AN ARCHAEOBOTANICAL STUDY OF GANJ DAREH TEPE, IRAN

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ABSTRACT: Excavations at Ganj Dareh Tepe, a mound site in the Zagros Mountains of western Iran, have been carried out by P.E.L. Smith. The Early Neolithic occupation covers a span of time between c. 7500 B.C. (or earlier) and c. 6600 B.C. Five principal stratigraphic levels (A to E) are distinguished, the earliest one (level E) without architectural remains. The results of the examination of the floral remains are presented in table 1 (seeds and fruits) and tables 6 and 7 (charcoal).

Palynological evidence for western Iran suggests that a forest-steppe constituted the natural vegetation of the Ganj Dareh area in the early Holocene. This conclusion is supported by the plant remains recovered from the site, which include *Pistacia* (pistachio), *Amygdalus* (almond), various leguminous genera such as *Astragalus* and *Trigonella*, *Stipa* (feather grass) and other grasses.

The only cereal species at Ganj Dareh is two-rowed hulled barley. Both wild and domestic barley (*Hordeum spontaneum* and *H. distichum*) could be established. The size class of the lentils, which occur rather frequently, corresponds to that of the wild species. Pistachio must have been an important wild food plant, especially in the lower levels. The role of barley in the economy of the site increased in the course of the habitation.

For construction purposes, especially the timber of poplar and/or willow was used. Other wood types attested for the site are *Pistacia*, *Celtis* (hackberry), *Prunus*-type and *Rhamnus* (buckthorn). The plant husbandry of Ganj Dareh is compared with that of some other Early Neolithic sites (table 10).

KEYWORDS: Ganj Dareh Tepe, barley, pistachio, forest-steppe, plant collecting, plant cultivation, use of wood.

1. INTRODUCTION

Ganj Dareh Tepe is a small mound site in the Zagros Mountains of western Iran, in what was formerly called Kermanshah District. It lies in a small upland valley at an altitude of c. 1400 m above sea-level, near the modern ethnic boundary between Kurdistan and Luristan. Discovered and briefly tested in 1965, it was more extensively investigated in four later seasons (1967, 1969, 1971, 1974). Over one-fifth of the present volume of the mound was excavated. There are five principal stratigraphic levels: A, B, C, D and E (from the top down). Level E, the earliest occupation, has no solid architectural remains and is characterized by many shallow depressions ('firepits') dug into virgin soil, with ashy zones and burnt stones. Level D is a group of tightly clustered brick and mud buildings, some with two stories, which were destroyed by fire. It contains a small number of examples of simple soft-ware pottery as well as some very large clay storage(?) vessels. Levels C, B and A are essentially continuations of level D with perhaps less elaborate architecture. Habitation of the site ceased with the Early Neolithic although there are a few traces of Iron Age and recent Islamic utilisation. More complete descriptions and discussions of the site are given in Smith (1967; 1968; 1970; 1972; 1974; 1975; 1976; 1978; 1983) in Smith & Young (1966; 1983) and in Smith & Crépeau (1983).

The role of plants in the diet and technology of Ganj Dareh was uncertain until the present study was made. We were not fortunate enough during excavations to discover large concentrations of plant remains such as are known in some other Near Eastern sites. The presence of many grinding and pounding stones after level E was suggestive of vegetable food processing, and the numerous flint blades bearing 'sickle polish' also pointed in the direction of plant exploitation. The yield of seeds and other remains in the samples hand-sorted in the field was small, however, and we were not optimistic that water separation of the earth and ash samples processed each season would be very rewarding. The extensive burning of level D and the resulting porous deposits, plus the gritty and abrasive nature of the soils in later deposits and the leached subsurface zone in level A, were hardly

