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PALEOETHNOBOTANICAL RESULTS FROM BENDEBAL AND JAFFARABAD

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INTRODUCTION

The archaeological sites of Bendebal and Jaffarabad are located on the Susiana plain in Khuzestan, Iran. Susiana is a dry steppe, and lies in the region of Nubo-Sindian vegetation (1). It is characterized by mild winters and very hot summers. Virtually no rain falls in the summer, and the area lies near the 300 mm isohyet (2). Today, the plain is nearly treeless, but poplar *(Populus)*, willow *(Salix)*, and tamarisk *(Tamarix)* grow along the streams and rivers. The gallery forests are regularly utilized by local people for firewood. Khuzestan is a major grain-producing region in Iran, and large scale agriculture would be impossible without irrigation. The Zagros mountains lie about 75 km to the east. The natural vegetation of the western slopes is pistachio-almond *(Pistacia-Amygdalus)* steppe forest (3).

Archaeobotanical materials from Bendebal and Jaffarabad provide direct evidence for environmental and agricultural conditions in Susiana during the late fifth and early fourth millennia B.C. Charred plant remains were extracted from soil samples by a simple water separation procedure (4) carried out at Susa during the winter of 1977. The material comes from a judgmental sample of the archaeological deposits made available to the author by Geneviève Dollfus.

BENDEBAL

Bendebal is a small (about 2 ha) mound on a marshy part of the plain 10 km north of Susa. Most of the deposits just pre-date the last occupation of Jaffarabad (5).

The six soil samples taken from Bendebal come from the late fifth millennium levels, and yielded charcoal and charred seeds and wheat spikelet forks (Tables 43, 44, 45).

Although the plant assemblage is meager, it resembles the characteristic debris of wood and animal dung burned as fuel (6).

The samples generally contain a mixture of carbonized material, the bulk of which is charcoal. Although wood could have been used in construction, the fact that the Bendebal samples do not come from burned areas suggests that the charcoal became carbonized through its use as fuel. Charcoal of poplar/willow and possibly almond could be identified, and one or two other indeterminate diffuse porous woods were seen.

(1) Zohary, 1963
(2) Guest, 1966.
(3) Zohary, 1963
(4) Miller, 1977
(5) Dollfus, 1978
(6) Miller, 1982 ; Miller and Smart, 1983

TABLE 43

Tepe Bendebal : catalog of archaeobotanical samples

Provenience square	locus	Sample	Level	Deposit Type	Approx. vol(l)	Total carb. (g.)	Density (g/l)	Carb. (C) (g)	Seeds (S) (g)	S (S+C)
E9		224	12	near brick platform 551	.5	.31	.62	.28	.03	.10
E9		256a	14	floor	2.5	1.23	.49	1.19	.04	.03
E9		256b	14	floor	7.5	1.69	.23	1.51	.18	.11
E8/E9		289.1	14	Pit	2.5	.57	.23	.56	.01	.02
F8	543	147	14	Floor R.543 near hearth 552	.5	.31	.62	.31	0	0
D7		321	16	Floor(store-room ?)	-	6.09	-	6.09	0	0

TABLE 44

Tepe Bendebal : table of taxa

Sample	*Hordeum* (g)	*Triticum* cf. *monococcum* (g)	Cereal indet. (g)	*Triticum* spike-letforks	cf. Cruciferae	*Lolium*	*Phalaris*	weedy Gramineae	*Medicago*	*Prosopis*	*Trifolium*
321											
224			+	1/2		1		1	1	.02	
256a	+	.03	6			3		+			
256b	.01	+ .04	23	1		5	6	6	4	.01	2
289.1			41/2			+		+			
147											

The remainder of the carbonized material consists of seeds and spikelet forks mixed and sparsely distributed in four of the samples. Due at least in part to the smaller amount of soil sampled, there were fewer taxa recovered from Bendebal compared to Jaffarabad (see below). The only cultigens are wheat (probably einkorn, *Triticum monococcum*) and barley *(Hordeum)*. Weedy legumes and grasses form the bulk of the other seeds, and there is one tentatively identified crucifer.

