	89.09	23	111	725	floor dep.			
29944	89.09	23	111	725	floor dep.			
30415	89.09	23	116	725	floor dep.			
33362	89.10	25	87	725	floor dep.			
33383	89.10	25	87	725	floor dep.			
33388	89.10	25	87	725	floor dep.			
33396	89.10	25	87	725	floor dep.			
33401	89.10	25	87	725	floor dep.			
29328	89.09	23	99	725.06	burned bldg. coll.			

29344	89.09	23	99	725.06	burned bldg. coll.			
23160	88.03	45	93	730.02	pit			
28494	89.14	25	65	730.04	pit			
29981	89.14	26	87	775	floor dep.			
29987	89.14	26	88	775	floor dep.			
21547	88.03	23	50	798	ext. surface			
23224	88.03	40	102	840	wall collapse?			
22779	88.03	46	86	840.01	pit			
23173	88.03	40	95	850	floor dep.			
23181	88.03	40	97	850	floor dep.			
23205	88.03	40	99	850	floor dep.			
23193	88.05	37	70	850.06	floor dep.			
31088	89.14	17	115	870.04	pit			
23570	88.05	41	81	970	trash			
26348	89.14	10	21	970	lensed trash			
26670	89.14	10	25	970	lensed trash			
CHARCOAL FROM BURNED BUILDINGS:								
20831	88.02	21	37	320	Coll. & floor dep.	15	15.55	26.75
20839	88.02	21	37	320	Coll. & floor dep.	8	2.83	2.86
21085	88.02	21	44	320	wall collapse	9	3.50	3.55
21126	88.02	21	50	320	wall collapse	10	10.43	15.53
23578	88.02	21	59	320	wall collapse	1	3.38	4.83
21094	88.02	21	46	330	roof collapse	8	548.44	548.44
21096	88.02	21	46	330	roof collapse	10	7.02	31.43
21122	88.02	28	52	330	roof collapse	10	7.14	12.71
22723	88.07	17	22	330	collapse	1	0.48	0.48
23294	88.07	23	38	330	collapse	10	3.70	4.61
23588	88.02	21	35	330	collapse	1	0.42	0.42
25724	89.07	7	19	330	wall collapse	10	4.49	6.32
20836	88.02	21	38	350	floor dep.	10	5.89	6.96
21056	88.02	21	40	350	floor dep.	10	9.50	17.11
21060	88.02	21	42	350	floor dep.	20	48.98	143.40
21143	88.02	21	55	350	floor dep.	10	17.91	25.78
21188	88.02	21	61	350	floor dep.	10	9.23	12.06
21190	88.02	21	61	350	floor dep.	20	55.70	176.90
21692	88.02	21	87	350	floor dep.	10	18.84	78.29
21831	88.02	21	94	350	floor dep.	21	16.11	80.54
23581	88.02	24	54	350	floor dep.	1	0.50	0.50
23590	88.02	21	42	350	floor dep.	1	2.20	2.20
21814	88.02	26	93	350.07	floor	1	1.72	1.72
31594	89.01	97	186	610	bldg coll./erosion	5	60.29	60.29
32130	89.01	97	191	610	bldg coll./erosion	10	37.11	61.35
32152	89.01	97	186	610	bldg coll./erosion	7	185.06	326.17
32188	89.01	97	189	610	bldg coll./erosion	6	95.55	200.00
32102	89.01	100	192	620	floor dep.	0	1100.00	1100.00
32132	89.01	100	192	620	floor dep.	19	239.18	399.61
32166	89.01	100	188	620	floor dep.	1	23.23	332.44

