Yemen has a long and rich history, stretching back millennia, but it is still terra incognita to most people. There is no other part of the Arabian Peninsula as rich in heritage, including architecture, irrigation works, inscriptions and a vital tradition of poetry, proverbs, music, dance and intellectual writing.

*Yemen Update Redux* is dedicated to providing a variety of past writing and images about Yemen's heritage. This includes selections from the earlier print edition of *Yemen Update* and other brief writings on Yemen and its people. Yemen's past lives on no matter the turmoil of the present.

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Archaeological research to date has taken only small strides toward writing a prehistory of Yemeni agriculture. Several current American projects are addressing this subject; one is Dr. Jay McCorriston’s work in Hadhramaut, and another is the Oriental Institute’s Dhamar Survey in the western highlands. The latter project, initiated in 1994 by McGuire Gibson and Tony Wilkinson, has the basic objective of tracing the development of the terracing that so distinguishes Yemen’s mountain landscape. In its six seasons of work to date, the project has developed a chronology for the area, investigated landscape and climate change over the past 10,000 years, addressed specific problems for the Bronze Age 1 (roughly speaking, 3000-1000 BC), the Iron Age and the Himyarite periods, and recorded South Arabian inscriptions and graffiti, among other topics. In 2001 the authors undertook, as part of this continuing project, excavations at two Bronze Age sites in Dhamar. For the first time in the project, the excavations systematically searched for prehistoric botanical remains, in order to gain information about Bronze Age crops. The following report summarizes the results of work still in progress.

Excavation of Bronze Age Sites in Dhamar, 2001

Extensive excavation at Hammat al-Qa’ (DS 101; see Wilkinson and Edens, Edens et al. for previous work at this important site) was the original intention of the Bronze Age program in 2001. When unsafe conditions in the local area made this plan impossible, the program selected two alternative sites for excavation, sites that promised to help fill several gaps in information about the Bronze Age and that also are under threat of destruction.

Hayt al-Suad (DS 324)

This site, first recorded during the 2001 survey season, is located at the eastern edge of Qa’-Jahran. The site covers around 3 ha. on the rising western slope of a volcanic hill that culminates in an abrupt drop on its other three sides. Architecture of several different kinds and dates form clusters up the slope. The architecture across the mid-slope includes rectilinear buildings constructed of large rough stones stacked in courses or laid on edge. Despite presenting features strongly reminiscent of Bronze Age assemblages, the pottery on the surface around these buildings and in nearby ash middens did not fit comfortably with known pottery groups elsewhere in Dhamar. Since basic systematics—chronology and spatial variability—are still a high priority in the project, the site seemed worth investigation.

Recent stone quarrying and associated activities have severely damaged portions of the site through the mid-slope. Here a long quarry cut provided a roughly 30 m. long section through archaeological deposits and into volcanic bedrock. The quarry cut sectioned at least two different architectural units, to the south a building constructed of massive stones, and to the north a wall of more modestly sized stones. After cleaning and drawing these portions of the sections, test excavations made small exposures in each area of architecture visible in the quarry section.

The north sounding (a triangular excavation 2.6 x 2.7 x 3.6 m. in area) exposed the corner of a building...
or room formed by two unbonded walls built of relatively small stones (generally 30-60 cm. long, 40 cm. wide, and 10-25 cm. high) set in rough courses above bedrock and preserved 1-1.2 m. high. Changes in appearance part way up both walls suggested that the original structure had been rebuilt at some point during its use; the lower (original) and upper (rebuilding) portions of the walls, together with associated soils, define two phases of occupation. An ashy compacted earth resting directly upon the bedrock represented the accumulating 'floor' of the room (?) defined by these walls. A broken cooking jar lay at the bottom of the floor deposit, directly on bedrock. Ashy soil and stone fall separated the latter floor deposit from looser ash deposits that belong to the second, rebuilt phase of the walls. A flimsy cross-wall also belongs to this upper phase.

