An Archaeobotanical Perspective on Environment, Plant Use, Agriculture, and Interregional Contact in South and Western Iran

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Plant remains from archaeological sites reflect many aspects of the relationship between people, plants, and the environment in which they lived. Plant macroremains—seeds and wood that are visible without a microscope—can address a wide range of questions. The most basic include what crops were grown? What was used for fuel? Do any of the plants come from distant lands? Examples from fourth and third millennium deposits at Farukhabad, Sharafabad, Godin, and Malyan show that within the basic agricultural assemblage of wheat and barley shared by all sites, Sharafabad and Godin have stronger evidence of irrigation, lentil and flax, and Farukhabad appears to be more oriented toward pastoral production than the other sites. This article provides an introduction to archaeobotany using examples drawn from several fourth and third millennium sites in southern and western Iran. Human impact on the vegetation in Khuzestan and Fars appears to have been minimal at this time. A few unexpected finds (a date pit from cold-country/*Sardsir* Malyan suggests trade and rice at Parthian Susa may be evidence of a new crop that had long been cultivated in the Indus valley.

Keywords: *archaeobotany, agriculture, Sharafabad, Farukhabad, Godin, Malyan*

Introduction

Plants are basic to human life, so if we are to understand ancient societies, we need to understand their botanical environment. In Iran and elsewhere, pollen analysis, the analysis of charred seeds and wood, the analysis of organic residues, and ethnoarchaeology all provide useful techniques and approaches for learning about the relationship between people and plants in the past (fig. 1). For example, from pollen studies carried out on lake sediments in the Zagros Mountains, we infer that much of Iran was so cold and dry during the Pleistocene it was inhospitable to human settlement (van Zeist and Bottema 1977, 1991). Charred seeds from Ali Kosh on the Deh Luran plain in Khuzestan document the rapid spread of agriculture from contact with farming societies to the west (Helbaek 1969; see also Bar-Yosef 1998). Organic residue analysis has identified very early evidence for fermentation in the remains of wine and beer from vessels found at Hajji Firuz and Godin dating to the Neolithic and Chalcolithic periods (Badler et al. 1990; McGovern et al. 1996). Ethnoarchaeological work at Malyan suggested that many seeds found on archaeological sites come from dung, burned as fuel. Therefore, many charred plant remains do not provide direct evidence for food crops and human diet (Miller 1984). In the future, newer techniques, such as ancient phytolith and starch analysis and the study of modern, and perhaps even ancient, plant DNA will undoubtedly provide information that will deepen our understanding of the relationship between people and plants in ancient Iran (for a survey of archaeobotany in Iran, see Miller 2003; for discussion of crops, see Zohary and Hopf 2000).

As stated, plant remains from archaeological sites reflect different aspects of the relationship between people, plants, the environment in which they lived. This paper discusses information obtained from plant macroremains—seeds and wood that are visible without a microscope. Most of these remains are preserved through charring; in the absence of oxygen, burnt plant materials keep their shape instead of turning to ash. Identifiable remains consist primarily of wood charcoal and charred seeds that are extracted by flotation from archaeological soil samples. In order to interpret the material, we must consider the archaeological context as well as the amounts and proportions of the various types. Plant remains do not precisely mirror the ancient environment or the way people used plants. One cannot simply say that if half of the wood remains are oak, the forest was 50% oak, or that if 90% of the grain is barley, barley was the most

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important crop. The plant remains we analyze have passed through two cultural filters: First, most came onto the site as a result of some human activity, and second, at some point they were burned. Experience suggests that much of the material is incompletely burned fuel—wood collected outside the site, and seeds that came from dung, burned as fuel.

Once we understand the nature of the remains, archaeobotanical data can answer a wide range of questions. The most basic include what crops were grown? What was used for fuel? Do any of the plants come from distant lands? The plant remains do not speak for themselves, so it is important to understand the kinds of arguments that allow you to reconstruct land use and human impact on the environment, and to evaluate evidence of interregional contact.

