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Archaeobotanical evidence for early Dilmun diet at Saar, Bahrain

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A flotation machine was used to process large quantities of earth at the Saar excavation in the 1990 and 1991 seasons. Carbonised seeds and charcoal were recovered from a wide range of contexts dating to about 1900 BC. While overall quantities were low, enough contexts were productive to allow quantification. Date stones were the most frequent crop remains, with smaller amounts of free-threshing wheat and hulled six-row barley. This confirms evidence from other sources (textual, dental) for the importance of dates as a staple food in the Early Dilmun period. A survey of ethnographic and archaeological evidence for date husbandry in Bahrain suggests that the date-palms and cereals were grown in irrigated date gardens similar to those found today.

Since the 1960s there has been a remarkable increase in archaeological activity in the Arabian Gulf, but this has rarely been accompanied by systematic recovery of plant remains or bones. Lorenzo Costantini's studies on imprints and some flotation samples in the southern Arabian peninsula, and the beginning of flotation at Failaka in Kuwait in 1988 are the only systematic attempts at recovering plant remains so far. A large-scale programme of dry-sieving and machine flotation was therefore a high priority from the first season at Saar in 1990 onwards. Very large quantities of bone and shell have also been recovered. The amount of charred seeds and charcoal is small but represents the only substantial data on Dilmun plant foods and environment to be studied since the discovery of this civilisation, some 30 years ago.

The excavations at Saar of the London-Bahrain Archaeological Expedition are directed by Robert Killick, Jane Moon and Harriet Crawford. The site lies in the northwest part of the island, bounded to the north by the houses and date gardens of Saar village, and to the south and west by a large area of Early Dilmun burial mounds (1).

Recovery

The rainy winters of Bahrain are sufficient to ensure that desiccated ancient material does not generally survive. All the plant remains found are charred, although some pieces of charcoal appear silicified. As no burnt destruction levels have been found at Saar, most of the charred material came from the flotation of contexts containing dispersed, redeposited plant remains. Without flotation, the only plant remains to have been recovered would have been a few date stones and fragments of charcoal from the dry-sieving; all the cereal grains and nearly all the charcoal came from flotation.

A Siraf-type flotation machine (2) was used. As all water had to be tanked into the site, a recycling system was used for the machine. The outflow passed into two settling tanks, with a pump taking water from the second tank back into the flotation machine. This recycling worked very well, with use of water restricted to cleaning out and refilling the flotation drum after every 220–240 litres of soil had been processed. The opportunity was taken to completely clean and refill the drum and settling tanks every time the water tanker came (*c.* every 5 days), but this could have been done much less frequently if water had been in short supply. Given that all the samples were of the same period, it was not felt necessary to empty and clean the drum between each sample. Cross-contamination because of the water recycling also appeared minimal. Although some tiny fragments of charred material passed through the sieves into the recycling tanks, these formed a scum on the surface, well above the level of the pump inlet. In any case, I doubt whether wet carbon would survive passage through a pump.

In the 1990 season a single, 0.41 mm mesh sieve was used. In 1991 I tried using a 1 mm sieve above a 0.3 mm sieve. This is the standard used at most Near Eastern sites, but at Saar the silt in the deposits quickly blocked the smaller mesh. A 0.41 mm mesh was then used instead of the 0.3 mm sieve. While this combination worked well, examination of some of the 0.41 mm mesh fractions from the more productive samples found no identifiable charred remains. While examination of all these samples might have produced one or two weed seeds, it was obvious that at this site virtually all the charred material was confined to the 1 mm mesh. The decision was therefore taken to discard all the 0.41 mm meshes where a pair of 1 mm and 0.41 mm sieves had been used and concentrate efforts on the 1 mm samples.

Sampling

In 1990 the flotation machine was operated by Rebecca Montague. Sampling was mainly restricted to deposits thought to be of ashy or burnt appearance. I briefly examined the 1990 material to see if there were any significant differences to the 1991 samples, on which analysis was concentrated. Table 1 shows total amounts of carbon in the 1990 samples (measured to 0.1 g accuracy only). The main feature of interest is two large samples of charcoal, but otherwise the material is comparable to that recovered in 1991.

In 1991 a much wider range of deposits was sampled, but with some variation in selection criteria between trenches. The sampling policy used has worked successfully at other Near Eastern sites. Essentially, at least a part of all deposits were floated, but with the partial exception of collapse debris. In all, nearly 7,000 litres of soil were floated in the 1990–91 season from 82 distinct contexts.

All the samples come from deposits with Early Dilmun Barbar ware, very similar to Period 1 pottery at Failaka and thus dated to about 1900 BC (3).

Table 2 shows the weights of the different types of charred material, listed by unit. Where a number of samples were taken from one feature ("unit"), scores have been amalgamated from all the productive samples within that feature.

At Saar most of the soil excavated is in fact collapsed walls covered in wind-blown sand. Of the 25 contexts sampled that could be classed by the trench supervisor as collapse, or deliberate make-up (i.e. dumping of near-sterile material to level floors and such-like), both shown as "rubble" in Table 3, only five contained any charred material, and the quantities are (unsurprisingly) very small. Sampling of this context type was therefore ended.

Table 1. Saar 1990: charred plant remains. Data from all 1990 samples containing 0.4 g or more charred material. Total weights to an accuracy of 0.1 g only. Relative abundance of different materials ranked within samples from + (least abundant) to +++ (most abundant).

Square	Unit	Object	Unit description	Quantity (litres)	Dates	Charcoal	Indet. material	Total weight	g carbon litre ×1000
E18	009	001	Occupation deposits	50	+	+++		3.1	62
E18	020	001	Occupation deposits	50		+++		1.3	26
F17	026	007	Occupation deposits	16	+	+		0.4	25
F18	029	006	Occupation deposits	50	+	+++	+	1	20
F18	050	001	Floor	50	+	++	+	1.8	36
F18	062	001	Occupation depostis	17.5	+	+++	+	8.7	497
G17	027	001	Pit fill	21	+	+++		0.5	24
G17	029	001	Pit fill	18	+++	++		0.8	44
G17	031	001	Pit fill	26	+	++		0.5	19
G17	032	001	Same pit	23	+	+++		11.3	491
G17	034	001	Pit fill	50	+++	+		1.5	30
G18	013	001	Occupation deposits	41.5	+	+++		5.2	125
K16	008	003	Occupation deposits	50	+++	++	+	0.4	8
K16	018	005	Pit fill	53.5	+++	+++		3.2	60
K17	012	005	Pit fill	63.5	+++	+		2.6	41

Table 2. Saar 1991: charred plant remains.