The south sounding (a rectangular excavation 3.5 x 4.5 m. in area) uncovered a much more substantial structure, the southeast corner of a room the walls of which were constructed of stones up to 1.4 m. long, 1 m. wide and 40 cm. high; these walls still stand 2 m. high (figs. 1 - 2). These walls were erected upon bedrock, which had been cut down inside the room to a depth of 20-40 cm., leaving the walls on a sort of plinth (visible in figs. 2 and 3). The floor of the room, separated from bedrock by a thin band of compact soil, was a plastered surface well-preserved in some parts of the room but eroded in others. The plaster had been renewed at least twice, with a fine ashy silt separating each plaster surface. The room contained several installations: a round bedrock mortar cut into the floor against the east wall; a bin of vertical stone slabs set in the corner of the room; and a pair of plaster-lined circular installations/ovens arranged across the room from the south wall into the north section, with traces of a smaller third plaster installation between them, all built into the plastered floor. A very large grinding stone lay next to the southern oven. Ashy sediment on the floor and around these installations represent occupation debris, which provided relatively small samples of pottery, charred seeds, animal bones, and small finds. A stony silty soil and sloping deposits of rock fall covered the occupation deposit.

Charcoal samples taken from two different components of the occupation debris over the floor in the south sounding returned identical radiocarbon dates that place the building and its contents in the second quarter of the 3rd millennium BC (Table 1; location of dated samples shown in fig. 3). This date matches the oldest dates obtained for Bronze Age settlements in Dhamar and Khawlan (see Edens 1999: 107 for a summary of Bronze Age dating evidence).

**Jubabat al-Juruf (DS 269)**

Jubabat al-Juruf, recorded during survey in 1998, lies at the eastern edge of the plain around Jabal al-Isi east of Dhamar, on a broad spur that rises gently from the west before dropping off abruptly to the south, east and northeast. The small caves and narrow rock
shelters that give the site its name occur mostly along
the base of the cliff-like southern edge of the spur.
South Arabian graffiti and rock art (mostly depictions
of caprins and camels) appear in numerous locations
around the southeastern and eastern edges of the spur,
and additional material exists on other rock faces in
the vicinity. Modern agricultural terracing, related
stone walls, several buildings, and earthmoving by
bulldozers have obscured the size and boundaries of
the Bronze Age site; the surface architecture remains
relatively intact and visible only in a few areas. Bronze
Age sites in Dhamar are typically very shallow, but
this site held the promise of a deeper accumulation.
A deep hole dug by a treasure-seeker revealed 1.4 m.
of cultural deposits immediately adjacent to a well-
preserved Bronze Age house. This site, therefore,
seemed to offer the prospect of obtaining a stratified
sequence, despite the heavy surface disturbances.

The sounding, a 7x7 m. square, encompassed the
eastern end of the house near the looter’s pit and the
unbuilt space the north of the building (fig. 4). The
house belonged to a standard highland Bronze Age type:
a rectangular structure 3.2-3.4 m. wide and running
at least 14 m. in length (the arrangement of its western
end is not clear) with one and perhaps two cross-
walls dividing the interior space into rooms, and a
doorway framed by a pair of massive stones set on
end within the long north wall. Two additional walls
extend from the short east wall of the building, one
wall running perpendicular to the east wall, and the
other running obliquely from the building’s northeast
corner.

The remains of the main building within the
excavation area proved to be relatively shallow, its
walls constructed as a single line of stone slabs laid
vertically around the edge of a shallow pit. A dense
concentration of small stones, seemingly deliberately
laid, but only intermittently preserved, formed the
room’s floor, 55 cm. below the modern surface. A
bench of flat-laid stones, about 1.2 m. long and 25
cm. high, lay against the south wall; a large pottery jar
was set at one end of this bench. The doorway in the
north wall was fitted with a single flat stone as a
threshold, set 5 cm. below the modern surface, with
rough stairs of three low treads leading down into
the interior of the building. The position of the threshold
suggests that the building had been constructed from
a surface approximately the same as the modern one,
while the nature of the walls, the position of the floor,
and the absence of exterior entry stairs all imply that
the construction of the building was semi-subterranean.
The same construction is also evident in the houses at
other Bronze Age sites (e.g. de Maigret 1990,
Wilkinson and Edens 1999).