32182	89.01	100	190	620	floor dep.	5	75.71	231.38
32186	89.01	100	190	620	floor dep.	0	223.03	223.03
32956	89.01	100	194	620	floor dep.	0	793.59	793.59
32966	89.01	100	198	620	floor dep.	0	0.00	335.60
32972	89.01	100	198	620	floor dep.	0	0.00	127.83
33073	89.01	100	198	620	floor dep.	0	338.58	338.58
33074	89.01	100	198	620	floor dep.	10	50.48	200.60
33092	89.01	100	202	620	floor dep.	10	355.93	355.93
33214	89.01	100	203	620	floor dep.	6	109.59	140.23
33225	89.01	100	203	620	floor dep.	10	29.79	113.30
33531	89.01	100	192	620	floor dep.	1	112.77	112.77
33532	89.01	100	192	620	floor dep.	2	82.85	82.85
33565	89.01	100	205	620	floor dep.	1	125.13	125.13
33584	89.01	100	205	620	floor dep.	10	23.56	79.32
33630	89.01	100	209	620	floor dep.	2	10.41	10.41
33645	89.01	100	211	620	floor dep.	1	69.89	137.66
33661	89.01	100	211	620	floor dep.	5	27.51	76.06
33689	89.01	100	211	620	floor dep.	20	87.02	183.44
33754	89.01	100	216	620	floor dep.	1	201.89	201.89
33755	89.01	100	216	620	floor dep.	1	155.16	155.16
33756	89.01	100	216	620	floor dep.	1	157.03	157.03
28137	89.09	23	78	725	burned bldg. coll., int.	10	4.47	9.02
28147	89.09	23	80	725	burned bldg. coll., int.	1	6.29	6.29
28565	89.09	23	83	725	burned bldg. coll.	10	18.88	22.53
28584	89.09	23	83	725	burned bldg. coll.	2	71.45	71.45
28594	89.09	23	88	725	burned bldg. coll.	10	9.22	15.48
29085	89.09	23	93	725	burned bldg. coll.	10	6.85	7.47
29095	89.09	23	95	725	burned bldg. coll.	6	5.59	6.16
29486	89.09	23	106	725	burned bldg coll/floor dep.	1	9.79	9.79
29497	89.09	23	109	725	burned bldg coll/floor dep.	10	5.93	11.02
29904	89.09	23	110	725	burned bldg coll/floor dep.	1	3.43	3.43
29915	89.09	23	111	725	floor dep.	10	3.83	18.81
29920	89.09	23	111	725	floor dep.	10	8.40	12.50
29921	89.09	23	111	725	floor dep.	5	3.19	8.93
30419	89.09	23	116	725	floor dep.	5	13.40	282.85
32466	89.10	25	57	725	floor dep.	20	99.59	190.12
33332	89.10	25	80	725	floor dep.	10	16.06	22.39
33336	89.10	25	80	725	floor dep.	17	54.48	100.98
33416	89.10	25	93	725	cleaning	10	14.38	29.46
33442	89.10	25	105	725	floor dep.	1	1.96	1.96
29906	89.09	23	112	725.05	burned bldg. coll.	10	7.07	21.62
29916	89.09	23	112	725.05	burned bldg. coll.	10	10.04	13.21
29326	89.09	23	99	725.06	burned bldg. coll.	0	0.00	2.90

Table E.2a. Debris (weight)

YH	op	locus	lot	stratum	Quercus	Pinus	Juni-perus	coni-fer	Fraxi-nus	Populus/ Salix	Rham-nus	Morus	Ulmus	Pyrus/ Crataegus	Prunus	Unk. 3	Unk. 4 Tamarix ?	Alnus cf. viridis	Unk. 1	Indet.
25745	89.07	9	21	100	0.95	0.3	0.42			0.08										
26092	89.02	42	58	100		0.39														
27094	89.07	10	53	110.01	1.5															
27397	89.07	10	68	110.01		0.08							0.68							
20510	88.02	17	23	110.02	1.35	2.36														
21089	88.02	17	23	110.02	0.44	0.8														
26262	89.02	42	77	110.04		1.65							0.22							0.22
26478	89.02	42	88	110.04	2.2	0.33				0.12			1.80	0.28						0.21
26506	89.07	8	23	110.07	0.39	1.9														
20500	88.01	11	21	120		0.33		0.10												
20781	88.01	12	37	140		0.62														
20946	88.01	24	47	150		0.66														
20833	88.02	21	36	300	3.89	7														0.27
21086	88.02	21	45	300		12.84														
22696	88.01	90	179	315		1.15														
26114	89.01	13.2	42	315		3.11														
22077	88.01	28	123	345.01	1.92															
23580	88.02	27	60	355		0.95														
26540	89.07	13	31	360	4.09					0.44										
28066	89.07	24	94	360.03	12.75															
25712	89.07	7	17	360.05	0.36	0.10	0.17			0.72										
26534	89.07	8	29	360.05	0.12					0.96										
25731	89.07	8	20	360.06	0.22	0.82				0.59				0.18						0.12
26204	89.07	13	33	360.06	0.31	0.59							0.14							
27055	89.07	13	47	360.06	4.48															
26225	89.07	13	38	360.09	0.45															
26230	89.07	15	40	360.10	1.63					0.34										
25748	89.07	8	22	360.13	0.35	0.8	0.28										0.67			

26502	89.07	8	22	360.13	0.8	0.04														1.57
26525	89.07	8	26	360.13		0.73				0.33										
26526	89.07	8	26	360.13	0.26	0.64							0.13							
26209	89.07	12	34	365	0.29			0.36											0.16	
26529	89.07	12	28	365										2.39						
27070	89.07	20	50	370	2.19	3.36														
27372	89.07	20	57	370	3.09	0.48														
28306	89.07	29	102	370.02	10.83					0.53										
23397	88.07	37	56	370.03		2.36														
28657	89.07	30	110	370.05	0.32	0.31														
31276	89.07	45	219	370.13	1.91	0.64														
23603	88.07	29	41	375.02	2.73															
22021	88.02	42	114	380.01	10.4															
22358	88.02	47	121	380.06		0.51														0.7
21971	88.01	38	73	380.15	2.37															
21586	88.01	50	93	380.17		1.62													0.04	
22059	88.01	62	119	380.19	0.31	0.26	0.09			0.25										
22364	88.02	46	120	380.24	0.45	0.17														
23120	88.02	71	169	380.26	0.24	0.22	0.18	0.13												
25613	89.01	10	23	390	1.36															
22852	88.02	64	155	400	0.5		1.04													
25226	89.01	5	7	400	0.37	1.9														
25515	89.01	5	7	400			0.47													
26900	89.02	55	119	400		2.57														
27226	89.02	57	134	400		1.34														
27900	89.07	26	91	400		0.53				0.08										
28542	89.01	45	120	400	3.72	0.36														
29251	89.07	26	136	400	0.66															
29261	89.07	26	127	400	1.01	2.03	0.64	0.25												
29423	89.07	26	93	400	1.83															
30141	89.01	53	156	400		7.24														