If carbonization had resulted from a general conflagration in a storage area, one would except large deposits of pure cultigens. The Bendebal samples clearly do not meet this expectation. For example, sample 321 from the floor of a possible storeroom contained no seeds at all. Alternatively, this mixture of seeds and spikelet forks found in the Bendebal samples could have become charred if, for example, debris from grain cleaning was dumped in a fire (7) ; this interpretation cannot be ruled out. However, the likelihood of archaeological preservation and recovery of plant materials is determined by the *frequency* with which they are intentionally put in a fire. Plant materials incorporated in fuel (e.g., dung or dung cakes) have a high probability of being preserved. The assemblage at Bendebal is quite consistent with this explanation of how this material became carbonized. If this explanation is correct, the particular exemplars of wheat and barley recovered could represent animal fodder, but there is no reason to doubt that these cereals were cultivated for human as well. The wild and weedy plants whose seeds were recovered may have grown in fields or in natural pasture around the site, and they are all suitable for fodder.

(7) cf. DENNELL, 1974 : 282

TABLE 45

Tepe Bendebal, Tepe Jaffarabad : identified charcoal

Identified charcoal			count	weight
BENDEBAL				
Sample	*321*	cf. *Populus/Salix*	4	.22
		diffuse porous	2	.10
	224	cf. *Populus/Salix*	1	.02
	256b	*Populus/Salix*	1	+
		cf.Amygdalus	1	+
		diffuse porous	4	.04
JAFFARABAD (weights not available)				
Sample	*602*	diffuse porous	2	
	1165a	cf. *Populus/Salix*	1	
	1675a	cf. *Populus/Salix*	1	
	1469a	cf. *Populus/Salix*	1	

JAFFARABAD

Jaffarabad is located on the Shaur river, about 7 km north of Susa. It is a small (less than 1 ha) mound which was occupied from the sixth to the fourth millennia B.C. (8). A few samples from Jaffarabad period I, Jaffarabad phase, pre-date the Bendebal samples, but they contain almost no carbonized material and will not be considered further.

The greatest quantity of carbonized plant remains from Jaffarabad comes from period III, the early fourth millennium, Susa phase (Tables 45, 46, 47). In contrast to archaeological deposits from many other sites, these are unusual for three reasons. First, there are high densities of carbonized material ; second, the samples contain almost no charcoal ; third, the seeds are primarily those of cultigens, rather than weeds. These characteristics reflect the nature of the deposits from which the samples come.

The high density of carbonized material is clearly a function of sampling strategy, which concentrated on archaeological deposits where carbonized material was apparent to the excavator. Nonetheless, the presence of carbonized material on the site requires explanation.

As is true of most archaeological sites, Jaffarabad was not burned in antiquity. This suggests that carbonized material was burned under controlled conditions, in hearths or possibly refuse disposal areas. Only a few samples have the low seed/charcoal (9) ratios which are characteristic of Bendebal (10). It is noteworthy that these samples also tend to have low overall densities of carbonized material as well. The fact that there is so little charcoal suggests that these deposits were not burned in wood-fueled fires. Despite the small quantity of charcoal, there were a number of samples with a high density of carbonized seeds, primarily cultigens. There are a few which seem to have been small deposits of nearly pure and generally well-preserved seeds (11). For example, lentils form the major component of samples 2347 ; 1723.1 ; 1723.2, wheat of samples 1464 ; 1165-a ; 1470 ; 1469-a, and barley of samples 2040 ; 1832 ; 1516 ; 1651 ; 1328. These samples have high S/(S + C) ratios (greater than 90% by weight), and of the identifiable cultigens, more than 70% by weight are lentil, wheat or barley. These samples, characterized by high densities of cultigens and relatively low proportions of weed seeds may have been burned either accidentally or as waste in the course of crop processing or food preparations (12) ; it is most improbable that these charred seeds originated in dung fuel. The Jaffarabad samples are quite different from those of Bendebal in this respect.