The oblique wall off the corner of the house bordered
a pavement of stone slabs 20 cm. below the modern
surface; the pavement was exposed only at the eastern edge of the sounding (fig. 4). The
pavement is clearly related to the oblique wall, but
the temporal relationship between the oblique wall
and the house remains uncertain.

The house, as well as the oblique wall and its
pavement, had been constructed upon and into the
upper layers of stratified deposits that were 2 m. thick
(fig. 5). The upper meter of these deposits consisted
of almost horizontally bedded ashy sediments that
included large amounts of stone and rubble, which
often gave the appearance of accumulations on
temporary surfaces. A small structure, roughly
rectangular in shape, 2 m. on one side and the other
side running 70 cm. before disappearing into the
section, appeared immediately below the floor of the
house, in the lower portions of the horizontal ashy
sediments (see figs. 4-5). The walls of this structure
were oriented parallel to the walls of the upper building,
and were preserved to a height of only 30 cm. Small
stones and plaster patches marked the small structure’s
floor, upon which was a soft gray soil distinctive from
the compact ashy sediments outside the small structure.
The small structure appears to have been a
construction not associated with, and older than, the
upper building. Although the floor of the upper building
could not be traced across the lower structure, the
location of the small structure with respect to the upper
building (in the center of the upper building, adjacent
to the doorway), would make a functional connection
between the two structures awkward and unlikely (e.g.
the small structure serving as a storage bin within the
upper building). More extensive exposure of both
structures is needed to decide this question.

The lower meter of deposits, exposed in a limited
area outside the house, was much more complex than
the upper meter (fig. 5, cf. fig. 4); it contained a circular
stone-lined bin or hearth similar to structures recorded
at other Bronze Age sites (de Maigret 1990, Wilkinson
et al. 1997), several small pits dug into existing ashy
and earthy deposits, and a wide shallow pit (well over 2m across but only 65 cm. deep). The bottom half of the latter pit contained four sets of alternating plastered surfaces and ashy soil, each set around 5-10 cm. thick; the ashy soil contained numerous charred seeds and other botanical remains. The function of the pit is unclear (a storage function seems unlikely because of the pit's shape).

Four radiocarbon dates coherently anchor this sequence in time (Table 2; see fig. 5 for stratigraphic location of two dates). The two oldest dates represent charcoal samples taken from a sediment into which the large pit was dug (Locus 3-34, 1.4 m. below the modern surface) and from the sediment that accumulated above this same large pit (Locus 3-24, 1.3 m. below the modern surface). The two dates (Beta-167970 and Beta-167969) present a slight chronological inversion, but are virtually identical; both refer to the final three centuries of the 4th millennium BC. The large pit, and the rich botanical samples it contains, must be assigned a similar date. The next date in the stratigraphic sequence is from Locus 18, a sediment unit immediately outside the small structure beneath the house, .8 m. below the modern surface; this date (Beta-167967) refers to the second quarter of the 3rd millennium. The fourth date comes from the sediment (Locus 3-6) immediately above a surface-like accumulation of stones, .6 m. below the modern surface; the date (Beta-167968) falls in the third quarter of the 3rd millennium. The house at the top of this sequence is not radiocarbon dated (a sample submitted for dating proved to be unusable). The pottery from the house and from the site's surface, however, bears a strong resemblance to pottery from Khurayb (DS 228), which has been assigned to the second half of the second millennium BC. In other words, the 2 m. of stratified deposits at Jubabat al-Juruf represent at least 800 years, and perhaps as much as two thousand years, of accumulation. The earliest dates at Jubabat al-Juruf are the oldest yet obtained for a Bronze Age site in Dhamar, and are matched only by a set of dates from the Radman area (Ghaleb 1990).
General Results

The excavation results confirm that the highland Bronze Age patterns of architecture and pottery use were firmly in place already by the final quarter of the 4th millennium BC; analysis of the botanical samples reported below also confirm agriculture by the same time. In this respect, Yemen now matches southeast Arabia, where agriculture and, hesitantly, pottery use also appeared near the end of the 4th millennium BC (see Cleuziou and Tosi 1989 for late 4th millennium developments in southeast Arabia). The pottery and other finds from these excavations will be published in detail elsewhere, and the following passages merely highlight the more significant aspects before turning to the botanical remains.