Assessing Agriculture and Land Use: Examples from Western Iran in the Late Fourth-Early Third Millennium

Archaeobotanical remains can help us understand how people adapted their food production strategies to local environmental conditions. This section discusses the remains from four, late fourth- and early third-millennium, sites that I have worked on—Tepe Sharafabad (Wright et al. 1981), Tepe Farukhabad (Miller 1981a), Godin Tepe (Miller 1990), and Tal-e Malyan (Miller 1982). The Sharafabad, Farukhabad and Godin deposits discussed here are characterized as Uruk-period with cultural or political ties to Susa and Susiana. The Malyan Banesh phase samples date to the slightly later Proto-Elamite period. Sharafabad was a rural administrative center located less than 20 km from Susa; excavated materials come from one very large trash pit (Wright et al. 1981). Farukhabad is centrally located in the neighboring Deh Luran plain and appears to have been a small administrative center during much of the Uruk period. The samples come from occupation deposits associated with architecture (Wright 1981). Even though Godin is in the Kangavar valley in Kermanshah, lowland political influence is apparent; originally thought to have been some kind of a trade outpost of Susa (Weiss and Young 1975), it is now less clear that the residents of the period VI burned Citadel were foreign (Rothman and Badler 2011). Unlike samples from the other sites, the Godin remains seem to have a high proportion of stored crops. Malyan is the largest of the sites. It was the political center of the Kur River Basin (Sumner 1986); the samples come from mixed trash.

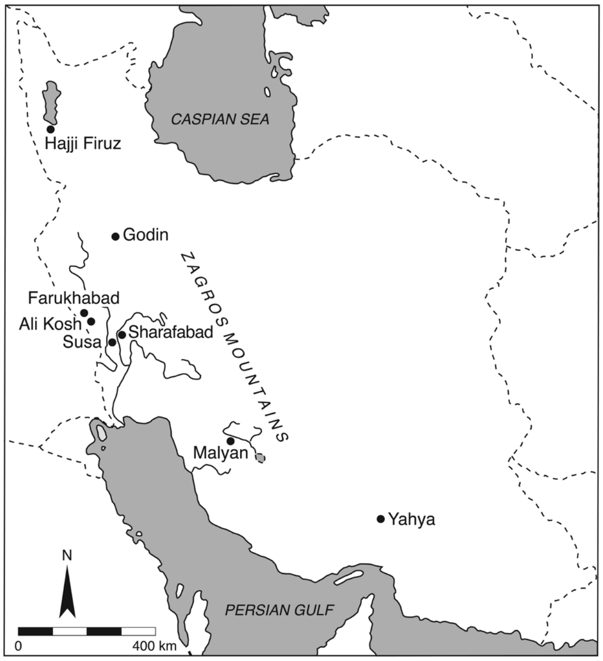

Fig. 1: Sites mentioned in text.

The sites are located in different environments. Although climate and vegetation zones may have shifted in the past five to six thousand years, it is reasonable to assume that relative between-site variations were similar to what we see today. I have been unable to obtain useful precipitation data, but all the sites seem to lie within the precipitation zone that receives 200-400 mm per year. More important for vegetation is the availability of moisture, which depends on temperature as well as precipitation. The vegetation zones of the sites therefore give some indication of moisture availability for crop production. From cool/moist to hot/arid, the prevailing vegetation patterns are oak woodland (*Quercus brantii*), pistachio-almond steppe forest (*Pistacia-Amygdalus*), Nubo-Sindian tropical vegetation (Zohary 1973; Table. 1). Malyan and Godin are in the Zagros highlands, within the rainfall agriculture zone. Rainfall agriculture would have been marginal at best at Farukhabad on the

Deh Luran plain and at Sharafabad in Susiana. Whyte (1977:373) comments that “for Deh Luran [the precipitation regime] means a winter growing season from December to April, which, without irrigation, would produce crops for only half the years they were sown.”