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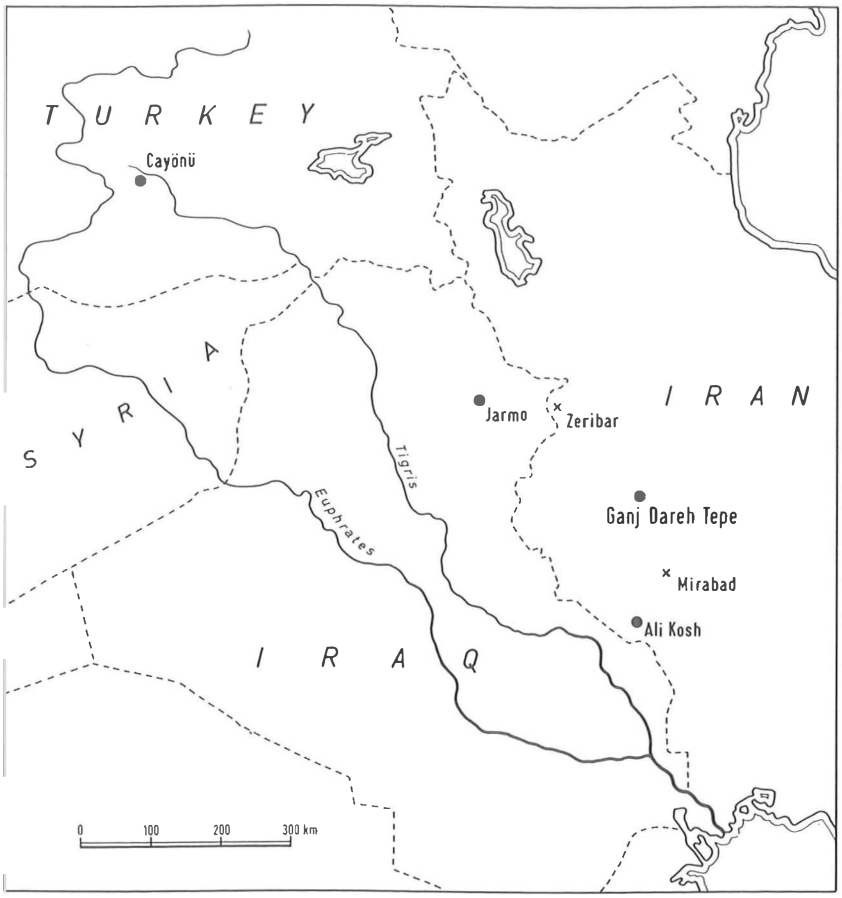

Fig. 1. West Iran and adjacent regions with the location of Ganj Dareh Tepe and other Early Neolithic sites mentioned in this paper. Zeribar and Mirabad are pollen-diagram sites (5.1.).

conducive to preservation even of the remains that were originally present. Indeed, the lack of information on the botanical materials from the site appears to have left the impression among some writers that no cereal or other plant remains at all were recovered.

In the light of this initial pessimism, it is gratifying that the floral remains are as abundant and representative as this report indicates. Particularly interesting is the identification by Professor van Zeist and his colleagues of barley, both wild and cultivated, in all levels of the site. Until recently we had assumed that level E, the basal occupation, was lacking in cultivated plants, just as, according to Hesse's (1978) analysis of the faunal remains, there are no traces of animal domestication before level D when goats were coming under cultural control. It is clear that the situation during the earliest phase of Ganj Dareh was more complex than we had thought and that our attempts at explanation must now be reconsidered in this light. There are in fact a number of very different potential models to account for the transition from level E to level D, and it is not yet possible to say which are the most plausible.

In good part the nature of the explanatory model to be adopted for Ganj Dareh as a whole is articulated with the problem of the absolute chronology of the site. This is a difficulty that is not yet resolved. The problem is not unique at Ganj Dareh, of course. Virtually all the 'Early Neolithic' sites in the Zagros have produced internally contradictory radiocarbon series, and thus we do not yet know whether a long or a short chronology should be adopted for the area. At Ganj Dareh we have made 20 radiocarbon determinations. Those from levels A to D are reasonably coherent and suggest a span of time between c. 7300 B.C. and 6600 B.C. (uncalibrated). Unfortunately the results from level E are eccentric. The first determination from a sample obtained in 1965 gave an age of 8450 ± 150 B.C. (Gak-807). Five other samples obtained in later seasons gave consistent results averaging c. 6600 B.C., *i.e.* younger than many of those from the subsequent levels. We do not have a good explanation for these discrepancies, nor can we say whether contamination of the base of the site by post-1965 agencies such as irrigation water is involved. Without going here into the reasons for our thinking, we can only say that we are inclined to believe that level E is no younger than c. 7500 B.C., and that levels D to A extend from c. 7300 B.C. to the early 7th millennium.