Square	Unit	Object	Date taken	Unit description	Unit type	Quantity (litres)	Weight of charred material (g): Dates	Charcoal	Indet. material	Grain	Total weight	g carbon/ litre ×1000
Q20	027	001	23.01.91	Animal disturbance above pit Q20:032	Unknown	60	0.49	0.01		0.01	0.51	8.5
F16	025	003	21.02.91	Waterproofed basin	Basin	23	0.59	0.19		0.01	0.79	34.3
I13	052	001	17.03.91	Fill of plaster basin in house	Basin	15	0.05				0.05	3.3
I13	040	001	13.02.91	Burnt area (*in situ*?) in house	Burnt	60	0.35	0.01			0.36	6.0
L17	070	001	12.03.91	*In-situ* burnt area in small room	Burnt	265	24.17	0.83			25.00	94.3
M17	039	002	14.03.91	*In-situ* burning, other depression	Burnt	58	0.30	0.57			0.87	15.0
E17	002	023–25	29.01.91	Midden	Midden	48	0.24	0.01		0.01	1.32	27.5
E17	004	017	28.02.91	Midden	Midden	60	0.15	0.01	0.13		0.29	4.8
K18	019–20		05.03.91	Midden	Midden	1298	27.16	1.74	0.06	0.10	29.06	22.4
R20	020	003	10.02.91	Midden	Midden	60	0.13	0.01		0.01	0.15	2.5
E16	010	009	20.02.91	Occupation deposits	Occupation	80	0.91	0.13		0.01	1.05	13.1
H13	010	001	13.02.91	Thick ashy layers W of altar	Occupation	10	0.01	0.04			0.05	5.0
H13	027	001	04.03.91	Temple sondage	Occupation	120	0.22	0.03		0.01	0.26	2.2
H13	028	001	09.03.91	10th spit in temple sondage	Occupation	80	0.24	0.14		0.01	0.39	4.9
K18	016	001	26.02.91	Occupation debris	Occupation	62	0.20	0.01			0.21	3.4
L17	065	008	02.03.91	Occupation debris in house	Occupation	60	0.55	0.03	1.36		1.94	32.3
E16	014	004	25.02.91	Ashy fill of pit	Pit	25	1.19	0.68		0.01	1.88	75.2
E16	016	004	26.02.91	Ashy fill of pit	Pit	20	0.40	0.11			0.51	25.5
E17	010	001	03.03.91	Ashy fill of pit	Pit	59	4.68	0.84			5.52	93.6
F17	079	001	03.03.91	Pit fill	Pit	55	0.79	0.02			0.81	14.7
L17	045,46,48		12.02.91	Pit fill	Pit	131	0.31	0.14	0.01	0.09	0.55	4.2
Q20	032	001	04.02.91	Pit fill	Pit	60	0.23	0.01			0.24	4.0
Q20	069–70		05.03.91	Pit fill	Pit	314	0.58	0.76	6.82	0.01	8.17	26.0
Q20	078	003	13.03.91	Pit-fill	Pit	53	0.04	0.05		0.01	0.10	1.9
R20	034	001	19.02.91	Pit-fill, *in-situ* burning	Pit	52			0.27		0.27	5.2
J16	005	006	23.01.91	Sand collapse	Rubble	30	0.04	0.03			0.07	2.3
K17	055	001	24.01.91	Floor make-up	Rubble	18	0.07	0.01			0.08	4.4
P19	017	003	10.03.91	Floor make-up	Rubble	60	0.96	0.20			1.16	19.3
Q20	052	003	27.02.91	Sand layer under collapse	Rubble	60	0.08	0.01			0.09	1.5
Q20	060	003	28.02.91	Below floor (under Q20:052)	Rubble	40	0.11	0.01		0.01	0.13	3.3
L18	031	001	12.03.91	Tanoor	Tanoor	40	0.87	0.54		0.03	1.44	36.0

Table 3. Distribution of 1991 charred material in different contexts.

	Burnt patches	Midden	Pit	Basin	Occupation	Rubble	Tanoor	Unknown	Total
Number of contexts sampled	3	6	15	4	21	25	8	1	83
Number containing charred material	3	4	9	2	6	5	1	1	31
									Average
Presence expressed as percentage	100	67	60	50	29	20	13	–	37
Average wt (g) charred materials/ litre ×1000	36	30	23	19	10	6	36	8.5	19

Disappointing results were also obtained from generalised "occupation" contexts, i.e. the build-up of soil above floors that accompanies occupation of an area. However, some of these spreads of soil were very rich in bone and shell, and are separately classified as "middens" in Table 3. These areas, interpreted as refuse disposal areas were, as would be expected, amongst the most productive in charred seeds and charcoal.

Three spreads of debris showed signs of *in-situ* burning ("burnt patches") and all three were amongst the richest samples. In contrast to these spreads of material, the remaining classes of deposit were in easily defined features such as pits and basins. Nine of the 15 pits sampled were productive, as were two of the four waterproofed basins. Surprisingly, only one of the eight *tannurs* (ovens) contained charred material.

The quantities of material are too small to allow investigation of the spatial distribution of the plant remains, except in terms of general categories of deposit. All the excavation trenches produced similar types and quantities of charred plant remains.

The comparative densities from different types of contexts suggest that in future seasons, a more limited programme of sampling should focus on areas of *in-situ* burning, middens, and features such as pits and basins. Ordinary occupation deposits and tannurs are a low priority.

Why so few seeds and charcoal?

At a typical second millennium site in the Near East, I would expect a flotation programme in which 6804 litres of soil was floated (as in the Saar 1991 season) to produce several large boxfuls of charred remains. The yield from the 1991 season at Saar was a mere 82 g. Some possible explanations can be ruled out. The flotation machine functioned very well, and there was no obvious damage to the charred remains in the water. Inspection of the heavy residues, including detailed sorting of the most productive samples, demonstrated that very little material was sinking. It seems then that there are very few charred remains in the soil matrix itself.

Not only is the amount of material rather small, but its context-related distribution, described above, has some curious features. For example, on a typical site in Turkey or Iraq, the pits would contain the greatest densities of charred remains, because their final use is often for refuse. At Saar some of the pits did appear to be full of sand only, but others should have contained more charred refuse. Only one of the tannurs contained any charred material – but similar tannurs at other sites always contain some seeds and fuel remains at the bottom.

The lack of material from Saar cannot be ascribed to limited sampling – some 82 contexts were sampled as 123 separate samples, nor to inadequate volumes of soil, with a minimum sample size of 40–60 litres. That even the most likely deposits were low in seeds and charcoal suggests that there must be a general explanation, one that applies to the site as a whole.

Little is known about the reasons for variation in seed densities between sites, which can often be very marked. Ethnographic and archaeological observations of the mechanisms by which seeds and wood are preserved on sites suggest the following possible explanations:

1. Little plant material was used at the site. This seems unlikely. On the grounds of ubiquity in the samples that were productive, it seems likely that dates and cereals were important foodstuffs, and it is difficult to imagine a totally animal diet for this substantial second millennium town. The abundance of grinding and pounding stones, and the presence of an oven in most houses, also suggest a typical middle-eastern, plant-food-based diet.

2. Little of the plant material present at the site was carbonised. Even if the cereal grain was imported from elsewhere, and the dates processed off-site, one would still expect the casual charring of material to occur in everyday life. At contemporary sites elsewhere even the least productive deposits will contain a few grains – an index of just how pervasive the charring of seeds is in an environment of hearths and ovens. There is plenty of evidence of cooking at Saar, so the necessary fires certainly existed.

3. Little of the carbonised plant remains were incorporated into the soil matrix of the site. There are two possibilities here. The inhabitants of Saar may have taken great care to use all ashy refuse (as opposed to bone, which they left all over the site) as fertiliser. As Popenoe (4) points out, the desert soils of date gardens in this region typically lack humus and benefit from ample fertiliser. Anything available may be used, ideally manure, but also fish heads and domestic refuse. The relative "cleanliness" of the houses, with few artefacts or layers of "fill" might support this idea. The other

possibility is that ashes were dumped in open areas and were broken down by climatic effects and trampling before becoming sufficiently covered by soil to be protected. Perhaps the stone construction of the site and the sandy nature of the soil prevent the build-up of the kind of protective, washed out mud-brick type of deposit found in countries further north?