30503	89.07	36	178	400		1.64														
31045	89.07	39	209	400	0.1															
31259	89.07	39	214	400		1.01	0.47							0.07						0.07
31260	89.07	41	213	400	0.39	0.44														
31290	89.07	46	221	400	1.62	0.88	2.18													
31547	89.07	53	242	400		1.85														
31960	89.07	54	244	400	3.97	0.87	1.78		1.56											
22406	88.01	71	139	410.07	0.69		0.39													
22895	88.02	65	166	410.15	0.64	0.05	0.13						0.61						0.16	
26966	89.01	15	44	410.17	4.8															
25544	89.01	7	14	410.18	1.2															
25661	89.01	7	14	410.18			5.82													
25679	89.01	7	16	410.18				0.02												0.62
30522	89.07	38	177	415		2.98								0.11						
30824	89.07	39	191	415	0.14															
30846	89.07	38	200	415	0.64	0.93														
31003	89.07	39	199	415		0.17	0.59	0.01												0.16
31040	89.07	43	210	415		1.41														
31305	89.07	47	225	415	1.78	1.49	0.57													
31330	89.07	48	232	415	3.3	0.89	0.96							1.24			0.36			
31340	89.07	39	230	415	0.16	0.47	1.31													
31342	89.07	39	227	415	0.02	0.05														
31995	89.07	57	251	415	3.38															
31998	89.07	58	258	415	3.37	0.33	0.64	0.95												
29737	89.07	31	160	415.03	0.32	0.45														
31546	89.07	51	240	415.04	13.2	0.85	1.1						3.67							
31966	89.07	55	245	415.05		9.71	5.47													
31339	89.07	49	233	415.08	0.65	3.1														
31523	89.07	50	237	415.10			1.02				0.31									
22440	88.01	75	149	420							3.1	3.99		5.44						
23138	88.02	73	173	420	2.08	0.06	0.17													

28934	89.01	51	129	420.01	1.4		1.47													
23043	88.01	93	187	420.02	2.74		0.41							0.71						
25660	89.01	8	15	420.03												0.43				0.15
25664	89.01	8	15	420.03	6.1															
22507	88.02	55	129	430			2.23													
22894	88.02	69	165	430	0.7	1.68										2.58				
22987	88.02	67	162	430		0.56														
23118	88.02	58	168	430	3.24		1.5													
23305	88.02	69	176	430	0.84									2.58						
23311	88.02	64	175	430	2.43	0.41	0.83	0.43												0.17
23505	88.02	55	180	430	1.5			0.25					0.6							
27510	89.01	25	75	430		1.95														
28429	89.02	64	177	430	0.24	0.07			0.38	1.7										
26781	89.01	2.3	62	430.02		1.05														
27624	89.01	2.3	62	430.02	0.77															
25522	89.01	5	10	430.03		0.15	0.59													
25524	89.01	5	10	430.03	4.99															
26624	89.02	53	96	430.12	2.17	2.01														
25588	89.02	28	36	430.15		7.7								0.18						
25282	89.02	10	14	430.17	12.01															
26185	89.02	48	70	435	2.47	0.31														
26802	89.02	6	118	435		0.86														
27432	89.02	60	146	435.05		2.43														
25247	89.01	3	6	450.01	1.32	1.67														
23459	88.01	97	204	460	0.94	0.51	1.68	0.08												
26646	89.02	30	98	470	0.26		1.72													
27820	89.01	33	98	470		2.61														
28769	89.02	11	182	470		1.3														
29529	89.01	52	133	495.06	2.13															
31938	89.12	33	46	500	1.2															
30694	89.02	78	243	510.05	5.44															

31438	89.02	88	287	515	1.92		0.25													
32620	89.12	25	56	540.03	10.82															
32634	89.12	38	60	550.01	2.97															
32636	89.12	39	61	550.02		5.3														
32683	89.12	42	71	550.04	19.62	4.76								1.14						
32801	89.02	87	330	570.11	0.31															
20083	88.04	10	16	640	1.01	0.39														
20098	88.06	2	1	640	1.74	1.03													0.17	
25123	89.08	2	3	640			0.32													
20233	88.06	10	12	660		0.39														
20342	88.05	10	10	660		0.98	1.36													
25067	89.11	4	9	660		0.94	1.84													
25069	89.11	4	9	660		5.23														
25087	89.11	4	16	660		0.6														
25111	89.08	1	2	660		1.23									0.31					
25137	89.08	3	7	660		1.22	0.65													
25171	89.09	2	6	660		2.06														
25858	89.08	3	12	660		0.33	0.75	0.27												
25865	89.08	3	14	660		0.29														
25129	89.08	2	6	670	0.17	2.04	0.38													
25178	89.09	2	8	670	0.41	2.46														
25879	89.08	5	17	670		5		0.48												
20577	88.05	17	19	700			1.15													
21280	88.05	26	30	700		1.03														
27189	89.11	15	45	700			0.78													
28118	89.09	21	73	700	0.27															
28725	89.11	21	67	700																0.23
28745	89.11	21	73	700	1.21															
28967	89.08	10	91	700			0.66													
29236	89.11	20	83	700		0.86	0.99													
29339	89.09	23	103	700			7.49													