We hope that this chronological problem will eventually be resolved, but at present time it is an obstacle to a clear understanding of the place of Ganj Dareh in the early food-producing period of the Zagros Mountains, of eastern Mesopotamia and of the Iranian Plateau. Regardless of precisely where in the 7th, 8th or even 9th millennia the site occupations occur, however, the floral materials described in this paper make a substantial contribution to our knowledge of the human use of plants for food, fuel and construction material in early Holocene times in this part of the world. The information concerning the natural vegetation in the vicinity of the site is another welcome addition to our knowledge of the Zagros environment at this time.

The present paper is the outcome of a cooperative effort. P.E.L. Smith, the excavator of the site, wrote the introduction and provided detailed information on the samples that had been secured in the field under his supervision. The examination of the charred wood remains was executed by W.A. Casparie and M. Suwijn (section 4, tables 6 and 7). The sorting of the samples for seeds and the preliminary identifications were carried out by R.M. Palfenier-Vegter. W. van Zeist is responsible for the seed identifications and for the discussion of the results.

G.C. Hillman (Institute of Archaeology, London) advised on the identification of some seed types. The drawings were made by H.R. Roelink, and G. Entjes-Nieborg rendered secretarial assistance in the preparation of the manuscript.

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2. THE SAMPLES

Two main types of botanical samples can be distinguished. So-called hand-picked samples consist of seeds or charcoal observed in the field with the naked eye. The majority of the samples are flotation samples: in the field c
coal were recovered from occupational deposits by means of water separation (flotation). Of each of the 1974 flotation samples, about half the volume was processed in the field and the remaining part in the laboratory in Groningen. There were no great differences in the plant remains recovered from both parts of these samples, and consequently the results of the subsamples have been combined. In addition, samples of burnt brick or clay with imprints of vegetable matter were secured for identification.

From the flotation samples, charred seeds and fruits and charcoal remains large enough to be identified were sorted out in Groningen. Non-carbonized seeds were discarded. The conditions at Ganj Dareh are such that only carbonized or mineralized (not observed) seeds could have been preserved for a long time. Fresh-looking seeds must have been due to recent intrusion probably brought about by burrowing animals or to contamination in the field. Not all flotation samples yielded carbonized seeds and/or charred wood remains suitable for identification.

The results of the seed and fruit identifications are shown in table 1. For each of the samples, the level (see section 1), the excavation unit, the archaeological context (provenance) and the 'degree of integrity' are given. Not all samples could be attributed to one specific level. The archaeological contexts are grouped here into 4 categories (provenance codes):

I heart, oven, kiln
II firepit (level E only)
III ashy soil, ash lens, dark soil
IV other deposits (loose brown soil, occupation layer, room fill, *etc.*)

The distinction between groups III and IV is sometimes rather arbitrary.

The degree of integrity provides information on the reliability of the archaeological unit from which the sample concerned is derived. Seven degrees of integrity are distinguished by the excavator:

1. In situ, pure, no evidence of mixture or contamination.
2. Probably in situ and unmixed.
3. Essentially in situ, but some signs of disturbance or contamination (rodent holes, pits, burials).
4. Not in situ activity or occupation surface, but provenance known with reasonable certainty (room fill, collapsed rubble, *etc.*).
5. Not in situ. Derived materials *e.g.* materials washed out of a room or area. Some degree of mixture possible.
6. Mixed from several strata.
7. Hopelessly uncertain (collapsed profiles, *etc.*).

In evaluating the results of the botanical examination the degree of integrity of the samples has not been taken into consideration. In table 1 the samples are in the first place arranged according to level (A-E) and within each level according to provenance code and sample number, respectively.