Pottery use seems well established at both sites, so the technological transition, and the social changes correlated with it, between aceramic and ceramic highland cultures must be sought in the mid-4th millennium. The pottery at Jubabat al-Jurf shows significant formal and decorative changes through the sequence. Pottery at the top of the sequence bears a resemblance to the Khurayb assemblage, but pottery from the mid-upper sections of the sequence is distinct from the coeval assemblages at Sibal, a mere 10 km. away, and at the more distant Hayt al-Suad. The pottery from the latter site includes several examples of simple designs executed in dull red paint, the first examples of painted decoration found in Dhamar. These observations show that sub-regional stylistic variation in Bronze Age material culture was already well established by the middle of the 3rd millennium, and probably earlier.

Both sites produced samples of beads and other ornaments. Carnelian was a favored material for the small (on the order of a half centimeter across) flat disc beads found at both sites, and was also used for a pendant from Jubabat al-Jurf. The use of carnelian is hardly surprising, given that carnelian is relatively common in the volcanic landscape (the famous ‘Ans sources of carnelian are only 60 km. away), and that carnelian beads are occasionally reported from neolithic and BA sites in the western highlands. More significant is the recovery in the deeper levels at Jubabat al-Jurf of production debris—small nodules and flakes of carnelian plus several chipped roughouts of beads that split during drilling and before polishing. The Jubabat al-Jurf production evidence is too scant to qualify as workshop debris, but it does mark the first documentation of craft activity within a highland Bronze Age settlement.

The other common small find at both sites are ‘microbeads’—short tubes 2-3 mm. across and 2 mm. high, made from an unidentified white material apparently by cutting a longer tube into sections. Similar beads, made from a white composite material, perhaps baked chlorite, are recently reported from early 3rd millennium BC tombs at Jabal Jidran north of Marib (Braemer et al. 2001:34), and these microbeads are extremely common in 3rd millennium
tombs in the Emirates and Oman, where the material is variously identified as serpentinite (Benton 1996:113) or talcose steatite (Friifelt 1991:114). The strong formal and technological similarity between the Yemeni and southeast Arabian beads adds to the slowly growing evidence for early links across southern Arabia (e.g. Newton and Zarins 2001, Vogt 1999).

A fragmentary stone ring found at Jububat al-Junuf also deserves comment. The ring, estimated to have been about 3 cm. across, with a flat bottom, gently curved vertical outer face, and narrow rounded top, is similar to somewhat larger rings made of siliceous stones, marble or quartzite found in several neolithic sites of Yemen (Kallweit 1996, Fedele 1986, diMario 1989). The Jububat al-Junuf example suggests that these rings—previously thought to be an exclusively neolithic product—continued to be used into the early phases of the Bronze Age.

Metals continue to be elusive in Bronze Age residential sites. Hayt al-Suad provided a fragment of a square-sectioned copper awl, found on the surface of the ash-midden at the northern edge of the site. Although similar to a piece attributed a Bronze Age date in Khawlan (de Maigret 1990: 22, fig. 83a), this surface find cannot definitively be assigned a Bronze Age date. Jububat al-Junuf provided two pieces of metal, both from uncertain contexts, one a bit of sheet copper found just below the modern surface, and the other a small corroded lump from an animal burrow. None of these finds contribute to the still scant evidence of metal-work in prehistoric Yemen.

**Early Agriculture in Dhamar**

One frequently remarked feature of the archaeological record of the Arabian peninsula, including Yemen, is the scarcity of charred seeds and other plant parts in archaeological sediments. Prior efforts to recover botanical samples in Dhamar had been rudimentary, and failed. The shallow deposits that are characteristic of Bronze Age sites in the highlands probably discourage the preservation of charred plant remains at most sites in the region. Hayt al-Suad and Jububat al-Junuf are unusual for their deep deposits, and the richness of the botanical samples from these settlements seems also to be unusual. There are over 1400 charred plant remains from Hayt al-Suad; the sample of 82 specimens from Jububat al-Junuf presented here is but a tiny fraction of the total sample from this site. The samples were recovered using a Siraf-type flotation system, the light fraction collected in 500 µm and 250 µm sieves. Flotation samples were taken systematically from recognized stratigraphic units, with supplemental samples also taken from potentially rich contexts.