Site	lat N	long E	Vegetation zone*
Sharafabad	32.29	48.34	*Pistacia-Amygdalus* steppe forest, near Nubo-Sindian tropical
Farukhabad	32.59	47.22	Quercetea brantii, near *Pistacia-Amygdalus* steppe forest and Nubo-Sindian tropical
Godin	34.45	48.01	Quercetea brantii, near *Pistacia-Amygdalus* steppe forest
Malyan	30.01	52.41	Quercetea brantii, near *Pistacia-Amygdalus* steppe forest

**After: Zohary 1973, map.*
***Table1 :** Site locations, most arid to most moist.*

Crop plants

With the beginning of agriculture about 10,000 years ago, people created a new ecological niche that favored the spread of some plants. For example, wild emmer wheat grows under a fairly narrow set of growing conditions within a limited area of the Levant. With cultivation, it may have taken as little as a few hundred years for domesticated emmer to spread down the Taurus-Zagros Arc all the way to Ali Kosh (Helbaek 1969). The earliest plants cultivated in Iran include two-row barley, emmer wheat, and lentils. By about 5000 BC other field crops become more prominent than they had been before, probably because irrigation became more widespread in western Iran. Crops which either require, or at least do better with, irrigation include six-row barley, bread wheat and flax. Even though many crop plants can thrive in a broader range of conditions than their wild ancestors, they are more suited to some environments and cultivation schedules than others. For example, with or without irrigation, wheat and barley are usually sown in the fall and harvested in the spring. Also, in general barley is more drought tolerant than wheat, and two-row barley needs less moisture than the six-row type. Lentil and flax are more likely to be spring or summer irrigated crops.

The four sites share many of the same crops, such as various kinds of wheat and barley, and lentil (Table. 2). It is not possible to compare the archaeobotanical assemblages directly because the archaeological context of the deposits is varied. For three of the sites, most of the seeds come from ordinary settlement debris, and most samples have more wild and weedy seeds than crops. At Godin, however, many of the samples come from burned buildings with concentrations of crop remains. For example, at Godin, lentil would seem to be the most important type, but that may simply reflect the fact that many of the remains were primarily burned stored food, rather than fuel. Is it significant that among the other three sites, only Sharafabad had more than a few lentils relative to other cultivated plants? Given the water requirements of lentil, it suggests spring or summer irrigation was important at both Sharafabad and Godin; Sharafabad is also the only site with flax, another crop that would have been irrigated; note that in earlier times on the Deh Luran plain, Tepe Sabz had large flax seeds indicative of irrigation (Helbaek 1969: 408).

The set of crops recovered from the Iranian sites fits what we know about the environmental and historical conditions. Barley occurs on all four sites, but it is difficult to distinguish many of the archaeological specimens of six-and two-row barley. Both types have straight grains, but in six-row barley, two-thirds of the grains are, in principle, twisted. According to Harlan (1968), when both are grown, six-row barley is more likely to be irrigated than the two-row type. Since irrigation is a lot of work, you might expect the six-row type to be less important in the moister highlands, where rainfall agriculture is more secure, yet all the sites have at least some twisted grains. At Malyan the ratio of twisted to straight grains is approximately 0.5 (50:53). At Godin, whose climate is a bit drier, it is approximately 1.5 (181:96); the Godin material has a relatively high proportion of the six-row type. (In pure six-row barley this ratio would be 2.0.) However, the quantitative data from the lowland

	Sharafabad (Uruk)	Farukhabad (Uruk)	Godin VI:1 (Uruk)	Malyan (Banesh)
No. of samples	N=15	N=8	N=10	N=70
Raw counts				
Wheat	6	8	1460	30
Barley	52	28	440	112
Cereal (indeterminate)	43	34	263	86
Lentil	47	1	5380	4
Wild grass	126	14	279	40
Endemic legume	2	257	22	21
Other wild or weedy	13	74	881	144
TOTAL Cereal	101	70	2163	228
TOTAL Wild or weedy	141	345	1180	205
Ratios Wheat/Barley (no./no.)	0.12	0.29	3.32	0.27
Wild or weedy/ Cereal (no./est. wt., g)	140	493	55	90
% endemic legume in wild or weedy seed assemblage	1%	74%	2%	10%

Table. 2: *Summary of plant remains.**
** cereal counts and estimated: 1 grain ≈ 0.01 g*
(After: *Farukhabad (Miller 1981a), Sharafabad (unpublished laboratory notes), Malyan (Miller 1982), Godin (Miller 1990))*

sites are inadequate to make any further comparisons.