4. Post-deposition destruction. The occupation levels of the site are covered in collapsed debris to a thickness of up to 1 m. Carbon preservation should be excellent under this cover, and there are no obvious soil conditions (such as salinity) at the site that might result in seeds and charcoal disintegrating. However, little is known of the effects of soil conditions on the preservation of charred materials.

While I suspect the answer lies with the incorporation of charred material into the site deposits, a definite explanation will need to await study of the site formation processes by soil micromorphology, and their comparison to other sites. George Willcox (5) remarks on the similarly fragmented and scarce nature of the plant remains from Failaka, and it may be that preservation is similarly poor at most Gulf sites.

Identification criteria

Date (Phoenix dactylifera)

Whole date stones, with their longitudinal ventral groove and round embryo spot on the dorsal side, are easy to identify (Fig. 1). Fragments show a distinctive structure in transverse section of

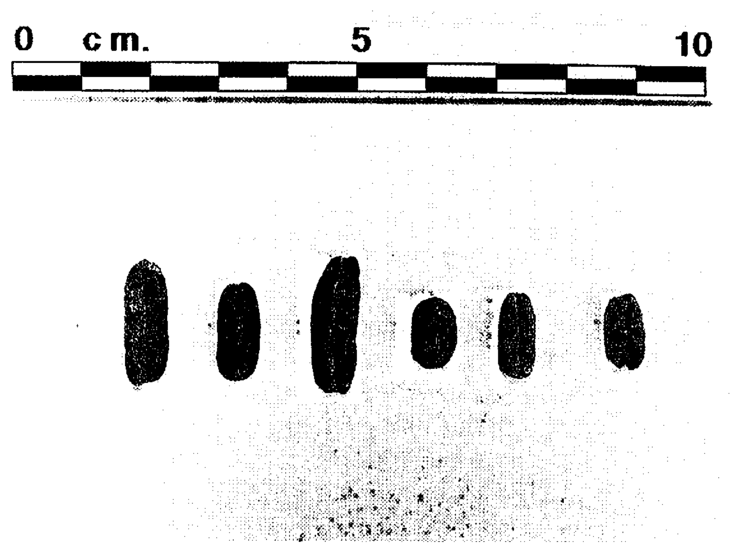

Fig. 1.
Date stones from dry-sieved deposits, Saar 1991.

Table 4. Measurements of charred date stones from Saar and Failaka.

Sample		L	W	T	L:W	T:W
		Measurements (mm)				
SAAR 1990						
K17:12:05		11.9		5.4		
SAAR 1991						
E16:06:03		14.6	5.7	5.5	256	96
E16:10:05		19.5	7.2	6.3	271	88
		14.5	6.5	5.4	223	83
		10.4	6.8	6.3	153	93
		12.8	5.9	6.2	217	105
E16:13:04		11.3	5.8	5.4	195	93
		12.5	5.4	5.3	231	98
E16:14:01		14.1	6.0	6.0	235	100
		11.0	5.7	5.1	193	89
E16:16:01		11.6	5.9	5.9	197	100
		11.8	5.9	5.2	200	88
E16:17:03		19.4	6.8	6.3	285	93
		12.7	4.6	5.2	276	113
Q20:32:05		12.6	5.9	6.0	214	102
R20:28:04		12.5	5.4	5.0	231	93
Saar	Min.	10.4	4.6	5.0	153	83
	Avg.	13.33	5.97	5.66	225	96
	Max.	19.5	7.2	6.3	285	113
	n.	16	15	16	15	15
Failaka	Min.	14.8	5.7	4.8	256	81
	Avg.	16.95	6.51	5.85	268	90
	Max.	18.7	7.5	6.8	280	98
	n.	4	28	28	4	28

Failaka measurements from Rowly-Conwy, Remains of date (*Phoenix dactylifera*) from Failaka.

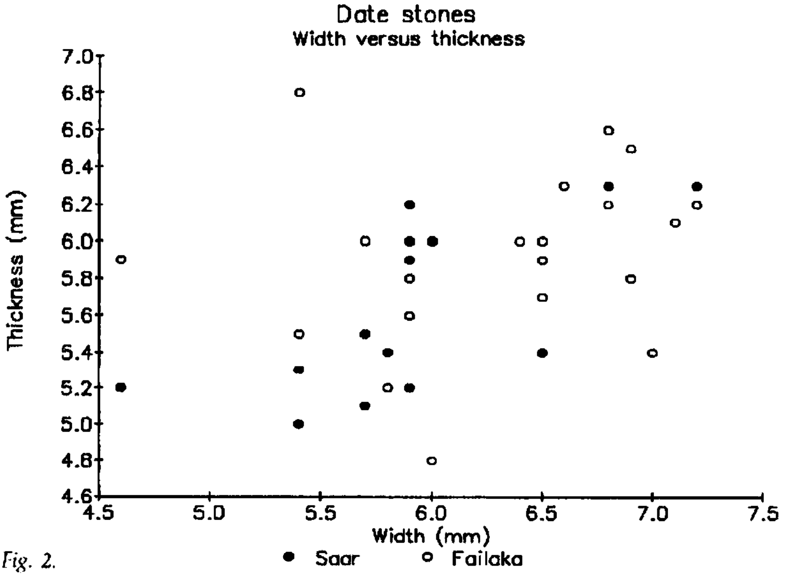

Fig. 2.
Width and thickness of date stones from Saar and Failaka.

radiating cells. A few stones have traces of the papery skin (endocarp) of the seed, and one has charred with the flesh almost intact. The size of the Saar date stones is very similar to those of Failaka (Table 4; Fig. 2). The variation in length – 10.4 to 19.5 mm – is particularly striking, and it is possible that, once larger numbers of stones are available for measurement, clusters of different sizes conforming to varieties may become apparent.

The hard, woody cup-shaped perianth usually adheres to the date fruit after picking, and it is surprising that none are present in the samples. They are too knobby to eat comfortably, and if the date stones result from domestic consumption, one would expect the perianths to have been discarded and charred too, as they were at Larsa (6).

Wheat (Triticum durum/aestivum) and barley (Hordeum vulgare)

The seven wheat grains all have the rounded flanks and greatest width close to the embryo typical of free-threshing wheats (Fig. 3a,