**Crop plants**

Domesticated cereals and legumes represent the crop plants. Among the cereals, barley (Hordeum vulgare) predominates, with several kinds of wheat (Triticum durum/aestivum, T. monococcum) also appearing. In the sample analyzed to date, barley outnumbers the wheats by a ratio of over 6:1 at Hayt al-Suad but is close to 1:1 in the much smaller analyzed sample from Jububat al-Junuf. Panic grass appears in Jububat al-Junuf sample, several examples of which appear to be broomcorn millet (Panicum miliaceum). The samples also contain a large amount of other cereal plant parts, including Rachis that can be identified to genus; here the barley predominates even more strongly.

The domesticated legumes are represented by the common lentil (Lens culinaris) along with specimens of several kinds of pea (Pisum sp., and Lathyrus or Vicia sp.), and chickpea (Cicer arrietinum), plus a substantial number of fragmentary large legume fragments.

**Wild plants**

Wild or probably wild plants are far more abundant, but much less identifiable to genus or species than are the domesticates. The most frequent are small legumes; one unidentified species accounts for nearly 90% of this group, and a probable Medicago sp., a Trigonella-type (i.e. the genus that includes fenugreek), and an Astragalus-type also occur. Wild grasses are also common, with at least four different forms being distinguishable, among them a Phalaris-like type (accounting for two-thirds of this sample) and a Setaria-type; panic grasses may also occur (see n. 8). Carex sp., a grass-like rhizomatous herb of the Cyperaceae family, probably also occurs. Four different types of Compositae form another significant contribution to the sample.

At least eight families of other herbs and shrubs
make less frequent contributions to the sample, among them Ranunculaceae (Ranunculus), Amaranthaceae (Amaranthus), Chenopodiaceae (Chenopodium), Caryophyllaceae (Silene and Gypsophila), Polygonaceae (two types of Polygonum, Rumex), Malvaceae (Malva), Boraginaceae (Alkanna and Arnebia), and Plantaginaceae (Plantago). Some of these plants were probably collected for human consumption or for animal fodder, while others may have been valued for medicinal or other qualities.

Several fruits—fig (Ficus) and eleven specimens tentatively identified pear (Pyrus)—along with fragments of unidentified nut shells, also appear. Edible wild species of fig exist in southwest Arabia, but pear is not indigenous to the region and its appearance here at such an early date would, if confirmed, make a significant contribution to the history of the species.

Discussion

These first results from the ongoing botanical analysis of the Dhamar samples bear important similarities with, and obvious difference from, the sample of plant impressions in Bronze Age pottery from Khawlan and Hada (Costantini 1990). In both sets of samples, barley and wheat provide the majority of domesticated cereals, although with somewhat different species identification. Broomborn millet, if these are not in fact a wild panic grass, makes a minor appearance in both areas. The Dhamar samples, however, lack the oats (Avena sp., several wild species of which are indigenous to Yemen; Wood 1997:350) and, more importantly, the sorghum (Sorghum bicolor) identified in the Khawlan samples.

In other respects the two sample sets differ significantly, hardly surprising given the differences in sample sizes (120 impressions in pottery from Khawlan, around 1500 charred plant remains in Dhamar). The Khawlan samples lack entirely the domesticated and wild legumes, the variety of wild grasses (Tragus (Cenchrus) racemosus is identified in Khawlan but not in Dhamar) and the other plant families that are so important in the Dhamar samples. The Dhamar samples are missing the date palm (Phoenix dactylifera) stones that appear twice in Khawlan, but this difference is not surprising because the date palm does not thrive in Dhamar's altitude and winter cold. The Dhamar samples are also missing the cumin (Cuminum cyminum) that figures as a minor element in the Khawlan sample.