31118	89.10	11	21	700		0.9														
31777	89.10	3	37	700	0.59		2.67													
31897	89.10	25	54	700	0.65		40.64													
29815	89.08	10	100	700.01	0.77															
20865	88.04	18	33	705		1.94														
25909	89.09	5	19	705	3.37	2.35														
28252	89.11	16	47	705				1.97												
28459	89.14	31	60	705		2.76														
26701	89.09	12	39	705.01				0.18												0.55
26703	89.09	12	39	705.01		1.53														0.26
26719	89.09	12	42	705.01		5.92														
26720	89.09	12	42	705.01	0.95	0.78														0.23
28733	89.11	14	70	705.01	0.7															
30580	89.10	4	11	705.05	1.33			0.33												
27039	89.08	9.4	44	705.10		0.82														
28982	89.08	10	95	705.12	1															
31465	89.08	30	149	705.12	3.94	4.2	2.86													
30495	89.11	31	119	705.23	3.81															
27474	89.09	16	63	720		1.33														
27481	89.09	16	62	720	12.84															
29064	89.09	21	89	720		2.42														
29334	89.09	23	101	720			4.91													
29348	89.09	21	102	720		6.51														
33321	89.10	25	76	720	1.26		17.66													
22756	88.03	45	81	730.02	1	0.4														
23242	88.05	39	73	730.04		2.26	2.2													
21279	88.03	23	45	735		0.95														
31796	89.10	16	41	740		0.96														
31876	89.10	16	51	740		1.23														
32487	89.10	29	67	745	0.13		2.45		0.42											
28710	89.11	19	58	750.02			0.27													

28734	89.11	20	71	750.02			0.97													
29216	89.11	21	77	755.02	1.04		0.89	0.23												
30460	89.11	14	110	755.03		1.33														
30395	89.11	25	105	755.05	1.22															
27033	89.08	9	42	760		0.6														
27979	89.08	9	53	760			1.59													
28952	89.08	9	84	760			0.46													
28154	89.14	19	44	770	1.66		1.76													
21482	88.06	27	39	795	1.09	1.19														
22704	88.06	30	46	795.02		0.78	0.07													
21545	88.03	23	50	798			0.5													
29202	89.11	21	73	798		1.07														
22162	88.03	37	62	800		3.42														
32736	89.11	44	184	840			5.31													
23151	88.03	40	91	850			0.78													
23178	88.03	40	96	850	0.35		8.38													
23199	88.03	40	98	850		1.21	6.44						0.68							
23213	88.03	40	100	850		3.08	13.13													
23220	88.03	40	101	850			1.05													
33156	89.11	46	189	850.01			7.51													
29978	89.14	39	85	870.01			4.74													
33143	89.14	60	167	900		8.82														
33252	89.14	60	168	900		3.77	2.88													
28836	89.14	10	72	970			0.22													
29371	89.14	10	75	970	3.63	0.21														
33263	89.14	61	170	1030		3.22														

Table E.2b. Debris (count)

YH	op	locus	lot	stratum	No. id'ed	Quer-cus	Pinus	Juni-perus	coni-fer	Fraxi-nus	Populus/ Salix	Rham-nus	Morus	Ulmus	Pyrus/ Crataegus	Prunus	Unk. 3	Unk. 4 Tamarix?	Alnus cf. viridis	Unk. 1	Indet.
25745	89.07	9	21	100	6	2	2	1			1										
26092	89.02	42	58	100	2		2														
27094	89.07	10	53	110.01	4	4															
27397	89.07	10	68	110.01	3		1							2							
20510	88.02	17	23	110.02	7	2	5														
21089	88.02	17	23	110.02	6	2	4														
26262	89.02	42	77	110.04	10		7							1							2
26478	89.02	42	88	110.04	15	5	2				1			4	2						1
26506	89.07	8	23	110.07	10	1	9														
20500	88.01	11	21	120	2		1		1												
20781	88.01	12	37	140	1		1														
20946	88.01	24	47	150	1		1														
20833	88.02	21	36	300	15	3	11														1
21086	88.02	21	45	300	10		10														
22696	88.01	90	179	315	1		1														
26114	89.01	13	42	315	1		1														
22077	88.01	28	123	345.01	10	10															
23580	88.02	27	60	355	1		1														
26540	89.07	13	31	360	10	7					3										
28066	89.07	24	94	360.03	3	3															
25712	89.07	7	17	360.05	14	6	1	1			6										
26534	89.07	8	29	360.05	10	1					9										
25731	89.07	8	20	360.06	9	1	3				3				1						1
26204	89.07	13	33	360.06	7	1	5							1							
27055	89.07	13	47	360.06	10	10															
26225	89.07	13	38	360.09	3	3															
26230	89.07	15	40	360.10	6	2					4										