Table 1. Numbers of seeds and fruits in the flotation samples. Values of less than ½ are indicated with a plus-sign (+). In the table are not included: sample 46: *Echinaria* 1
sample 129: *Pisum* 1; sample 136: *Bromus* ½, Malvaceae 1; sample 141/2: *Cleome* 3; sample 167: *Fumaria* ½; sample 171: *Medicago radiata* 1; sample 176: *Cleome* 1; sample 191: *Pyrus/Malus* +, unident. Umbelliferae 1; sample 199: Malvaceae 1.

Level	Provenance code	Sample number	Unit	Integrity code	Hordeum	Hordeum internode(s) (fragments)	Agrostis-type	Stipa	Triticoid type	Unident. Gramineae	Lens	Astragalus	Medicago	Melilotus-type	Scorpiurus	Trigonella astroites	Trigonella-type	Vicia	Unident. Leguminosae	Pistacia	Amygdalus	Unident. Cruciferae	Neslia	Malcolmia	Euclidium	Brassica-type	Silene	Bellevalia	Galium	Glaucium	Heliotropium	Scirpus maritimus	Ziziphora	Unidentified seeds
A	I	58	523	2	-	-	-	-	-	-	½	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	III	1	77	3	+	-	-	-	-	-	-	-	-	-	-	-	-	1½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	III	3	52	5	6	-	-	-	-	½	½	-	-	-	-	-	-	1	-	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	III	24	230	4	+	-	-	-	-	-	-	-	-	-	-	-	-	1	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	1
A	III	25	236	4	+	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	III	26	231a	4	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	III	57	543	4	+	-	2	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A	IV	4	7	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A-B	I	61	542	6	-	-	-	-	1	-	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
A-B-D	IV	27	258	6	2	-	2½	-	-	-	1	84	-	-	2	27	54	-	155	-	-	-	3	-	-	-	1	½	-	-	-	5	1	-
B	I	67	648	1	5	-	-	-	1	-	1	-	-	-	-	-	-	-	-	+	-	-	-	-	2	-	-	-	-	-	-	1	-	-
B	I	75	649	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	I	100	741	1	5	-	-	-	-	-	-	7	-	-	-	-	-	1	-	1½	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	I	108	741	1	5	-	-	-	-	-	3	-	-	-	-	-	-	2	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	9	101	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	15	121	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	35	311C	1	14	-	2	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	36	311C	1	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	38	311D	1	3	-	-	-	-	1	½	1	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	1	-	-
B	III	37	304	2	7	-	1	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	47	415	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	69	651	1	14	-	1	-	3	1	-	-	1	-	-	-	1	1	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	70	651	1	52	-	-	10	1	2	1	1	-	1	-	-	-	-	-	3	+	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	71	651	1	2	-	1	½	-	-	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	84	644	4	+	-	-	-	-	-	½	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
B	III	93	658	2	+	-	-	-	-	-	-	-	-	-	-	-	-	½	-	+	-	-	-	-	-	1	-	-	-	-	-	1	-	-
B	III	95	729	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	III	106	728	4	-	-	-	-	-	+	1½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	IV	12	136	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	IV	43	424	4	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	IV	52	514	4	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	1	-	-	-	-
B	IV	55	515	5	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	IV	80	647	2	10	-	-	-	1	2	-	7	-	-	-	-	-	-	-	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	IV	81	647	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	IV	83	674	2	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	IV	85	674	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	IV	91	674	2	1	-	-	-	-	-	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	IV	88	644	4	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	½	-	-	-	-	-	2	-	-	-	-	-	-	-	-
B	IV	90	693	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B	IV	97	693	1	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B-C	I	48	483	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B-C	I	98	703	6	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-
B-C	IV	94	658/681	6	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	½	-	-	-	-	-	-
B-C-D	III	31	289	6	2	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	½	-	-	-	-
B-D	III	29	308	6	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
C	I	45	431	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	I	46	437	2	4	-	4	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
C	I	63	564	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	+	-	-	-	-	-	-	-	-	-	-	1	-	-
C	I?	111	797	2	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 1 (continued).