The Dhamar Survey had in previous seasons made significant discoveries pertaining to early agriculture in the Yemeni highlands. Terrace construction for agriculture appears to have a deep history in southwest Arabia. A correlation in space between remnant terraces and Bronze Age settlements, and the extremely eroded condition of these terraces, strongly suggests that terracing was a regular feature of Bronze Age agriculture in Dhamar (Wilkinson and Edens 1999:5). A radiocarbon assay on charcoal from a soil associated with a terrace buried under six meters of silt in the valley floor near Seddah-Dhra' indicates that terracing may have begun by early in the 4th millennium BC (Wilkinson 1999). Elsewhere, Kallweit (1996:166) reports relic terraces in Wadi Dhahr, immediately north of Sana'a, of probable Bronze Age date.

The new archæobotanical results from Dhamar add to the previous Khawlan evidence to give a clearer picture of the crops grown on these terraces. Quite clearly agriculture depended on a typically Near Eastern suite of crops—6-row barley, bread wheat, lentils, and other legumes—which was introduced to the Yemeni highlands by the last quarter of the 4th millennium BC. In addition to growing these crops, Bronze Age communities also collected a wide variety of wild plants, including figs, nuts, wild legumes, grasses and grass-like herbs. The high barley: wheat ratio found in both the Dhamar and the Khawlan samples is a feature of the traditional crop suite in Yemen, as a response to risk; barley is preferred over wheat under conditions of relatively low rainfall and high inter-annual variability of rainfall; barley is also more cold-tolerant than wheat, an important consideration for a winter crop in the highlands.

The scarcity of identified sorghum, relative to barley and wheat in Khawlan, and sorghum's absence from the Dhamar samples, strongly suggest that if sorghum did in fact have a place in Bronze Age agriculture in the Yemeni highlands, it was not yet the principle crop that it later became. Based on his sorghum identification, Costantini (1990:199) raised the possibility of Bronze Age farmers growing two crops a year. With sorghum at best a minor crop, however, barley and wheat were surely the major
summer crops, to take advantage of spring and late
summer rains; indeed, barley and wheat may not have
been grown over the winter which, in the traditional
highland agricultural system, is a minor and usually
"wet-year" season. In other words, the traditional crop
preferences and schedule of the western highlands
had not yet taken shape by the end of the 3rd
millennium BC.

The absence of sorghum in the Dhamar samples
analyzed so far may also have wider implications. The
early history of sorghum cultivation and domestication
remain shrouded in uncertainty. The species has an
African origin, and communities in northeast Africa
consumed wild sorghum as long ago as 8500 bc. But
the earliest evidence of domesticated sorghum in Africa
is only two thousand years old, whereas domesticated
sorghum is known from sites in northwest India and
Pakistan from around 2000 BC. In the latter area,
moreover, two other African crops also make an early
appearance, finger millet during the second half of the
3rd millennium BC, and pearl millet by around 2000
BC (see Meadow 1996:399-401; Weber 1998). In
addition, early domesticated sorghum is reported from
two locations in southern Arabia, at Hili 8 (Abu Dhabi)
in late 4th millennium and mid-3rd millennium BC
contexts (Cleuziou and Costantini 1980, 1982), and
at two sites in Khawlan (Yemen) dated to the second
half of the 3rd millennium BC. Many pre-historians
argue for the transmission of sorghum, and of finger
millet and pearl millet, from northeast Africa across
southern Arabia and into the Indian subcontinent
during the 3rd and early 2nd millennia (e.g. Meadow 1996,
Weber 1998, Tosi 1986). In this scenario, the
morphological changes of domestication did not occur
until sorghum was introduced to non-native regions
such as Yemen during the 4th-3rd millennium BC (e.g.
Haaland 1996). Other observers, however, suggest
that many identifications of these African crops in
Arabia and the Indian peninsula are in fact mistaken,
and point out that sorghum does not appear in the
growing number of archaeological samples from
eastern Arabia, and that neither pearl millet nor finger
millet are reported from anywhere in prehistoric
Arabia. In other words, the question is not settled.

The failure, thus far, to identify sorghum in Dhamar
despite the rich samples of charred plant remains,
poses a problem. There are several possibilities to
consider.