25748	89.07	8	22	360.13	9	1	5	1										2			
26502	89.07	8	22	360.13	3	1	1														1
26525	89.07	8	26	360.13	2		1				1										
26526	89.07	8	26	360.13	5	1	2							2							
26209	89.07	12	34	365	4	1			1											2	
26529	89.07	12	28	365	10										10						
27070	89.07	20	50	370	10	2	8														
27372	89.07	20	57	370	10	7	3														
28306	89.07	29	102	370.02	10	9					1										
23397	88.07	37	56	370.03	1		1														
28657	89.07	30	110	370.05	4	2	2														
31276	89.07	45	219	370.13	10	8	2														
23603	88.07	29	41	375.02	1	1															
22021	88.02	42	114	380.01	5	5															
22358	88.02	47	121	380.06	6		4														2
21971	88.01	38	73	380.15	10	10															
21586	88.01	50	93	380.17	5		4													1	
22059	88.01	62	119	380.19	8	1	2	1			4										
22364	88.02	46	120	380.24	2	1	1														
23120	88.02	71	169	380.26	6	1	2	1	2												
25613	89.01	10	23	390	1	1															
22852	88.02	64	155	400	3	1		2													
25226	89.01	5	7	400	4	1	3														
25515	89.01	5	7	400	1			1													
26900	89.02	55	119	400	1		1														
27226	89.02	57	134	400	10		10														
27900	89.07	26	91	400	5		4				1										
28542	89.01	45	120	400	5	4	1														
29251	89.07	26	136	400	1	1															
29261	89.07	26	127	400	10	2	6	1	1												
29423	89.07	26	93	400	10	10															

30141	89.01	53	156	400	1		1														
30503	89.07	36	178	400	1		1														
31045	89.07	39	209	400	1	1															
31259	89.07	39	214	400	7		2	2							2						1
31260	89.07	41	213	400	4	3	1														
31290	89.07	46	221	400	7	1	2	4													
31547	89.07	53	242	400	10		10														
31960	89.07	54	244	400	15	6	4	4		1											
22406	88.01	71	139	410.07	4	3		1													
22895	88.02	65	166	410.15	10	3	1	1						4						1	
26966	89.01	15	44	410.17	5	5															
25544	89.01	7	14	410.18	1	1															
25661	89.01	7	14	410.18	10			10													
25679	89.01	7	16	410.18	3				2												1
30522	89.07	38	177	415	10		9								1						
30824	89.07	39	191	415	1	1															
30846	89.07	38	200	415	7	2	5														
31003	89.07	39	199	415	8		1	5	1												1
31040	89.07	43	210	415	4		4														
31305	89.07	47	225	415	10	4	5	1													
31330	89.07	48	232	415	15	8	2	2							2			1			
31340	89.07	39	230	415	10	1	4	5													
31342	89.07	39	227	415	5	1	4														
31995	89.07	57	251	415	10	10															
31998	89.07	58	258	415	11	2	2	3	4												
29737	89.07	31	160	415.03	5	3	2														
31546	89.07	51	240	415.04	15	7	2	4						2							
31966	89.07	55	245	415.05	6		4	2													
31339	89.07	49	233	415.08	10	1	9														
31523	89.07	50	237	415.10	10			9				1									
22440	88.01	75	149	420	20							5	6		9						

23138	88.02	73	173	420	10	8	1	1													
28934	89.01	51	129	420.01	2	1		1													
23043	88.01	93	187	420.02	10	2		2							6						
25660	89.01	8	15	420.03	3												1				2
25664	89.01	8	15	420.03	10	10															
22507	88.02	55	129	430	1			1													
22894	88.02	69	165	430	2	1	1														
22987	88.02	67	162	430	2		2														
23118	88.02	58	168	430	10	8		2													
23305	88.02	69	176	430	10	4									6						
23311	88.02	64	175	430	15	6	2	2	4												1
23505	88.02	55	180	430	8	6			1					1							
27510	89.01	25	75	430	1		1														
28429	89.02	64	177	430	10	1	1			1	7										
26781	89.01	2.3	62	430.02	1		1														
27624	89.01	2.3	62	430.02	1	1															
25522	89.01	5	10	430.03	2		1	1													
25524	89.01	5	10	430.03	1	1															
26624	89.02	53	96	430.12	10	5	5														
25588	89.02	28	36	430.15	20		19								1						
25282	89.02	10	14	430.17	10	10															
26185	89.02	48	70	435	7	6	1														
26802	89.02	6	118	435	7		7														
27432	89.02	60	146	435.05	3		3														
25247	89.01	3	6	450.01	7	2	5														
23459	88.01	97	204	460	15	4	5	5	1												
26646	89.02	30	98	470	2	1		1													
27820	89.01	33	98	470	7		7														
28769	89.02	11	182	470	1		1														
29529	89.01	52	133	495.06	1	1															
31938	89.12	33	46	500	1	1															