This discussion of crops shows that even a simple catalogue of cultivated plants, considered in an environmental and cultural context, is potentially informative about agriculture and food. But it should be remembered that we are dealing with charred material, food that was consumed.

Fuel Procurement

The most likely material to be put into a fire is fuel, and wood is the most obvious fuel we find in archaeological sites. Fuel is important for domestic cooking and heating, and it is also important for ceramics and metal production. It is not economical to transport wood more than about 50 km or so. Therefore, wood charcoal analysis is the best way to figure out what kinds of trees grew near a site. For example, at about 3000 BC at Malyan, the closest woodland types were pistachio, almond and juniper (Miller 1985). At Farukhabad, the very small quantity of wood reflects its location in the more arid steppe-forest—the charcoal was mostly tamarisk, which is not even a woodland species, but rather one which typically grows along streams and in wet areas.

What about the charred seeds? People do not intentionally burn their food, so in general on sites in the Near East, there is good reason to think most of the seeds found in ordinary occupation debris originated in dung burned as fuel, and that dung provided a cheap and handy alternative to wood fuel (Miller 1984). As at the much earlier Ali Kosh, negligible quantities of wood charcoal relative to burned seeds at Farukhabad and Sharafabad suggest dung must have been used at those lowland sites (Miller 1996).[1] Even in the heart of the Zagros forest zone, pieces of burnt dung were recovered from flotation samples at Malyan and Godin.

With most of the seeds coming from wild plants rather than crops, and from animal fodder instead of human food, charred seed assemblages provide a window onto pasture and grazing. Seed analysis of three sites along the Euphrates River (fourth-second-millennium BC), has demonstrated that the distribution of plant remains across time and space may reflect agricultural practices (Miller 1997). In particular, the proportion of wild seeds to cereals can be used to assess the relative dependence of herding and farming. If the figure is high, it suggests the animals are sent out to graze; that is, they eat more wild plants. If it is low, it suggests that fodder is being grown for the animals. In the dry-farming zone of the Euphrates, that means that as you go from the wetter north to the drier south, the number of wild seeds increases. Along the Euphrates, the wild: cereal ratio was associated with the proportion of sheep and goat relative to cattle and pig. This

[1] I do not have quantitative data from Farukhabad and Sharafabad, which were the first sites I worked on. I did not think to measure flotation charcoal but did note that there was very little.

suggests that the caprines were more likely to be sent out to steppe pasture.

Applying the same reasoning to the Iranian sites gives a useful perspective (Table. 3). If you compare the proportions of the major domestic food animals, the highland and lowland sites show similar proportions of caprines relative to cattle and pig, the seed remains suggest some differences in foddering (Table. 2)[1]. Of the four sites, Farukhabad has the highest amount of wild seeds relative to cereals, which suggests an emphasis on pastoralism over agriculture there. This is fully consistent with what we know about the historic past and environmental conditions—pastoralism has always been important on the Deh Luran plain (Whyte 1977). This point is emphasized if one considers that the most significant category of wild seed is endemic (native) legumes, many of which provide high quality forage (Table. 2); this category includes clover (*Trifolium*) and similar plants (*Trigonella*, some *Astragalus* and others). These seed types were very common at the earlier site of Ali Kosh, at the very beginning of farming and herding. Therefore, the data suggests not only that pastoralism played an important role in the economy of Uruk-period Farukhabad, but that grazing had not yet severely affected the natural vegetation. Based on the lower proportion of endemic legumes, grazing at Sharafabad, and to a lesser extent at Malyan, appears to have occurred on land that had experienced more disturbance. The seed data is insufficient to say whether that disturbance was due to farming or overgrazing, but given the evidence for irrigation at Sharafabad and urbanism at Malyan, field clearance may be the better explanation.