(8) DOLLFUS, 1978 ; a preliminary ethnobotanical report for Jaffarabad has been published elsewhere, MILLER, 1977
(9) To avoid the arithmetic problem of zero occuring in the denominator for samples with no charcoal, the ration of seeds (S) to total carbonized material (seeds, S + charcoal, C), S/(S + C) has been calculated.
(10) For example, samples 255 ; 533 ; 731
(11) In the preliminary report (MILLER, 1977), it was suggested that a number of samples were nearly pure. Now, taking the identifiable fragments into account, that generalization can no longer be supported, although a few samples do fit this description. In addition, the specific, interpretations of Well 824 and Hearth 678 presented in the preliminary report are not valid.
(12) DENNELL, 1974 ; 1976

TABLE 46

Tepe Jaffarabad : catalog of samples

Provenience Sq.	Locus	Sample	Level	Deposit Type	Sample approx. vol. soil(l)	tot.wt. charred(g)	density (g/l)	charcoal(C) (g)	seeds(S) (g)	S/(S+C)
PERIOD III , LEVELS 1 and 1c										
E10	53)	252	1	hearth	.5	.11	.22	.09	.02	.18
E9		533	1	basin	1	.05	.05	.04	.01	.20
F7		602	1c	fill	2	.04	.02	.02	.02	.50
F8/9		731	1c	fill	1	.11	.11	.08	.03	.27
PERIOD III , LEVELS 2 and 2f										
		263	2	near hearth	.5	.17	.34	.06	.11	.65
E9/10		1239	2f	fill	.5	.23	.46	0	.23	1.00
PERIOD III , LEVELS 3, 3a, 3b, 3c, 3d, 3f, 3g										
		1388	3c	hearth	.5	3.30	6.60	0	3.30	1.00
G7		1464	3	oven	.25	1.71	6.84	.01	1.70	.99
H8/9	678	1165a	3c	oven	.5	3.90	7.80	.03	3.87	.99
H8	678	1165b	3c	oven	.25	.93	3.72	+	.93	1.00
H8	673	1470	3c	oven	.1	.96	9.60	+	.96	1.00
H8/9	672	1468	3	floor, near oven 678	.25	5.90	23.60	0	5.90	1.00
H6		1216	3	near hearth	.25	1.15	4.60	0	1.15	1.00
G8		1465	3a	floor	.1	.04	.40	.02	.02	.50
F6/8	824	2391	3b	well	.25	3.89	15.56	+	3.89	1.00
F8/G8	824	2040	3b	well	1	7.78	7.78	.05	7.73	.99
F8	824	2487a	3d	well	?	.89	-	.05	.84	.94
F7/G7	824	2487b	3d	well	.5	.05	.10	+	.05	1.00
D10/E10		247	3	fill	1	.16	.16	.09	.07	.44
F7	784	1675a	3b	fill	.1	.10	1.00	.08	.02	.20
F7/8	784	1675b	3b	fill	.5	.23	.46	.03	.20	.87
F8/G8	824	1832	3b	fill	?	6.30	-	.02	6.28	1.00
F8/G8	824	2347	3b	fill	1	.65	.65	.01	.64	.98
G7		1723.1	3b	fill	1	1.11	1.11	.04	1.07	.96
G7		1723.2	3b	fill	1	3.77	3.77	.03	3.74	.99
I9		1516	3b	fill	.25	2.94	11.76	.19	2.75	.94
F8/G8		1651	3g	fill	.5	4.67	9.34	+	4.67	1.00
G8		1277	3g	fill	1	.37	1.52	.06	.31	.84
G8		1328	3g	fill	?	1.52	-	.05	1.47	.97
H9		1469a	3g	fill	.5	4.04	-	.19	3.85	.95
H9		1469b	3g	fill	1	.67	1.34	.02	.65	.97
H9		1469c	3g	fill		1.53	1.53	.01	1.52	.99
PERIOD I , LEVELS 5 and 5a										
A7/B7	1017	2472	5	pit	?	+	-	0	+	-
D6		2611	5	floor	?	.02	-	.02	0	0
C6/7		2471	5a	floor?	?	.02	-	+	.02	1.00
Miscellaneous baulk samples										
		1	3		i	.03	.03	.01	.02	.67
		2	3		2.5	.53	.21	.43	.10	.19
		3	3		5	1.10	.22	.86	.36	.33
		4	5	pit	5	.41	.08	.15	.26	.63