30694	89.02	78	243	510.05	10	10															
31438	89.02	88	287	515	10	9		1													
32620	89.12	25	56	540.03	1	1															
32634	89.12	38	60	550.01	1	1															
32636	89.12	39	61	550.02	10		10														
32683	89.12	42	71	550.04	20	10	8								2						
32801	89.02	87	330	570.11	1	1															
20083	88.04	10	16	640	4	3	1														
20098	88.06	2	1	640	10	5	4														1
25123	89.08	2	3	640	2			2													
20233	88.06	10	12	660	2		2														
20342	88.05	10	10	660	7		3	4													
25067	89.11	4	9	660	10		4	6													
25069	89.11	4	9	660	1		1														
25087	89.11	4	16	660	1		1														
25111	89.08	1	2	660	10		9									1					
25137	89.08	3	7	660	6		5	1													
25171	89.09	2	6	660	2		2														
25858	89.08	3	12	660	7		2	3	2												
25865	89.08	3	14	660	2		2														
25129	89.08	2	6	670	8	1	4	3													
25178	89.09	2	8	670	4	2	2														
25879	89.08	5	17	670	10		9		1												
20577	88.05	17	19	700	4			4													
21280	88.05	26	30	700	1		1														
27189	89.11	15	45	700	1			1													
28118	89.09	21	73	700	10	10															
28725	89.11	21	67	700	1																1
28745	89.11	21	73	700	1	1															
28967	89.08	10	91	700	1			1													
29236	89.11	20	83	700	6		2	4													

29339	89.09	23	103	700	10			10													
31118	89.10	11	21	700	1		1														
31777	89.10	3	37	700	5	2		3													
31897	89.10	25	54	700	10	1		9													
29815	89.08	10	100	700.01	5	5															
20865	88.04	18	33	705	1		1														
25909	89.09	5	19	705	16	7	9														
28252	89.11	16	47	705	1				1												
28459	89.14	31	60	705	5		5														
26701	89.09	12	39	705.01	3				2												1
26703	89.09	12	39	705.01	8		7														1
26719	89.09	12	42	705.01	1		1														
26720	89.09	12	42	705.01	4	1	2														1
28733	89.11	14	70	705.01	5	5															
30580	89.10	4	11	705.05	2	1			1												
27039	89.08	9.4	44	705.10	2		2														
28982	89.08	10	95	705.12	1	1															
31465	89.08	30	149	705.12	6	4	1	1													
30495	89.11	31	119	705.23	3	3															
27474	89.09	16	63	720	1		1														
27481	89.09	16	62	720	10	10															
29064	89.09	21	89	720	1		1														
29334	89.09	23	101	720	10			10													
29348	89.09	21	102	720	5		5														
33321	89.10	25	76	720	10	1		9													
22756	88.03	45	81	730.02	3	2	1														
23242	88.05	39	73	730.04	12		2	10													
21279	88.03	23	45	735	1		1														
31796	89.10	16	41	740	4		4														
31876	89.10	16	51	740	1		1														
32487	89.10	29	67	745	11	1		8		2											

28710	89.11	19	58	750.02	1			1													
28734	89.11	20	71	750.02	1			1													
29216	89.11	21	77	755.02	5	3		1	1												
30460	89.11	14	110	755.03	1		1														
30395	89.11	25	105	755.05	10	10															
27033	89.08	9	42	760	4			4													
27979	89.08	9	53	760	3			3													
28952	89.08	9	84	760	2			2													
28154	89.14	19	44	770	10	4		6													
21482	88.06	27	39	795	10	5	5														
22704	88.06	30	46	795.02	5		4	1													
21545	88.03	23	50	798	5			5													
29202	89.11	21	73	798	1		1														
22162	88.03	37	62	800	1		1														
32736	89.11	44	184	840	2			2													
23151	88.03	40	91	850	1			1													
23178	88.03	40	96	850	10	1		9													
23199	88.03	40	98	850	10		1	7						2							
23213	88.03	40	100	850	10		3	7													
23220	88.03	40	101	850	2			2													
33156	89.11	46	189	850.01	4			4													
29978	89.14	39	85	870.01	7			7													
33143	89.14	60	167	900	10		10														
33252	89.14	60	168	900	10		6	4													
28836	89.14	10	72	970	1			1													
29371	89.14	10	75	970	2	1	1														
33263	89.14	61	170	1030	1		1														

Table E.3a. Buildings (weight)

YH	op	locus	lot	stratum	Quercus	Pinus	Juni-perus	coni-fer	Fraxi-nus	Populus / Salix	Ulmus	Alnus cf. viridis	Indet.	Other items, notes
20831	88.02	21	37	320	1.61	13.94								
20839	88.02	21	37	320		2.83								
21085	88.02	21	44	320	0.78	2.38							0.34	
21126	88.02	21	50	320	9.14	1.29								
23578	88.02	21	59	320		3.38								
21094	88.02	21	46	330		548.44								beam; reed-25ml (5.28g)
21096	88.02	21	46	330	0.69	6.33								
21122	88.02	28	52	330		7.14								
22723	88.07	17	22	330		0.48								
23294	88.07	23	38	330	3.70									
23588	88.02	21	35	330		0.42								
25724	89.07	7	19	330	2.98	0.90	0.40			0.21				
20836	88.02	21	38	350		5.89								
21056	88.02	21	40	350		9.5								
21060	88.02	21	42	350	32.48	13.01			3.49					
21143	88.02	21	55	350	0.22	17.69								
21188	88.02	21	61	350	8.55	0.68								
21190	88.02	21	61	350	24.09	29.41			2.20					
21692	88.02	21	87	350		18.84								
21831	88.02	21	94	350	1.25	14.86								reeds-25ml(3.34g)
23581	88.02	24	54	350	0.50									
23590	88.02	21	42	350		2.20								
21814	88.02	26	93	350.07	1.72									
31594	89.01	97	186	610		60.29								
32130	89.01	97	191	610		37.11								
32152	89.01	97	186	610		185.06								2 bags of pine