Level	Provenance code	Sample number	Unit	Integrity code	Hordeum	Hordeum internode(s) (fragments)	Agrostis-type	Stipa	Triticoid type	Unident. Gramineae	Lens	Astragalus	Medicago	Melilotus-type	Scorpiurus	Trigonella astroites	Trigonella-type	Vicia	Unident. Leguminosae	Pistacia	Amygdalus	Unident. Cruciferae	Neslia	Malcolmia	Euclidium	Brassica-type	Silene	Bellevalia	Galium	Glaucium	Heliotropium	Scirpus maritimus	Ziziphora	Unidentified seeds
C	III	65	597	1	½	-	-	-	-	1	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C	III	76	613	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C-D	IV	110	766	6	25	-	-	-	3	-	1	-	-	-	-	-	-	1	1	+	-	-	-	-	-	-	-	-	-	-	-	1	-	-
C-D	IV	124	683	6	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	I?	102	708	2	3	-	-	-	-	-	-	-	-	-	1	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	I	185	1434	1	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	III	34	315	4	+	-	-	-	-	-	-	30	2	-	-	11	-	-	15	+	-	-	-	-	-	-	-	-	-	-	-	1	-	-
D	III	109	735	4	+	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	½	-	-	-	-	-
D	III	115	824	3	-	-	-	-	1	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	III	117	845	3	-	-	-	-	-	-	½	4	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
D	III	141/2	1155	5	-	-	2	-	-	-	3	21	-	-	-	1	1	-	-	8	-	-	-	-	-	-	1	-	-	-	-	5	-	-
D	III	144	1158	5	-	-	15	-	1	-	½	1	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
D	III	145	1158	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	+	-	-
D	III	146	1166	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	+	-	-	-	-	-	-	-	-	-	-	-	-	-
D	III	147	1182	5	½	-	2	-	-	-	-	-	-	-	-	-	-	-	-	4	+	-	-	-	-	-	-	-	-	-	-	-	-	-
D	III	187	1452	2	-	-	1½	-	-	-	1	-	-	-	-	-	-	-	-	1½	+	-	-	-	-	-	-	3	-	-	-	1	-	2
D	III	188	1458	2	-	1	6	-	-	-	-	-	-	-	-	-	-	-	-	1½	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	III	189	1482	4	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	1	-	-	-	-	5	-	-
D	III	190	1482	4	+	-	2	-	-	-	-	1	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	6	-	-
D	IV	14	71	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
D	IV	119	885	4	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	IV	129	1079	4	19	-	-	-	1	2	1	5	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	IV	148	1178	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	IV	149	1204	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	+	-	-	-	-	-	-	-	-	-	-	6	-	-
D	IV	153	1213	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-
D	IV	155	1264	5	-	-	4	-	-	-	-	14	-	-	-	2	3	-	5	2	+	-	-	-	-	-	-	-	-	-	-	18	-	-
D	IV	180	1389	4	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D	IV	183	1399	4	5	5	95	1	1	1	1½	1	-	-	-	-	-	1½	-	4	+	1	-	-	-	-	3	-	-	-	-	-	-	-
D	IV	186	1415	4	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	7	+	-	-	-	-	-	-	-	-	-	-	1	-	-
D	IV	191	1488	1	-	1	1	-	-	-	-	4	-	-	-	-	5	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	1	4
D	IV	198	1569	2	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	1½	-	-	-	-	-	-	2	-	-	-	-	-	-	-
D-E	III	122	1029	6	8	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	1	-	-
D-E	III	150	1196	6	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	7	+	-	-	-	-	-	-	-	-	-	-	7	-	-
D-E	III	168	1214	6	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	7	+	-	-	-	-	-	-	-	-	-	-	-	-	-
D-E	III	169	1214	6	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	1
D-E	III	175	1228	6	1	-	1	-	-	-	-	-	-	-	-	-	-	-	1	5	-	-	-	-	-	-	-	-	-	-	-	4	-	-
D-E	III	181	1407	6	1	-	15	-	-	-	½	-	-	-	-	-	-	-	-	1	+	-	-	-	-	-	-	-	-	-	-	-	-	-
D-E	III	182	1407	6	1½	1	9	-	-	-	-	-	-	-	-	-	-	1	-	+	+	-	-	-	-	-	1	-	1	-	-	-	-	-
D-E	III	195	1495	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	½	-	-	-	-	-	-	-	-	-	-	-	-	-	-
D-E	IV	152	1211	6	-	-	3	-	-	-	-	1	-	-	-	-	-	-	-	8	+	-	1	-	-	-	-	-	-	-	-	1	-	-
E	II	132	1144	1	+	-	-	-	-	-	-	3	-	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	1	-	-
E	II	136	1104	1	55	1	-	1	1	6	1	50	-	-	-	-	1	-	-	8	+	-	-	-	3	-	-	-	-	-	1	19	-	4
E	II	140	1126	1	½	-	-	½	-	-	-	14	-	-	-	-	-	-	2	7	+	-	-	-	-	-	-	-	-	½	-	2	-	+
E	II	157	1278	1	+	-	11	+	-	-	-	5	-	-	-	1	-	-	-	6	+	-	-	-	-	-	-	-	-	-	-	10	-	-
E	II	158	1278	1	1	-	1	-	-	-	-	1	1	-	-	-	-	-	-	25	+	-	-	-	-	-	-	-	-	-	-	5	-	-
E	II	159	1322	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	II	161	1322	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	1	-	-	-	-	-
E	II	162	1295	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	II	163	1302	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	II	164	1313	1	-	-	2	-	-	-	-	2	-	-	-	1	-	-	-	4	+	-	-	-	+	-	-	-	-	-	-	1	-	-
E	II	165	1321	1	+	-	1	-	-	-	-	½	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
E	II	166	1323	1	½	-	7	1	-	+	2½	2	-	-	-	-	-	-	-	30	+	-	-	-	-	-	-	-	-	-	1	9	-	-