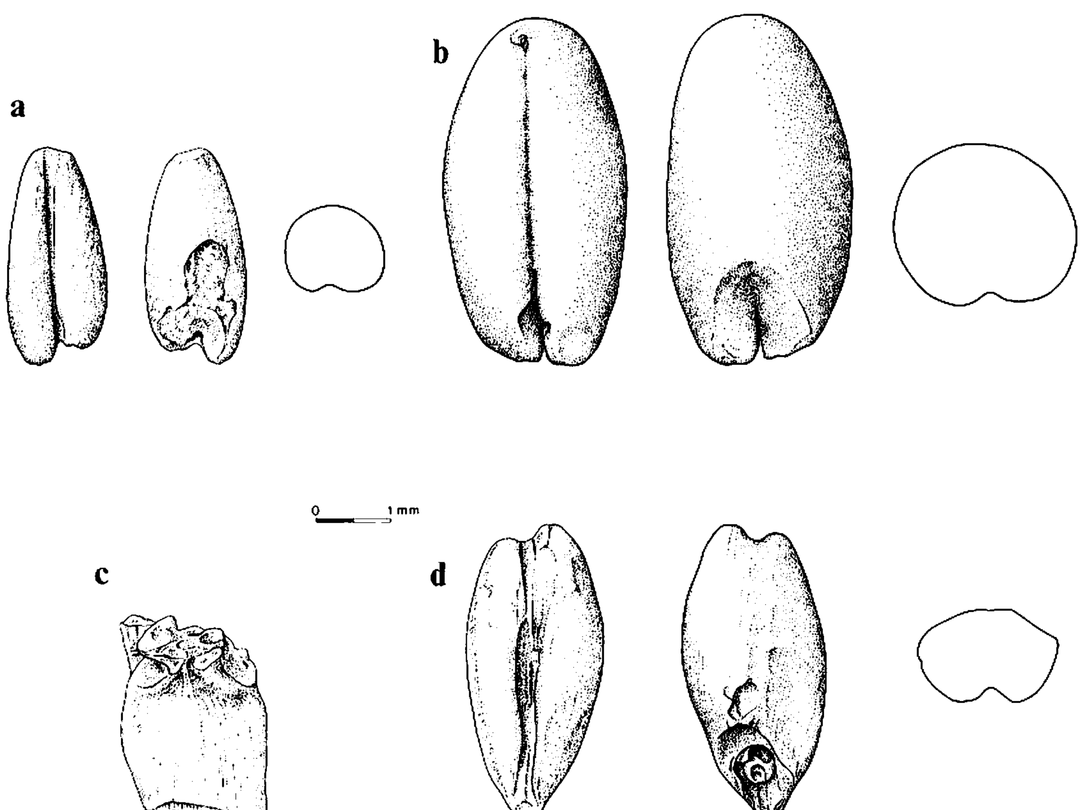

Fig. 3.

a. Small free-threshing wheat grain. Saar 1991. K18:19:02. b. Large free-threshing wheat grain. Saar 1991. L17:46:01. c. Bread wheat (*T. aestivum*) rachis internode. Saar 1991. K18:20:11. d. Twisted hulled barley grain. Saar 1991. L18:31:01.

b). One wheat rachis (Fig. 3c) has the shield-shaped rachis, longitudinal striations and low-rimmed cups at the glume bases of hexaploid (bread) wheat (*T. aestivum*). However, with only one rachis it is impossible to be certain that all the grains derive from hexaploid wheat.

The barley husks have not survived charring, but the angular corners of the grains in transverse view demonstrate that the barley is a hulled type (Fig. 3d). Nine grains are definitely twisted and, nine straight. The presence of twisted grains shows that 6-row barley is present. While the ratio of twisted to straight grains is not precisely the 2:1 to be expected of pure 6-row barley, the small number of grains and the high proportion too distorted to be classed as twisted or straight, mean that a deviation from the 2:1 ratio need not be evidence for the additional presence of 2-row barley. The barley rachis internode comes from the basal part of the rachis and is not referable to type.

Importance of the plant foods

With a larger suite of plant remains, one would typically analyse each sample in terms of its place in the crop-processing sequence, and thence of the relative abundance of each species in each sample. It would then be possible to characterize each species as major crop, minor crop, contaminant, import, etc. The quantities of material from Saar are too small to allow such detailed studies.

However, although the quantities are small, we do have a suite of 31 samples, and 82 g of charred material (Table 5). If these seed remains have any relationship to plant use on site (and I believe it to be a severely "filtered" but representative set of material), then the relative presence of species in those samples that contained charred material, and the abundance of the species overall, can be used (cautiously!) as an indicator of overall importance at the site. As date stone fragments are present in 30 of the samples, and are the most abundant seed in terms of volume and weight, it is likely that dates were an important foodstuff. Similarly the presence of barley grains in 58% of samples indicates that it was important, while naked wheat (present in only 13%) was less important.

Table 5. Relative abundance of the 1991 plant remains.

	Date	Charcoal	Indet. material	Barley	Wheat	Any cereal	Weeds
Presence in contexts (n=31)	30	29	6	18	4	20	7
Presence expressed as percentage	97	94	19	58	13	65	23
Total quantity (g)	66.11	7.17	8.65	–	–	–	–

While this is a narrow range of crop plants, with no other fruit or vegetables recovered, ethnographic data from the Gulf discussed later on does support an interpretation in which dates, followed by barley and wheat, are the major food items.

Uses and history of the plant foods

Cereals

The presence of six-row hulled barley and free-threshing wheat is not surprising – both are present at sites of the same period in Iraq. The number of grains is too small to allow us to be absolutely sure that the absence of emmer is significant, but if it was important in Bahrain at the time (and it is at Mesopotamian sites), one would expect at least some grains here.

The presence of two pieces of cereal chaff does not necessarily indicate local crop processing: some cereal chaff invariably remains behind in processed, cleaned stored grain. While barley is most commonly noted as animal feed (7) in cuneiform documents, both the barley and the free-threshing wheat present at Saar are suitable for a wide range of foodstuffs, and the presence of a tannur in every house suggests that flat bread (such as that found at mid-third millennium Ur (8)) was one. The husks of hulled barley can easily be removed on a grinding stone so that the grain is suitable for human use (9). The greater abundance of barley compared to wheat reflects the same pattern in Mesopotamian texts and archaeobotanical assemblages.

History of the date

Little is known about the domestication of the date palm. Efforts to distinguish truly wild palms from feral escapes have met with limited success (10), but the original wild ancestor would have grown somewhere in the area of North Africa, Arabia, the southern part of the Near East and the Indus basin where dates are cultivated today. It is perfectly possible that truly wild dates once grew on the swampy shoreline of Bahrain, but the cultivation of date gardens over millennia would have wiped out any trace of their existence.

Many archaeobotanical records of date stones are from earlier excavations where the stratigraphy is unreliable. Records from early sites that do seem reliable include:

Tepe Gaz Tavila, Iran	5400–4800 BC (11)
Tell el-Oueili, Iraq	5th mill. BC (12)
Eridu, Iraq	4th mill. BC (13)
Teleilat Ghassul, Palestine	3700–3500 BC (14)
Jericho, Palestine	3200 BC (15)

Nahal Mishmar, Palestine	3200–3000 BC (16)
Hili 8, U.A.E.	3000 BC (17)
	2600–2500 BC
Tell Abraq, Oman	late 3rd–early 1st mill. (18)
Ur, Iraq	mid-third mill. BC (19)
Tepe Yahya, Iran	2400–1800 BC (20)
Shahr-i Sokta, Iran	2100 BC (21)
Failaka, Kuwait	2000 BC (22)
Ar-Raqlah, Yemen	2000 BC (23)
Tell Yelkhi, Iraq	2000–1800 BC (24)
Tell ed-Der, Iraq	Early 2nd mill. BC (25)
Qal'at al Bahrain, Bahrain	1475 BC (26)
Rumeilah, U.A.E.	800–400 BC (27)

Costantini (28) reports two uncarbonised, silicified date stones from Mehrgarh in Pakistan, dating to 6000 and 5000 BC. It is always difficult to be certain of the age of uncharred material, which may be intrusive. Confirmatory material would be very welcome.