TABLE 47

Tepe Jaffarabad : table of taxa

Sample	*Hordeum* (g)	*Triticum dicoccum*(g)	*Triticum monococcum*(g)	Cereal ind.(g)	*Lens* (g)	Leguminosae (frags, g)	Other (*Triticum* spikelet fork, *Hordeum* internode *Vicia ervilia*)	*Aegilops*	cf. *Bromus*	*Lolium*	*Lolium* (fragments (g)	*Phalaris*	weedy Graminae (indet.)	wt.Graminae (total , g)	*Medicago*	*Prosopis* (g.)	Malvacae	*Fumaria*	*Galium*
PERIOD III, levels 1 and 1c																			
252	+			+															
533				+			*Trit.*sf:1/2												
602				.01			*Trit.*sf:1/2										+		
731				.01			*Trit.*sf:1												
PERIOD III ,levels 2 and 2f																			
263	.01			.03			*Trit.*sf:5 1/2												
1239	.02	.01		.05		.02	cf.*V.ervilia*:1						3	+	1				
PERIOD III , levels 3, 3a,3b, 3c, 3d, 3f, 3g																			
1388	.15	.24		.59	.59		*Trit.*sf:11			5	.01		3	.02					
1464	.28	.77		.47			*Trit.*sf:1			32				.07					
1165a	.16	1.05	.04	1.67	.35		*Trit.*sf:3 1/2			26			21	.08					
1165b	.08	.19		.44			*Trit.*sf:6			20				.03					
1470	.06	.43		.43			*Trit.*sf:3			4			3	.01					
1468	.46	1.05		4.22			*Trit.*sf:6			51	.06		5	.16					
1216	.06	.10		.31	.30	+	*Trit.*sf:1/2		2										
1465				.01															
2391	.62	.04		.46	1.71		*Trit.*sf: 6 1/2; *Hord.*int:1		1	1			2	+					
2040	2.09	.36		2.47	.39		*Trit.*sf:71/2;*Hord.*int:3			9	.01		9	.03					
2487a	.06			.16	.41		*Trit.*sf:1/2						3	+					
2487b	.01			.01	.01														
247	.01	.01		.01	.01														1
1675a						+	*Trit.*sf:3;*Hord.*int:1						3	+					
1675b	.03			.03	.09		*Trit.*sf:2			1				+					
1832	1.75	.19		2.57	.23	+	*Trit.*sf:3			3			6	.02					
2347	.06	.02		.05	.30														
1723.1	.01			.04	.60														
1723.2	.03	.01		.11	1.40														
1516	.75			1.15	.03								1	+					
1651	.99	.21		2.17	.19		*Trit.*sf:1 1/2			2			9	.03					
1277	.07	+		.17			*Trit.*sf:3 1/2			2			9	.02					1
1328	.52	.02		.49	.14		*Trit.*sf:3			2			3	+					
1469a	.28	.86	.02	2.34			*Trit.*sf:74;*Hord*.int.1	1	2	44			46	.16					
1469b	.01	.02		.09	.01	.11	*Trit.*sf:2						3	+					
1469c	.04	.02		.22	.02	.20							3	+					
PERIOD I , levels 5 and 5a																			
2472																			
2611																			
2471														+					
MISCELLANEOUS BAULK SAMPLES																			
1																+	5		
2				.04			*Trit.*sf:1 1/2		2	1	+		.02		1				
3	.03	03		.06	.02		*Trit.*sf:18 1/2;*Hord.* int:1		1	6	.01								
4							*Trit.*sf:1			2	.01		.08						