Table 1 (continued).

Level	Provenance code	Sample number	Unit	Integrity code	Hordeum	Hordeum internode(s) (fragments)	Agrostis-type	Stipa	Triticoid type	Unident. Gramineae	Lens	Astragalus	Medicago	Melilotus-type	Scorpiurus	Trigonella astroites	Trigonella-type	Vicia	Unident. Leguminosae	Pistacia	Amygdalus	Unident. Cruciferae	Neslia	Malcolmia	Euclidium	Brassica-type	Silene	Bellevalia	Galium	Glaucium	Heliotropium	Scirpus maritimus	Ziziphora	Unidentified seeds
E	II	167	1330	1	1	-	5	-	-	+	1½	1	-	-	-	1	-	-	-	22	+	-	-	-	2	-	1	-	-	-	-	3	-	-
E	II	171	1284	1	-	-	1	-	-	-	-	-	-	-	-	-	-	½	2	30	+	-	2	-	1	-	-	-	-	1	-	6	-	1½
E	II	172	1289	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	7	+	1	-	1	-	-	1	-	-	-	1	3	-	-
E	II	173	1290	1	-	-	2	-	-	-	-	-	-	-	-	-	1	-	-	5	+	-	1	1	-	-	-	-	½	-	-	1	-	-
E	II	174	1305	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	+	-	-	1	-	-	-	-	-	-	-	-	-	-
E	II	176	1312	1	2	1	6	+	-	-	-	-	-	-	-	-	-	-	3	4	+	-	½	-	-	-	-	-	-	1½	-	17	-	-
E	II	177	1303	1	1	-	2	-	-	-	-	1	-	-	-	-	1	-	-	4	+	1	½	-	-	-	-	-	-	1	-	1	-	-
E	II	179	1348	1	+	-	-	-	-	-	-	-	-	-	-	-	-	-	3	9	+	-	-	-	-	-	-	-	-	-	1	1	-	-
E	III	123	1041	2	+	-	-	-	1	-	4	-	-	-	-	-	-	-	-	1½	-	-	-	-	2	-	-	-	-	-	-	-	-	-
E	III	156	1237	1	+	-	3	-	-	-	-	-	-	-	-	-	-	-	-	2	+	-	-	-	-	-	-	-	-	-	-	-	-	-
E	III	160	1281	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	III	184	1413	2	+	-	5	-	-	1	1	-	-	-	-	-	-	-	-	1	+	-	-	-	-	-	-	-	-	-	-	2	-	-
E	III	192	1518	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	½
E	III	193	1530	2	+	1	-	-	-	½	-	-	-	-	-	-	-	-	-	4	+	-	-	-	-	-	-	-	-	-	-	2	-	-
E	III	194	1536	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	4	-	-	-	-	2	-	-
E	III	196	1556	2	-	-	-	-	-	-	-	5	-	-	-	-	-	1	-	2½	+	-	-	-	-	-	-	-	-	-	-	2	-	-
E	III	199	1595	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	1	-	-
E	IV	154	1242	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1	+	-	1	-	-	-	-	-	-	-	-	-	-	-
E	IV	170	1255	2	3	-	11	1	-	-	-	7	-	-	1	-	-	-	-	17	+	-	-	-	2	-	-	-	-	1	2	15	-	-
E	IV	178	1340	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
E	IV	197	1595	1	-	-	1	-	-	-	-	3	-	-	-	-	-	-	-	11	+	-	-	-	-	-	1	-	-	-	-	+	-	-