While the archaeobotanical record is doubtless very incomplete, and likely to remain so until dry-sieving or flotation is more widely implemented, it does seem that dates have been cultivated since at least the fifth millennium BC.

Dates in Mesopotamia

In addition to the archaeobotanical evidence cited above, there is an impressive corpus of seal engravings and texts documenting the use of the date palm in Mesopotamia since the middle of the Sumerian period (*c.* 2500 BC onwards). It should be noted that this is simply the first date for which we have this kind of evidence in quantity; the archaeobotanical evidence is that dates, whether wild or cultivated, were used in Mesopotamia well before we have written or pictorial evidence for them.

The cuneiform texts that mention dates are mainly contractual, therefore relating either to date palm husbandry, or to the supply of dates in baskets. The most common terms are "suluppû" and "uhinnu". Both terms are used in Old Akkadian language (*c.* 2500 BC) onwards, and their precise meanings are still unclear. The Chicago Assyrian Dictionary (29) suggests "ripened and plucked" dates for "suluppû", Postgate (30) suggests "dried dates"; for "uhinnu" von Soden (31) has "fresh, green dates", Postgate "fresh date, in the autumn".

There are few clues to culinary uses. Landsberger (32) quotes a recipe for a cake "butê" made from dates, pomegranates, raisins and figs, and the Chicago Assyrian Dictionary (33) defines the Neo-Babylonian (*c.* 1000 BC) term "ģiddê" as a kind of cake made from dates, emmer and sesame. There is also a brief textual reference to a wooden mortar used for processing dates (34), tantalising in view of the abundant evidence for both dates and milling equipment at Saar. In second millennium Mesopotamia, barley beer was the main alcoholic drink, and date wine does not become important until the mid-first millennium BC (35). The textual evidence is therefore unhelpful, beyond suggesting that the "seated god in a flounced robe drinking through a straw" found on one of the seals from Saar (36), is more likely to be drinking a cereal beverage than date wine.

Cuneiform evidence for Dilmun dates

The term "asnû" is used in Old Babylonian (*c.* 2000 BC) documents to refer to "Dilmun" date palms and dates (37). Uses mentioned in the texts include temple offerings and food. As Potts (38) points out, "asnû" refers to a variety of date palm rather than to dates imported from Dilmun. "Asnû" date palms appear to have produced especially sweet dates. That the reputation of "Dilmun dates" reflects the renown of dates from Dilmun itself is suggested in a Sumerian myth quoted by Kramer (39):

"Dilmun – its dwellings are good dwellings,
Its barley is very small barley (40),
Its dates are very large dates."

Uses of the date palm in Bahrain

Given that dates were a major resource in Dilmun period Bahrain, how might they have been used, and how would this be reflected in the archaeological record? Although dates are no longer a major foodstuff in terms of calories, and the dried dates on sale in the Manama market today come from Saudi Arabia, dates are still highly regarded by Bahrainis. Not only are they an appreciated foodstuff, but dates have strong, favourable associations with religion and health. For example, it is customary to eat one date before breaking the Ramadan fast, and it is said that Mary fed dates to Jesus (41). Such modern-day evidence for the special position of dates strengthens arguments for a place for the date palm in ancient religious traditions (42).

The fibrous parts of the date-palm have a very wide range of uses, including roofing, matting and basketry, and one might expect to find traces of this in the phytolith record. The numerous fragments of palm charcoal show that it was used for fuel.

The date stones give few clues as to how the date fruits were used. The obvious way is as a dried or fresh fruit, and there are numerous modern recipes, for example for dates pounded into a smooth paste and made into biscuits, and for various combinations of dates and flour. Dishes such as that described one hundred years ago by Theodore Bent: "They make *sheerah* for their own consumption out of dates dried for three days; then date-juice is poured over them and sesame seeds, walnuts, or ginger powder mixed with them" (43) are similar to those made today in Bahraini homes. For example a dish called *dabbas* is made from dates mixed with a little date syrup, with sesame and candied ginger on top. This is an early morning food to eat with coffee.

An important modern culinary use, and one archaeologically attested at other sites since *c.* 1750 BC, is as date syrup "dibs". In Bahrain today, dibs (also known as "black honey" *el asal al aswad*) is much used as a sweetener with staple foods such as rice and bread, as well as in confectionary.

Dates at their driest, most mature stage of ripeness ("tamur"), are packed in date palm leaf baskets in date presses ("madbasa") in August-September. As the dates ferment, date syrup runs off. Rougeulle (44) suggests that the word "dišpu", used from Old Akkadian times onwards and conventionally translated as "honey" (45), may have meant "dibs", prior to the advent of bee-keeping in the first millennium BC.

Ancient "madbasa" are known from mid-second millennium BC Qal'at el-Bahrain (46), 13th century AD Islamic levels at the same site, and from 13th–14th century AD fort Sohar in Oman. An undated, but presumably medieval madbasa, is in the courtyard of the fort at Arad, Bahrain. All these have characteristic plastered corrugated floors, with channels leading to tanks or earthenware jars (47). Similar structures, but with flat plastered floors, have been found at levels in Failaka dating to *c.* 1750 BC. Presses need not have the characteristic corrugated floors of Gulf examples. In Iraq today, dates are simply heaped in unroofed mud-walled enclosures out in the date gardens (48). Occasionally the floor is covered in hard pitch. The crucial identifier for date presses must be some kind of sunken jar or tank to catch the liquid date syrup. Such structures have not yet been found at Saar, but date syrup production may have taken place in specialised areas of the settlement that remain to be discovered.

A different kind of date syrup ("merees") is also produced in Bahrain on a smaller, kitchen, scale by soaking dates in water and squeezing them in cloth.

The part of the date that survives uneaten, and is therefore most likely to be charred, is the stone, and it has a number of uses that may be archaeologically visible. Today, date stones are ground into small pieces (but not powder) and fed to animals mixed with wheat bran. Whole stones can also be fed to animals after cooking in water. This custom is described by a visitor to Bahrain in the late nineteenth century: "Green dates (salang) are given to the donkeys for fodder, and to this the Bahreini attribute their exceptionally good breed" (49). With a fat content of about 8%, and 5% protein, date stones are a useful fodder (50). The absence of the perianths that would normally accompany date stones suggests that the heavily fragmented charred stones at Saar may, at least in part, derive from debris from pounding. While stone fragments might be charred after passing through animals and being burnt as a constituent of dung, the absence of charred dung fragments (especially as compared to the ubiquitous charcoal) suggests dung was not an important fuel at Saar. Even in the recent past, despite the apparent barrenness of the island, palm wood and shrubs have always provided enough fuel to allow all dung to be used as fertiliser rather than fuel.

In the light of evidence at Saar of bronze working, the observation of Strabo (16.I.13) (51) that in Mesopotamia: "The bronzesmiths use the stones of the fruit [of date] instead of charcoal" may be relevant. Dowson similarly records that in modern Iraq date stones were sold to charcoal makers, and after conversion into charcoal, favoured as a fuel by silversmiths (52).

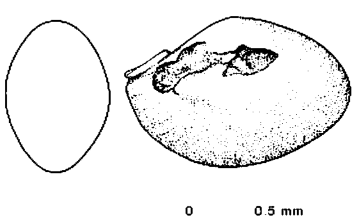

Fig. 4.
Canary grass grain. Saar 1991. L18:31:01.