THE TAXA

CULTIGENS

Barley *(Hordeum)*. Table 48

No complete grain was recovered from Bendebal, so it is not possible to provide a species designation. Most of the barley from Jaffarabad is designated as the six-row type *(Hordeum vulgare)* since more than one-third of the whole grains were twisted. Of the 11 samples with more than ten barley grains, 10 included twisted grains. A few of the samples may have two-row barley *(H. distichum)*. Nowadays, in areas where both two-and six-row barley are grown, the latter tends to be irrigated (13) ; this was probably true in the past as well. Of the three main cultigens recovered from Jaffarabad, barley is the most ubiquitous and most plentiful by weight. In addition to barley grains, a few rachis internodes were recovered.

TABLE 48

Tepe Jaffarabad : barley

Sample	*N*	*L(mm)*	*B(mm)*	*T(mm)*	*L/B*	*T/B*
1832	32	4.6 (3.4-5.7)	2.1 (1.5-2.7)	1.6 (1.0-2.1)	2.19 (1.79-2.56)	.76 (.67-.90)
2040	35	4.7 (4.0-6.4)	2.3 (1.7-2.9)	1.8 (1.2-2.5)	2.06 (1.48-2.56)	.77 (.63-.95)

(13) HARLAN, 1968

Wheat *(Triticum)*. Tables 49 and 50

One unmeasurable grain, tentatively identified as einkorn *(Triticum monococcum)* was recovered from Bendebal. There were also several wheat spikelet forks and fragments.

TABLE 49
Tepe Jaffarabad : emmer

Sample	N	L(mm)	B(mm)	T(mm)	L/B	T/B
1165a	50	3.8 (2.1-5.6)	2.0 (1.2-3.6)	2.0 (1.1-3.2)	1.81 (1.33-2.23)	.93 (.78-1.07)
1464	26	4.8 (4.0-6.1)	2.7 (2.0-3.2)	2.3 (2.0-3.0)	1.81 (1.45-2.50)	.92 (.71-1.05)

TABLE 50
Tepe Jaffarabad : einkorn

Sample	L(mm)	B(mm)	T(mm)	L/B	T/B
1165a	3.6	1.4	1.5	2.57	1.07
	4.4	1.4	1.6	3.14	1.14
	2.8	1.2	1.4	2.33	1.17
	3.1	1.3	1.4	2.38	1.08
	5.2	2.0	2.2	2.60	1.10
X(N=5)	3.8	1.5	1.6	2.60	1.12

At Jaffarabad, wheat is somewhat less ubiquitous than barley, and represents about 40% by weight of the identified grain. Most of the identified wheat has been designated as emmer *(T. dicoccum)*, although two samples contain einkorn. Most samples contain spikelet forks of wheat. Contrary to the tentative identification presented in the preliminary report (14), bread wheat *(T. aestivum)* is not in evidencee in these samples.

Lentil *(Lens)* Table 51

The third most ubiquitous cultigen is lentil, present at Jaffarabad but absent at Bendebal. The lentils seem to be a small seeded variety, with average diameters of less than 3.0 mm.

TABLE 51
Tepe Jaffarabad : lentils

Sample	N	D(mm)	T(mm)	D/T
2391	111	2.9 (1.9-4.3)	1.7 (1.0-2.5)	1.71 (1.44-2.08)
1723.1	28	2.9 (1.9-3.4)	1.7 (1.3-2.3)	1.66 (1.35-2.27)
1723.2	50	2.8 (2.1-4.0)	1.6 (1.1-2.1)	1.73 (1.38-2.37)

(14) MILLER, 1977 : 50

Bitter vetch *(Vicia ervilia)*

One exemplar of a probable bitter vetch was identified at Jaffarabad. Vetch seed is reportedly fed to sheep in England (15), and is grown for animal feed in Iran today.