32188	89.01	97	189	610		95.55								2 bags of pine
32102	89.01	100	192	620		1100								4 bags of pine; log
32132	89.01	100	192	620		239.18								
32166	89.01	100	188	620		23.23								
32182	89.01	100	190	620		75.71								2 bags of pine
32186	89.01	100	190	620		223.03								1 bag of pine
32956	89.01	100	194	620		793.59								1 bag of pine chunks
32966	89.01	100	198	620										1 bag of pine;"planks"
32972	89.01	100	198	620										1 bag of pine
33073	89.01	100	198	620		338.58								1 bag of pine
33074	89.01	100	198	620		50.48								
33092	89.01	100	202	620		355.93								
33214	89.01	100	203	620		109.59								
33225	89.01	100	203	620		29.79								
33531	89.01	100	192	620		112.77								beam, found in yh32102
33532	89.01	100	192	620		82.85								beam, found in yh32132
33565	89.01	100	205	620		125.13								
33584	89.01	100	205	620		23.56								
33630	89.01	100	209	620		10.41								
33645	89.01	100	211	620		69.89								
33661	89.01	100	211	620	27.51									including ≈ 50rings
33689	89.01	100	211	620	51.20	35.82								
33754	89.01	100	216	620		201.89								
33755	89.01	100	216	620		155.16								pine log
33756	89.01	100	216	620		157.03								pine log
28137	89.09	23	78	725			4.47							
28147	89.09	23	80	725			6.29							
28565	89.09	23	83	725		0.30	18.58							
28584	89.09	23	83	725			71.45							

28594	89.09	23	88	725			9.22							
29085	89.09	23	93	725		2.32	4.53							
29095	89.09	23	95	725		5.59								
29486	89.09	23	106	725		9.79								
29497	89.09	23	109	725		0.2	5.73							
29904	89.09	23	110	725			3.43							
29915	89.09	23	111	725	3.83									
29920	89.09	23	111	725		5.72	2.68							
29921	89.09	23	111	725			3.19							
30419	89.09	23	116	725								13.4		mystery wood;"planks?"
32466	89.10	25	57	725	4.96	16.36	78.27							
33332	89.10	25	80	725		10.64	3.98				1.44			
33336	89.10	25	80	725	11.79	13.48	13.74	1.29		14.18				
33416	89.10	25	93	725			6.53			7.85				
33442	89.10	25	105	725		1.96								
29906	89.09	23	112	725.05			7.07							
29916	89.09	23	112	725.05		8.92	1.12							
29326	89.09	23	99	725.06										reeds/grass stem

Table E.3b. Buildings (count)

YH	op	locus	lot	stratum	Quercus	Pinus	Juni-perus	coni-fer	Fraxi-nus	Populus / Salix	Ulmus	Alnus cf. viridis	Indet.
20831	88.02	21	37	320	2	13							
20839	88.02	21	37	320		8							
21085	88.02	21	44	320	2	6							1
21126	88.02	21	50	320	8	2							
23578	88.02	21	59	320		1							
21094	88.02	21	46	330		8							
21096	88.02	21	46	330	1	9							
21122	88.02	28	52	330		10							
22723	88.07	17	22	330		1							
23294	88.07	23	38	330	10								
23588	88.02	21	35	330		1							
25724	89.07	7	19	330	5	1	1			3			
20836	88.02	21	38	350		10							
21056	88.02	21	40	350		10							
21060	88.02	21	42	350	12	7			1				
21143	88.02	21	55	350	1	9							
21188	88.02	21	61	350	7	3							
21190	88.02	21	61	350	8	11			1				
21692	88.02	21	87	350		10							
21831	88.02	21	94	350	2	19							
23581	88.02	24	54	350	1								
23590	88.02	21	42	350		1							
21814	88.02	26	93	350.07	1								
31594	89.01	97	186	610		5							
32130	89.01	97	191	610		10							

32152	89.01	97	186	610		7							
32188	89.01	97	189	610		6							
32102	89.01	100	192	620									
32132	89.01	100	192	620		19							
32166	89.01	100	188	620		1							
32182	89.01	100	190	620		5							
32186	89.01	100	190	620									
32956	89.01	100	194	620									
32966	89.01	100	198	620									
32972	89.01	100	198	620									
33073	89.01	100	198	620									
33074	89.01	100	198	620		10							
33092	89.01	100	202	620		10							
33214	89.01	100	203	620		6							
33225	89.01	100	203	620		10							
33531	89.01	100	192	620		1							
33532	89.01	100	192	620		2							
33565	89.01	100	205	620		1							
33584	89.01	100	205	620		10							
33630	89.01	100	209	620		2							
33645	89.01	100	211	620		1							
33661	89.01	100	211	620	5								
33689	89.01	100	211	620	7	13							
33754	89.01	100	216	620		1							
33755	89.01	100	216	620		1							
33756	89.01	100	216	620		1							
28137	89.09	23	78	725			10						
28147	89.09	23	80	725			1						
28565	89.09	23	83	725		1	9						