Wild plants

The four wild grass seeds (Table 6; Fig. 4) have the extreme lateral compression and convex dorsal and ventral profiles of canary grass (*Phalaris* sp.). Canary grass is not common on the island today, but *P. minor* has been recorded in a variety of habitats. In Iraq this species grows in depressions in the desert and is a weed of cereal fields and irrigation canal banks.

The three Trifoliae seeds belong to one of the small seeded members of the pea family related to clover. Such species grow both in the desert and in irrigated fields. The weed seeds could therefore be derived either from grain cleaning or from fodder, and are not diagnostic of agricultural practices.

Indeterminate material

A category used to define material that is clearly not seed or charcoal. The large quantity of material in Q20-69/70 appears to consist of tangled masses of cells, but awaits SEM examination.

Fuelwoods

Most of the samples contain some date palm charcoal, easily identifiable by the fibrovascular bundles embedded in a rather amorphous looking matrix of cellular tissue. However, the rest of the charcoal presumably represents other woody species of the island. While

Table 6. Cereal grains and weeds in the 1990 & 1991 Saar samples.

	Cereals					Weeds		
	Naked wheat	Straight hulled barley	Twisted hulled barley	Indet. hulled barley	Indet. cereal grain	Canary grass	Small Leguminosae	Other weed
SAAR 1990								
G17:29:01	–	–	1	–	–	–	1	–
G17:31:01	–	–	–	1	–	–	–	–
G17:32:01	–	1	–	–	–	–	–	–
G17:34:01	1	–	1	–	3	–	–	–
SAAR 1991								
E16:10:09	–	–	–	–	2	1	–	–
E16:14:04	–	–	2	–	1	–	–	–
E17:02:24	–	–	–	1	–	–	–	–
F16:25:03	–	1	–	–	–	–	–	–
H13:27:01	–	–	–	2	2	–	–	–
H13:28:01	–	–	–	1	–	–	–	–
I13:52:01	–	–	–	–	–	–	1	–
K18:19–20	3 (*)	2	2	7	10	–	–	2
L17:45–46	1	1	–	–	13	–	–	–
L17:70:01	–	–	–	2	1	–	–	–
L18:31:01	2	2	2	3 (+)	–	2	–	1
Q20:27:01	–	1	–	–	–	–	1	–
Q20:32:01	–	–	–	–	–	1	–	–
Q20:52:03	–	1	–	–	–	–	–	–
Q20:60:03	–	–	–	–	1	–	–	–
Q20:69:01	–	–	1	1	–	–	–	–
Q20:78:03	–	–	–	1	–	–	–	–
R20:20:03	–	–	–	4	–	–	–	–
Total	7	9	9	23	33	4	3	3

* One hexaploid wheat rachis segment. + One barley rachis segment.

there are no truly wild trees on the island, except for the mangrove swamps of the coast, there are plenty of shrubs, including the dominant *Zygophyllum qatarense.* Analysis of the charcoal (by Dr Rowena Gale) will indicate whether the vegetation was substantially different 4000 years ago.

Agricultural systems on Bahrain

The main factor affecting agriculture on Bahrain is the availability of water. Annual rainfall is highly variable, falling from November to March and averaging about 6 cm/year, but with variation within a decade from 14 cm to 0.4 cm (53).

Cultivation has therefore been restricted to flat land that can be irrigated by gravity flow irrigation systems from natural springs (54). Such land is restricted to a belt around the northern side of the island, amounting to about 85 km^2 in all, less than 14% of the island's total land area (55). In the 1940s crops of wheat were successfully grown on unirrigated land in the valley of Rifat, but yields were so variable from year to year that the enterprise failed.

Temperature, ranging from a low of 9°C in December to 44°C in June is much less limiting, and a very wide range of fruits, cereals and pulses can be grown successfully.

Hansen's description (56) of agricultural life in Saar in 1960 is typical of village life on Bahrain in the recent past: the date gardens were irrigated by four qanats and one shaduf. Some Indian Zebu cows were kept permanently inside cowsheds in the compounds, fed on lucerne, date stones and dried fish. A small number of fat-tailed sheep, duck and poultry were also kept in the village. Herds of goat lived on plants in the desert surrounding the village. The basic foods were rice, dates and fish, with other meats more rarely. Even though oil had already affected life on the island, the husbandry of the date palms was still a key activity.

Details of date cultivation are the same as elsewhere in the Gulf (57). Somewhere between 500,000 (Popenoe's estimate in the 1920s) and 417,000 (Ahmed, mid 1970s) palms grow in date gardens concentrated in a coastal belt around the northern half of the island, where water from springs and qanats is available. Trees are artificially pollinated in February and March, and dates appear on the market from late July to late October. At present Bahraini dates are only sold fresh, but this may be a result of declining yields in recent years reducing the number of dates available for sale (58). At least 15 varieties of date in Bahrain were described to me. The varieties differ primarily in colour, time of harvest and uses.

Date gardens form the basic agricultural unit of Bahrain today. A network of small channels takes water to rows of date trees and to small rectangular areas of soil, surrounded by heaped up banks, between the trees. There are three main elements to the date gardens – the date trees, the fodder plants, and the other food plants. This system may be as old as the cultivation of dates, as once large-scale date cultivation started, with its requirement for systematic irrigation, use of the shady, easily watered spaces between trees would naturally follow. At ancient Saar the ubiquity of dates suggests that they were an important foodstuff, and large-scale date cultivation must have been taking place in order to supply sufficient to a town as large as Saar.

Today the list of food plants grown in the date gardens is still close to those recorded early this century by Dowson (59) in Iraq: onions, leeks, hibiscus, eggplant, beans, cucumbers, vines, ziziphus, peaches, melons, figs and pomegranates. Given the restricted area available for agriculture, production naturally focuses on foodstuffs best eaten fresh, rather than on cereals such as wheat and rice which can easily be imported from other countries. However, Albuquerque described the island in 1510 as "noted for its large breeding of horses, its barley crops, and the variety of its fruits ..." (60). Fodder plants are also best grown locally as being too bulky to import. Today handsome onions seem to be the most common of these crops. In the third millennium, Sumerian written texts refer to "sum-dilmun[ki]", translated as Dilmun onions or garlic (61), although as with Dilmun dates this does not necessarily mean that the onions were imported from Dilmun.

The narrow range of food plants recovered at Saar does not include any of these vegetables or fruits. The absence of onion seed is not surprising as vegetables eaten green are unlikely to leave many seed remains, but the lack of fruit is odd. The cherry-sized, orange fruits of *sidr* are widely used in Bahrain today. Similar fruits are found both on the wild species, *Ziziphus nummularia*, and on the cultivated *Z. spina-christi*. The large woody stone should char well, and possibly survive uncharred, but careful checking of heavy residues (and the extensive dry-screening programme) has not yet recovered any. *Ziziphus* wood (but not fruit) is present in Bronze Age Failaka (62), and at Hili 8 in Oman at 2500 BC, and the fruit stones have been recovered from fourth millennium layers at RH5 in Oman (63). By the second millennium, major Near Eastern domesticates such as grape and pomegranate should have had time to reach Bahrain. Again, if the archaeobotanical evidence is representative, this is further evidence for a conservative date-orientated diet.