Other seeds

The remaining seeds are all from plants which could have grown in fields or pasture around Bendebal and Jaffarabad (16). All come from plants that are eaten by herbivores.
Grasses (Gramineae). Several wild grasses have been identified : *Lolium* (rye grass), *Phalaris* (canarygrass), cf. *Bromus* (brome grass), and *Aegilops* (goatgrass). *Lolium* is a common weed of grain fields. The *Lolium* seeds found in the Jaffarabad samples are smaller than those of the noxious *Lolium temulentum* (Table 52) (17). *Aegilops* is "devoured with avidity by goats" (18) and a number of species grow on grassy steppe or as field weeds (19). *Phalaris* and *Bromus* also grow in steppe or field conditions (20).

TABLE 52
Tepe Jaffarabad : *Lolium*

Sample	N	L(mm)	B(mm)	T(mm)	L/B	T/B
1469a	19	3.3 (2.6-3.6)	1.3 (1.0-1.5)	0.9 (0.7-1.0)	2.58 (2.23-3.20)	.72 (.64-.83)

Legumes (Leguminosae). Two weedy legumes, clover *(Trifolium)* and medick *(Medicago)* were found at Bendebal and Jaffarabad, as well as some mesquite *(Prosopis)*. *Prosopis* is eaten by sheep, which "eat the fruit pods, (while) the seeds pass through them undamaged" (21).
Miscellaneous. Seeds of *Fumaria* (fumitory), *Galium* (bedstraw), a member of the mallow family (Malvaceae) and a member of the mustard family (Cruciferae) complete the list of identified weedy taxa.

CHARCOAL (Table 45)

Only tentative identifications are advanced because the charcoal is highly fragmented. No piece is larger than 2 mm on a side, and there were very few pieces that had even one complete growth ring.

Poplar/willow *(Populus/Salix)*. The most commonly identified charcoal type at Bendebal and Jaffarabad is a diffuse porous wood that is tentatively identified as poplar/willow. Both of these types grow along rivers and streams in Khuzestan, and are among the most common types growing in the generally treeless, arid environment of Susiana.

Almond *(Amygdalus)*. A tentatively identified piece of almond charcoal was found in a Bendebal sample. Almond is a mountain wood and would not have grown right around the site. It probably could have been obtained from the lower elevations of the Zagros, about 100 km away, in the pistachio-almond forest. There is no other evidence for the utilization of forest products (such as pistachio or almond nutshells) at either Bendebal or Jaffarabad.

CONCLUSIONS

The plant assemblages from Bendebal and Jaffarabad are quite different due to differences in the nature of the deposits sampled. The Bendebal samples seem to be the remnants of spent fuel, as are a few of the Jaffarabad samples. Many of the rest of the Jaffarabad samples consist of the burnt remnants of crop and food processing activities. There is clear evidence for the cultivation of barley, wheat, and lentil, reported from the neighboring Deh Luran plain as early as the seventh millennium (22). Fallow fields,

(15) TOWNSEND and GUEST, 1974 : 526
(16) TOWNSEND and GUEST, 1974 ; 1980 ; BOR and GUEST, 1968
(17) BOR and GUEST, 1968 : 92 ; VAN ZEIST, 1973
(18) BOR and GUEST, 1968 : 174
(19) BOR and GUEST, 1968
(20) BOR and GUEST, 1968
(21) TOWNSEND and GUEST, 1974
(22) HELBAEK, 1969

stubble, and natural pasture were probably available for animals to graze on. The arboreal vegetation was probably similar to that of today, limited to riverine areas. Finally, all but one of the plants represented in the archaeological record could have come from within a few kilometers of the two sites, which suggests that the inhabitants did not need to travel far to meet their primary fuel and subsistence needs, and did not use extensive trade networks to obtain the plant products recovered archaeologically.

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