1. since the Dhamar samples are older than the
Khawlan evidence (late 4th millennium to mid-3rd
millennium versus second half of the 3rd millennium
BC), the evidence might be taken at face value as
recording the arrival of sorghum in the Yemeni
highlands around the middle of the 3rd millennium; or,

2. Costantini's sorghum identifications may in fact
be incorrect, and the species may not have been
present at all in the western highlands of Yemen during
the 3rd millennium BC.

In either case, of course, sorghum and the two
African millets may have been present along the coast,
where topographic difficulties make bleak the prospect
of recovering prehistoric botanical samples, except
perhaps from deep shell middens. Only considerably
more research, and re-examination of the Khawlan
impressions, can settle these questions.

Notes

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Naomi Miller for advice on plant identifications.

2. The “Bronze Age” is a purely conventional term in
Yemen, and one fraught with ambiguity; very few metals are
reported from “Bronze” Age sites, and the culture complex
found along the coast around Aden and in Zabara extended
well into the 1st millennium, i.e. overlapped significantly with
the “Iron Age” as identified in other parts of Yemen.

3. Among the project's publications are the following:
field reports, Gibson and Wilkinson 1995, Wilkinson
et al. 1997, Wilkinson and Edens 1999; landscape, climate
change, and early terracing, Wilkinson 1997, 1999; Bronze
Age pottery and settlement, Edens 1999, Edens et al. 2000; 

4. Mr. Jamal Thabit recorded and photographed several
dozen of these inscriptions on behalf of GOAM. Among the
graffiti are several executed in the cursive script that normally
was used for inscribed sticks; de Maigret (1986) reports a
similar site at Gahub al-Harib, north of Jabal al-As. Their
archaeological characteristics place most if not all the graffiti
in the last half millennium of the South Arabian civilization; the corresponding settlement has not been located.

5. This dating for the Khuray pottery is based on two of the four radiocarbon dates available from the site. These two dates are from contexts containing the pottery characteristic of the site. The other two radiocarbon dates from Khuray are far older, and match the range now obtained from Jabhat al-Jurf. But the pottery through most of the stratigraphic sequence at Jabhat al-Jurf is distinct from the Khuray assemblage, an observation that appears to confirm the interpretation that the two older Khuray dates refer to earlier occupation at that site (less than 5 km separates the two sites, and intraregional variation seems an unlikely explanation of the ceramic differences; see Edens 1999 for details).

6. Various alternative interpretations may be offered the scarcity of archaeological remains across Arabia (e.g. Nesbitt 1993, Willeco and Tengberg 1995; see also Young and Thompson 1999), among them the practices of the communities responsible for the archaeological record (e.g. consumption of relatively little plant material, processing plants in ways not conducive to charring, processing plant at locations distant from settlements, routine disposal of refuse outside of settlements), depositional factors (e.g. extremely slow deposition rates that allowed charred plant remains to break down before burial), and post-depositional factors (e.g. destruction as salt and gypsum crystals formed in charred plant remains, due to high evaporation rates).

7. The seeds seem identical to specimens from Khawlan that Costantini (1990) identifies as Panicum cf. milletes. However, several wild species of Panicum occur in Yemen, and Costantini hedges his identification; the identification of this species at Jabhat al-Jurf is therefore provisional, and they may prove to be wild panic grass(es). P. milletes is a domesticate thought to be of (East) Asian origin.

8. Chenopods and amaranths made important contributions to prehistoric diets in many parts of the world, and two species of Amaranthus were once cultivated in Yemen (Wood 1997: 87); Malva parviflora is still used today to make the slimy but delicious dish madukh, ya (Varisco 1982: 490).


10. 2-row barley appears in Khawlan and not Dhamar, but 6-row barley is the most common form in both areas; emmer is as frequent as hard/bread wheat, and einkorn is not reported, in Khawlan, whereas in Dhamar hard/bread wheat is the most common wheat, emmer absent, and einkorn makes a hesitant appearance.

11. A hedging of bets is required for the absence of sorghum from the Dhamar samples. All these samples include vesicular cereal fragments, some of which (particularly those from Hayt al-Sud) have a very “glossy” appearance. Experimental charring of modern sorghum at high temperatures shows that sorghum chars to a very “glossy” appearance, presumably a consequence of its high starch content. Further work on this identification problem may clarify the question.