Work on dental pathology has shown a very high occurrence of caries at all periods on Bahrain, including the Middle Bronze Age (skeletons dating from 2500 to 1700 BC, some from the Saar burial ground). The nature of the caries points to a non-fibrous and tacky food (64), and the pathologists who have carried out this work plausibly suggest dates to be the major culprit – further evidence of their importance in the Dilmun period. The details of the location of the caries on teeth apparently point to a relatively minor role for grain foods in the diet, and this complements the archaeobotanical evidence of the much greater abundance of date remains.

The main fodder plant cultivated in the date gardens of Bahrain today is lucerne, *Medicago sativa*. Another fodder crop known from similar current-day date gardens in the region is the clover *bersim, Trifolium alexandrinum*, recorded in the Al 'Aīn oasis (65). However, we have no direct evidence for ancient fodder beyond the seeds of canary grass and small Trifoliae, which could just as well be weeds of cereal fields.

Keith Dobney's preliminary study of the animal bones from Saar finds fish to be the main economic base, with some gazelle as the other important wild animal, and sheep and goat, with some cattle, as the main domesticates. These relative quantities (with the exception of gazelle, extinct in the wild in Bahrain) closely match Hansen's twentieth century record for Saar village, and it is tempting to speculate that herding and feeding patterns may have been similar.

Bahrain's identification with the textually known trading entrepot known as "Dilmun" and its role in the export of copper from Oman to Mesopotamia is generally accepted (66). Much less is known about the import or export of foodstuffs from Bahrain. Today, virtually all rice and other cereals are imported, and there is no reason why barley and wheat could not have been imported in similar fashion in the past. As we have seen, the Dilmun dates of Mesopotamia were probably locally grown, and there is no literary evidence for date trade in either direction.

An early 2nd millennium text from Ur mentions sesame oil "for expedition to Dilmun to buy copper there" (67), and there is mention of issue of a barley ration to "Dilmunites" – who may have been living at Ur (68). One Old Akkadian text (late 3rd millennium) text reports a consignment of flour on a boat to Dilmun. This is the sum of hard evidence for trade in foodstuffs with Dilmun.

The most striking aspect of food production in Bahrain is its continuity. The diet of Saar some 4000 years ago – lots of dates, some cereals, lots of fish and a little goat, sheep and cattle – can be compared to that observed by Hansen in the village that is the modern successor to ancient Saar, in 1960, and to Nieuhoff's observations:

> The common people make use of dates instead of bread or rice; for it is observable that the ordinary food of the Indians [i.e. natives] all along the coast from Basora to Sinde, is dates and fish dried in the air; the heads and guts of the fishes they mix with date-stones and boil it altogether with a little salt water, which they give at night to the cows after they come out of the field where they meet with very little herbage" (69).

Larsen (70) has integrated evidence for settlement patterns, trade and environment for the 6000 years of known occupation in Bahrain. The resulting synthesis elegantly demonstrates three peaks in population, each coinciding with increased foreign trade (and, in the first case, increased water supplies). The three peaks are in the Barbar I and II periods (*c.* 2100–1700 BC), the Neo-Assyrian and Neo-Babylonian periods of the first millennium BC, and the medieval period (14th century AD onwards).

Putting the Barbar II period, the time of Saar, in perspective, Larsen writes of the early third millennium: 'Higher relative sea levels may have reinforced artesian springs to provide more abundant water supplies ... This hypothetical increase in hydrostatic pressure was synchronous with a period of increased rainfall that watered the colluvial soils surrounding the Bahrain dome making them available for additional cultivation', leading in the Barbar I phase to 'greater social differentiation, population growth, and increased demands on the agricultural system. Grains and other foods were imported into the islands ... Dates from the various gardens provided a durable export crop'. In the Barbar II phase, 'Increasing agricultural demands also reached a maximum ... Settlements spread to their farthest extent along the southwest coast' (71).

This reconstruction, which sets Saar firmly in the context of expanding trade and increased water supplies (especially rainfall) is attractive, but D. T. Potts (72) has drawn attention to some flaws in the evidence. The securest part of Larsen's work is the archaeological survey: there *is* a peak of occupation (admittedly partly represented by the highly visible burial mounds) in the Barbar I and II periods, with 26 known sites, compared to just four in the following Kassite period. Even though survey data of this type are open to all kinds of biases, such a large difference is surely significant. The difficulties lie in the explanations for this expansion. With regard to climatic changes, as Potts points out (73), even the major shifts between dry and wet climatic phases of the Upper Pleistocene and Early Holocene are still the subject of widely diverging views, and therefore the use of what are even less clear-cut data, the location of 'lakeside' sites in one oasis in eastern Arabia (74) to indicate higher rainfall in the third millennium is highly debatable. The suggestion that rainfed cultivation of cereals extended over the area of 68 km^2 identified as colluvial soils hinges on this evidence for increased rainfall. For trade, it is true that there is evidence of extensive trading contacts, but evidence for trade in foodstuffs is slim. As Potts points out, not only is there no evidence for the export of dates then or at any other time prior to the late medieval period, but the suggested export of dates to southern Mesopotamia, a major area of date production, is particularly unlikely (75).

Looking at longer term patterns of change, Larsen focuses on evidence for export of dates (as we have seen, not attested until the 19th century) and on textual records from the Hellenistic and medieval periods which, because they do not explicitly mention cereal crops, are interpreted as evidence that they were not grown, and must have been imported (76). However, in the 12th century surplus production of barley on Bahrain is recorded, and in the 19th century wheat and barley are amongst the main agricultural products of Bahrain (77). It is not surprising that some descriptions of Bahrain mention the date gardens and not the cereals, as the date palms are the most striking agricultural feature. While there probably have been fluctuations in the area of cereals cultivated, and while increased rainfall would allow a greater area of land to be cultivated, the textual and archaeological evidence available at present does not allow even tentative conclusions to be drawn on these subjects.

In contrast, literary evidence for different types of crops does exist, for example in observations made by one of Alexander the Great's admirals, Androsthenes, around 323 BC and recorded by Theophrastus. The text includes descriptions of mangrove and tamarind trees, and then discusses the cotton plant: 'They say the island also produces the "wool-bearing" tree in abundance. This has a leaf like that of the vine, but small, and bears no fruit, but the vessel in which the "wool" is contained is as large as a spring apple, and closed, but when it is ripe, it unfolds and puts forth the "wool", of which they weave their fabrics, some of which are cheap and some very expensive' (78). Pliny paraphrases this text, with some extra details that indicate that cotton was still grown in the first century BC. In the 14th century AD Ibn Batutta records of Bahrain, 'In this place are palm enclosures, and pomegranates, lemons, and cotton are cultivated'. Cotton can only have been grown in the date gardens, whose area has always been limited by the availability of water, and its importance as a cash crop through extensive stretches of time, together with evidence for the abundance of cereals grown on the island in the medieval periods, suggest that even in the medieval period, a time of high population, Bahrain had the capacity to feed itself without importing foodstuffs. However, it would be unwise to extrapolate this productive capacity back to the second millennium, as it may well have been dependent on an expansion in the area of irrigated land owing to the introduction of the *qanat* system. This is most likely to have reached Bahrain in the first millennium BC.

In summary, the basic elements of diet observed in Bahrain in the recent past seem to have been established by the early Dilmun period – dates, fish, cereals (wheat and barley then, rice today), domestic animals. Two changes that have occurred are in the range of fruits grown on the island and, perhaps owing to the introduction of the new irrigation technique of the *qanat*, in the growing of cash crops such as cotton at some periods in the island's history. Flotation of samples from sites covering these later periods could be highly informative.