	Sharafabad	Farukhabad	Godin VI:1	Malyan
	(Uruk)	(Uruk)	(Uruk)	(Banesh)
Sheep or goat	1125	327	no data	7761
Cattle	29	12	no data	166
Pig	20	0	no data	0
% Caprine	96%	96%	no data	98%

Table. 3: *Bone counts of sheep, goat, cattle, pig.*
(After: *Farukhabad (Redding 1981; sheep/goat proportions are estimated for the sheep/goat/gazelle category, so the sheep/goat percent is probably an underestimate), Sharafabad (Wright et al. 1981), Malyan (Zeder 1991))*

Interregional Cultural Contact

Seeds can sometimes demonstrate cultural contact between regions. Because plants have specific growth requirements and geographical distributions, it is sometimes possible to identify contact between different regions. I have already mentioned the very early contact between Iran and the west; Hans Helbaek (1969) pointed out that the wild ancestor of emmer wheat is restricted to the Levant and was domesticated there, so the domesticated emmer at Ali Kosh is evidence for the spread of farming cultures to the east. (Plant domestication began in the west and spread east, but animal domestication began in the Zagros and spread west [Hole 1984; Zeder and Hesse 2000].)

Sometimes, plant finds are more likely to be evidence of trade than of the expansion of cultivation. For example, the species of pistachio (*Pistacia vera*) reported by Lorenzo Costantini from fifth-millennium Tepe Yahya (Lamberg Karlovsky and Tosi 1989) is unlikely to have grown there for two reasons. First, Yahya is out of the natural range of the wild type, which is in Central Asia (Zohary 1973). Second, tree culture was in its infancy; orchard production did not become widespread until the third millennium B.C. (Zohary and Spiegel-Roy 1975). Therefore, even though the nuts from cultivated and wild pistachio trees are indistinguishable, the mere presence of *Pistacia vera* at this time and place is best interpreted as evidence for some kind of trade contact between the Iranian plateau and the north.

An example of short-range trade would be the two date pits from second-millennium BC deposits at Malyan (Miller 1982: 190). The closest date-growing region is about 100 km from the site.

Finally, even after the development of agriculture, adoption of new crops may show cultural interaction over a distance. In this case, the

[1] Crabtree (2011) reports the presence of sheep, goat, cattle and some pig; her unpublished data suggested that the Godin residents did not follow a «pastoralist strategy.» Rather, animal husbandry emphasized meat production.

site is Susa and the plant is rice (Miller 1981b). Rice was cultivated as early as the third millennium in the Indus valley. Trade contacts between Harappa and Mesopotamia are, of course, well-documented. But the Susa rice dates to the Parthian period. Rice husk impressions in mudbrick (identified by Richard I. Ford; Robert Wenke pers. comm.) show that the grain was threshed at Susa, and so was cultivated there (see also Nesbitt et al. 2010:322, 325). Perhaps rice could not be successfully grown in Susiana until an advanced irrigation technology and administration was in place. Rice cultivation does not appear to have spread further west until sometime later (Zohary and Hopf 2000).

Conclusion

Iran was both a source of agricultural innovation and a conduit through which plants moved. I hope this brief survey has shown how archaeobotanical analysis can inform and deepen our understanding of ancient culture in Iran. The analysis of seeds and charcoal gives an insight into ancient land use practices and also allow us to trace cultural contacts across regions and time periods. I only wish my examples had been more definitive. Although this paper has emphasized charred plant remains as direct evidence for crops and other plants that grew near a site, our understanding of ancient life will advance faster as we begin to integrate different kinds of archaeobiological evidence, from molecular residues and DNA, to microscopic phytolith and starch, to even larger archaeobiological remains: seeds, wood, and bones. Iran's central location in Eurasia makes it one of the most fascinating areas in the Old World to study ancient economies.

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