28584	89.09	23	83	725			2						
28594	89.09	23	88	725			10						
29085	89.09	23	93	725		4	6						
29095	89.09	23	95	725		6							
29486	89.09	23	106	725		1							
29497	89.09	23	109	725		2	8						
29904	89.09	23	110	725			1						
29915	89.09	23	111	725	10								
29920	89.09	23	111	725		8	2						
29921	89.09	23	111	725			5						
30419	89.09	23	116	725								5	
32466	89.10	25	57	725	3	4	13						
33332	89.10	25	80	725		6	2				2		
33336	89.10	25	80	725	3	4	6			4			
33416	89.10	25	93	725			4			6			
33442	89.10	25	105	725		1							
29906	89.09	23	112	725.05			10						
29916	89.09	23	112	725.05		6	4						
29326	89.09	23	99	725.06									

Appendix F
Flotation Samples

The tables in Appendix F include the inventory of flotation samples analyzed and their contents. Samples used to generate the summary statistics are numbered in Column A or Row A in rough order by period and locus number. Following those samples are the ones from the floor deposits of the three burned buildings: 1a-e (Early Phrygian Terrace Building 2A, YHSS 620), 2a–b (Hellenistic "Abandoned Village," YHSS 350), 3a–i (Early Iron Age "BRH"=Burnt Reed House, YHSS 725).

App F1 Inventory of samples

sheet 1: List of samples analyzed for this report with brief context information. Column H: Mary Voigt's description of context; Column I: NFM's interpretation of context description; Column J: context simplified for sorting by category; Column Q: date analyzed.
sheet 2: density by deposit type
sheet 3: density by time period
sheet 4: distribution of common taxa by context type

App F2 YHSS 1–6 (basic sample information and wild seeds)

row A: the numbers correspond to the order of the samples by YHSS number; samples from Destruction level (YHSS 620; cols ED–EH) and burned room of "Abandoned Village" (YHSS 350; cols EJ–EK) are listed separately because their contents are not included in the summary statistics.
sheet 1: col. a: family abbreviation
sheet 2: ubiquity
sheet 3: calculation of median values

App F3 YHSS 1–6 (economic plants)

row A: same as for Table F2

App F4 YHSS 1–6 (plant parts and uncharred)

row A: same as for Table F2

App F5 YHSS 7–10 (basic sample information and wild seeds)

row A: the numbers correspond to the order of the samples by YHSS number; samples from the Burnt Reed Structure (YHSS 725) are listed separately because their contents are not included in the summary statistics.
sheet 1: col. a: family abbreviation
sheet 2: ubiquity
sheet 3: calculation of median values

App F6 YHSS 7–10 (economic plants)

row A: same as for Table F5

App F7 YHSS 7–10 (plant parts and uncharred) row A: same as for Table F5

App F8 Heavy fractions

sheet 1: Archaeobotanical contents of heavy fractions (spread sheet sortable by type)
column A: the numbers correspond to the order of the samples listed in row A of the main data tables (F2–F7)
column D: some heavy fractions were picked in the field, but could not be found in the laboratory in the U.S.

sheet 2: Archaeobotanical contents of heavy fractions (spread sheet summarized by type)

App F9 summaries of sample characters

sheet 1: density and seed:charcoal by deposit type
sheet 2: density by date
sheet 3: wild:cereal distribution
sheet 4: medians (density, seed:charcoal, wild:charcoal)

Charred density: as is typical of archaeobotanical samples, most samples have relatively low density; the distribution is not normal (see bar graph), so the mean value calculated here is, in fact, meaningless. Rather than mean, one can look at the distribution of charred density by category of deposit. The bar graph suggests three divisions, low, ordinary, and high. A chi-square test suggests there are statistically significant differences by time period in charcoal density of the deposits examined, but NOT by category of deposit.

Seed:charcoal values. Here, too, the distribution is not normal (see bar graph), and so the mean value is not relevant. One can look at the distribution of seed:charcoal values by category of deposit. The bar graph suggests the divisions low, ordinary, and high. A chi-square test suggests there are no statistically significant differences by either time period or category of deposit in the deposits examined. (Chi-square calculator through Georgetown Linguistics, http://www.georgetown.edu/faculty/ballc/webtools/web_chi.html, by Catherine N. Ball and Jeffrey Connor-Linton (1996-2003), verified December 4, 2006

Appendix G
Analysis Summaries

The tables in Appendix G are the basis for the major conclusions reached in this report. They incorporate the flotation and charcoal data, as well as the rough animal bone counts reported by Zeder (work in progress).

App G 1 Ubiquity
Includes percent ubiquity data for the major cultigens and wild types.

App G 2 Cultigen summary
sheet 1: sample characters and seed and rachis summaries
sheet 2: cereal and rachis numbers

App G 3 Wild and Animal summary
sheet 1: wild plant taxa percents
sheet 2: comparisons showing animals, plants, and trees