A few of the hand-picked samples yielded charred pistachio (*Pistacia*) nutshell remains (see 3.1.); the other samples consisted of modern seeds only. Of a few imprints of vegetable matter the species has been determined (3.11.). Most of the imprints consisted of unidentified plant remains, mainly grass stems.

The results of the identification of the charred wood remains from the flotation samples are presented in table 6. Charcoal fragments smaller than 1 mm^3 have not been identified because on these fragments the characteristic features cannot usually be observed adequately. Some of the larger charcoal pieces could not be identified because of poor preservation. In table 6 the volumes of each of the wood types, the volumes of the identified fraction and the total volumes per sample are shown. The samples in table 6 are arranged in the same way as those in table 1. As initially the differentiation between the charcoal of *Pistacia* and *Celtis* posed problems (4.2.), in the table of the flotation samples both types are shown combined.

Two groups of hand-picked charcoal samples are distinguished in table 7, *viz.* samples from timber which had evidently formed part of the structure of houses (architectural), and those from wood whose function is not clear.

3. PLANT REMAINS OTHER THAN WOOD

Not all seed and fruit types established for Ganj Dareh Tepe are mentioned in this section. Only seeds and fruits which gave occasion to some comments will be treated here. For descriptions and illustrations of the other types the reader is referred to van Zeist & Bakker-Heeres (1982(1985)).

3.1. Anacardiaceae

Pistacia (Pistachio). From nearly all samples listed in table 1 *Pistacia* nutshell remains were recovered. No complete nutshells were found. The fragments have been converted to whole specimens on the ba-

sis of 0.021 gram per *Pistacia* nut. This is the average weight obtained for charred pistachio nutshells from Ramad, in western Syria (van Zeist & Bakker-Heeres, 1982(1985)): 5.2.). If the fragments equal less than half a nutshell, this is indicated with a plus-sign (+). Three hand-picked samples from level E (nos. 76, 8
mains. In one case length and breadth of the nut could be determined: 5.1×6.4 mm.

Pistacia atlantica Desf. is a common constituent of the forest-steppe vegetation assumed for the surroundings of the site (see 5.).

3.2. Boraginaceae

Heliotropium (Heliotrope). A characteristic feature of *Heliotropium* nutlets is the protruding hilum (fig. 2: 20). The fruit surface is rugulose. Dimensions of 4 fruits: 1.3×1.0-1.7×1.4 mm.

The absence of other boraginaceous species, such as *Arnebia* (prophet-flower) and *Lithospermum* (gromwell), the fruits of which can be quite numerous in archaeological sites, is striking.