Ancient agriculture, Bahrain and the Gulf

Few plant remains are available for comparison in the northern Gulf: Failaka (79), Qal'at al Bahrain (80) and Tell Abraq (81) have all produced abundant date remains, and little more can be said. The elucidation of the earlier history of the date palm awaits the recovery of plant remains from earlier sites. Much more comparative material is available from sites to the south. The most obvious difference in contemporary assemblages from these southern sites is the presence of sorghum, both in the mountains of Yemen and in the oasis of Al 'Aīn.

It has often been suggested that Arabia, with its extensive trading contacts and central position, acted as a bridge for the spread of crop plants such as sorghum from Africa to India (82). Sorghum is known to have been domesticated in Africa, as this is where the wild ancestor grows (83). The earliest archaeobotanical records from Arabia come from the third millennium BC. At Ra's al-Hamra on the coast of Oman, sorghum has been found in layer 4 at the site RH5, radiocarbon dated to about 3000 BC (84) and at Hili 8, a settlement mound in the Al Aīn oasis in Abu Dhabi, some 500 km SE of Bahrain. Charred seeds and mudbrick imprints from phases I and II (radiocarbon dated to about 3000 BC) include wheat, 2-row barley, sorghum, jujube, melon, date stones and palm wood (85). Sorghum has also been found at Wādī Yanā'im (radiocarbon dated to *c.* 1750 BC) in Yemen (86). Sorghum has now been identified from a number of early second millennium sites in India (87), and it does seem likely that crop plants were moving between Africa, Arabia and India from at least the third millennium.

It may seem surprising that early second millennium Saar, with its trade links with Oman and, perhaps, the Indus valley does not have sorghum. While it is difficult to be absolutely certain, owing to the poor preservation of charred remains, that sorghum was not grown at Saar and Failaka, there are grounds for regarding the northern and southern parts of the Gulf as separate agroecological areas. Today sorghum is mainly a crop of sub-Saharan Africa, Yemen, and India (88). Despite Dilmun's trading links with Oman and the Indus valley, its location in the northern part of the Arabian Gulf means that it would not be surprising if its agricultural patterns are more typical of Mesopotamia.

To what extent the presence of sorghum in oases in southern Arabia in ancient times made the agricultural economy different to that of Mesopotamia and the northern Gulf is at present an open question. The introduction of highly productive, irrigated summer crops similar to sorghum, such as millet, sesame and cotton, does seem to be linked to major economic changes in other parts of the Near East at other times, for example in the Iron Age, the Islamic period (89), and in the early second millennium on the Indian subcontinent (90).

Future work

Unless unusually carbon-rich contexts are discovered, flotation in future seasons is likely to recover much the same kind of material. A limited flotation programme is justified because additional material, especially of the cereals, would be useful, and as material accumu-

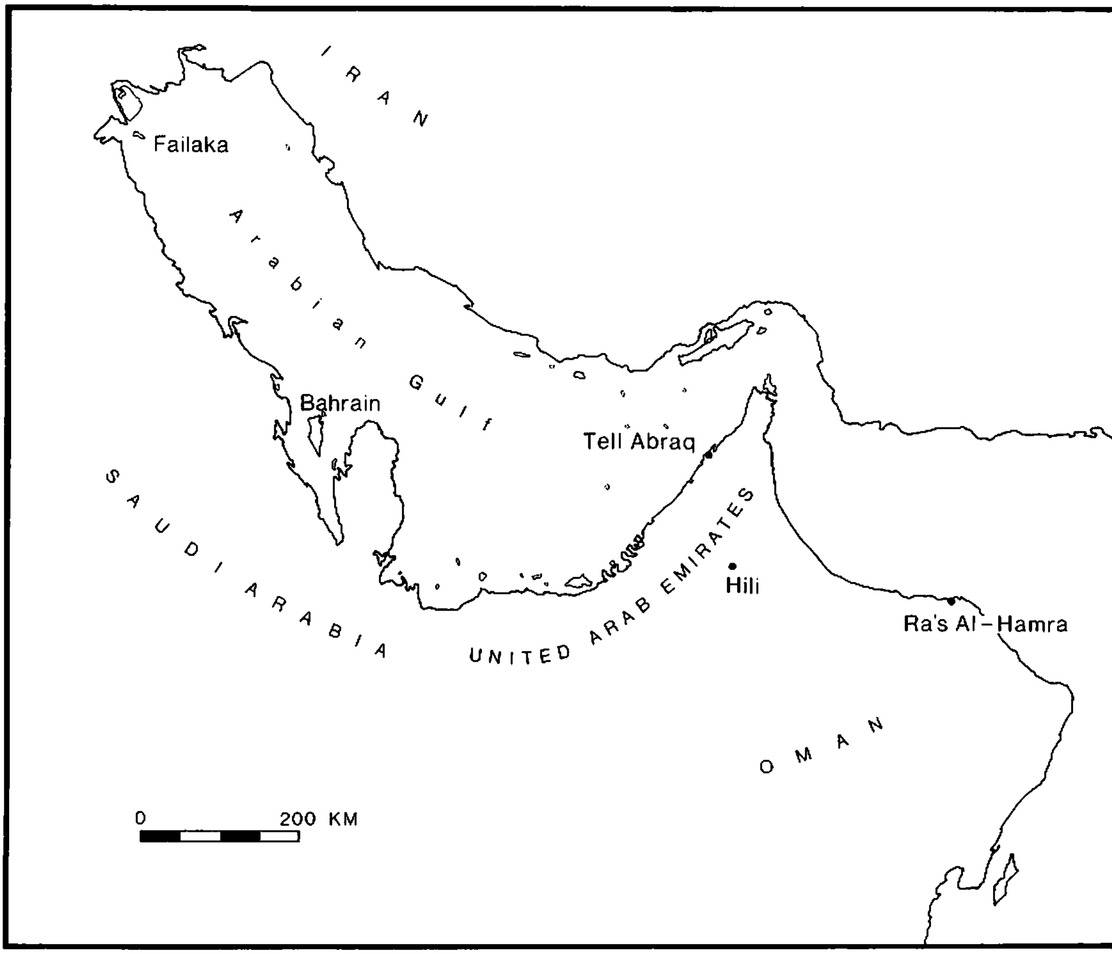

Fig. 5.
Arabian Gulf sites mentioned in the text.

lates, the continuing absence of food plants such as emmer wheat, sorghum and *Ziziphus* would be more solid evidence of non-use. While flotation has recovered sufficient charred plant remains to give worthwhile information on foodplants (and fuelwoods) at the site, fundamental questions such as whether the cereals were imported, and how important they were, remain unanswered.

Sites such as Saar that have poor preservation of charred material are excellent candidates for other, more recently developed, techniques. The analysis of residues from 13 sherds from the 1991 season is in progress. The collection of seed imprints from sherds has proved worthwhile at other Gulf sites, but a range of sherd material was examined in the 1991 season and appears very unpromising. A larger number of the "vegetable-tempered" type would be worth inspection. Phytolith analysis identifies the silica bodies of plants. These survive without any need for charring or other special conditions, and at this site could provide a more representative record of plant use. Cereal grains and chaff contain very distinctive sheets of phytoliths, and if chaff (and, therefore, grain processing) is present at the site in large quantities this technique should detect it.

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