12. Costantini reports as Sorghum sp. four grain impressions from two sites dated to the later centuries of the 3rd millennium BC. Although entertaining no explicit reservation about his identification, Costantini (1990: 193, 195) does state that two of the impressions are unusually large and refers to a third impression as “cf. Sorghum sp.”

Bibliography


Table 1: Radiocarbon Dates from Hayt al-Suad*

<table>
<thead>
<tr>
<th>Lab#</th>
<th>Context</th>
<th>Radiocarbon Age</th>
<th>2-Sigma Calibration</th>
<th>Probability Distribution within 2-Sigma Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta-156626</td>
<td>HS-S 15</td>
<td>4110 +/- 40 bp</td>
<td>2870-2470 calBC</td>
<td>.19 2870-2810 calBC .69 2760-2560 calBC</td>
</tr>
<tr>
<td>Beta-156625</td>
<td>HS-S 18</td>
<td>4110 +/- 40 bp</td>
<td>2870-2470 calBC</td>
<td>.19 2870-2810 calBC .69 2760-2560 calBC</td>
</tr>
</tbody>
</table>

*Radiocarbon age corrected for isotopic fractionation; calendrical calibration according to CALIB 3.0.3, rounded to the nearest decade.

Table 2: Radiocarbon Dates from Jubabat al-Juruf*

<table>
<thead>
<tr>
<th>Lab #</th>
<th>Context</th>
<th>Radiocarbon Age</th>
<th>2-Sigma Calibration</th>
<th>Probability Distribution within 2-Sigma Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta-167968</td>
<td>Loc. 3-6</td>
<td>3940 +/- 70 bp</td>
<td>2620-2200 calBC</td>
<td>.98 2580-2200 calBC</td>
</tr>
<tr>
<td>Beta-167967</td>
<td>Loc. 1-18</td>
<td>4120 +/- 40 bp</td>
<td>2880-2490 calBC</td>
<td>.21 2870-2810 calBC .68 2760-2570 calBC</td>
</tr>
<tr>
<td>Beta-167969</td>
<td>Loc. 3-24</td>
<td>4490 +/- 50 bp</td>
<td>3360-2920 calBC</td>
<td>.95 3350-3020 calBC</td>
</tr>
<tr>
<td>Beta-167970</td>
<td>Loc. 3-34</td>
<td>4470 +/- 40 bp</td>
<td>3350-2920 calBC</td>
<td>.94 3340-3010 calBC</td>
</tr>
</tbody>
</table>

* Radiocarbon age corrected for isotopic fractionation; calendrical calibration according to CALIB 3.0.3, rounded to the nearest decade.
Table 3: Identification of Charred Plant Remains from Dhamar

<table>
<thead>
<tr>
<th>Crop Plants:</th>
<th>Hayt al-Suad</th>
<th>Jubabat al-Juruf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hordeum vulgare</td>
<td>44</td>
<td>3</td>
</tr>
<tr>
<td>Triticum durum/aestivum</td>
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<td>0</td>
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<tr>
<td>Triticum monococcum</td>
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<tr>
<td>Triticum sp.</td>
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<td>2</td>
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<td>Panicum miliaceum</td>
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<td>2</td>
</tr>
<tr>
<td>cf. Panicum</td>
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<td>6</td>
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<tr>
<td>Lens culinaris</td>
<td>44</td>
<td>6</td>
</tr>
<tr>
<td>Lathyrus/Vicia</td>
<td>2</td>
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<td>Cicer arietinum</td>
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<td>Pisum</td>
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<tr>
<td>large legume frag.</td>
<td>149</td>
<td>40</td>
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<td>indet. cereal caryopsis</td>
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<td>Hordeum rachis</td>
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<td>Triticum rachis</td>
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<tr>
<td>indet. cereal rachis</td>
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<td>spikelet fork</td>
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<tr>
<td>indet. Graminae part</td>
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<table>
<thead>
<tr>
<th>Wild Plants:</th>
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<tr>
<td>Small Legumes</td>
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<td>Trigonella type</td>
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