3.3. Capparidaceae

Cleome. Samples 141 and 176 yielded a few reniform *Cleome* seeds (c. 0.8×0.7 mm). The surface is densely covered with minute granulae arranged in concentric rows (fig. 6: 1). Various *Cleome* species are reported for Iran (Hedge & Lamond, 1970).

3.4. Caryophyllaceae

Silene spec. (Catchfly). Reniform seeds with concentric rows of radially elongated and flat papillae on the side faces as well as on the dorsal surface. Samples from D and E levels yielded one or a few, mostly more or less seriously deformed seeds. The seed depicted in fig. 6: 2 is the best preserved specimen. Greatest diameter of 15 seeds: 1.06(0.95-1.2) mm. In Iran (*cf.* Parsa, 1951: pp. 1055-1138) and in other Near Eastern countries *Silene* is represented by great numbers of species.

The Ganj Dareh *Silene* seed type is largely similar to that found in Ramad (van Zeist & Bakker-Heeres, 1982(1985): fig. 23: 4), but differs from that established for Erbaba (van Zeist & Buitenhuis, 1983: fig. 10: 4, 5). In the latter type the papillae on the dorsal surface are round and pointed.

3.5. Cruciferae

Brassica-type (Mustard). A few almost spherical *Brassica*-type seeds were recovered, the best preserved specimen of which is depicted in fig. 2: 14. The seed wall was no longer present, so that the interior surface is exposed. The location of the cotyledons and the radicle shows up clearly. In fact this configuration made the identification as *Brassica*-type possible. The greatest diameter of the charred seeds is c. 1.6 mm. Most likely a *Brassica* species is represented. *B. elongata* Ehrh., a species from rocky slopes and steppes, at elevations between 450-1700 m, could come into consideration (Davis, 1965: p. 264; Hedge, 1968: pp. 33-34).

Euclidium. A two-seeded cruciferous fruit type (fig. 2: 13) matches that of modern *Euclidium syriacum* (L.)R.Br. kindly placed at our disposal by Dr. G.C. Hillman (London). The nervation on the fruit valves shows a reticulate pattern. The branched hairs have not survived carbonization. Dimensions of the charred fruit remains: c. 1.4×1.2×1.6 mm. One fruit (with two seeds) is listed as 2 in table 1. *Euclidium syriacum* is an annual herb from steppe and fields.

Malcolmia-type (Malcolmia). Small, flat seeds, elliptic in outline, rounded at the apex, more or less truncated at the base. The top of the radicle is free from the cotyledons (fig. 2: 16). This type shows much resemblance to *Malcolmia* seeds. Only three seeds of this type were found. Dimensions: c. 1.1×0.6 mm. Various *Malcolmia* species are reported for Iran (Hedge, 1968: pp. 252-266).

Neslia apiculata (Ball mustard). Characteristic of *Neslia* are the one-seeded fruits. Several capsule valves were found. They are almost circular with a reticulate surface structure (fig. 2: 18). Mean dimensions of 6 charred capsule valves: 1.65×1.55 mm (possible remains of fruit stalks are not included in the measurements). One capsule valve is counted as 1 (table 1).

In addition, one intact and one half seed have been ascribed to *Neslia*. The laterally flattened seed is charaterized by the radicle which forms a radicular ridge, on both faces separated from the cotyledons by a radicular furrow (fig. 2: 17).

Only one *Neslia* species is reported for Iran, *viz. N. apiculata* Fisch., Mey. & Avé-Lall, which is closely related to *N. paniculata* (L.)Desv. (Hedge, 1968: pp. 129-130). At present *Neslia apiculata* is a widespread species from fields, roadsides, *etc.* (Davis, 1965: p. 350).

3.6. Cyperaceae

Scirpus maritimus (Sea club-rush). The three-sided nutlets of *Scirpus maritimus* L. (fig. 2: 12) have been reported for various prehistoric sites in the Near East. This fruit type occurs quite frequently in the Ganj Dareh deposits, particularly in D and E levels. The fruits (table 2) are, on average, somewhat larger than those from Aswad (the only other

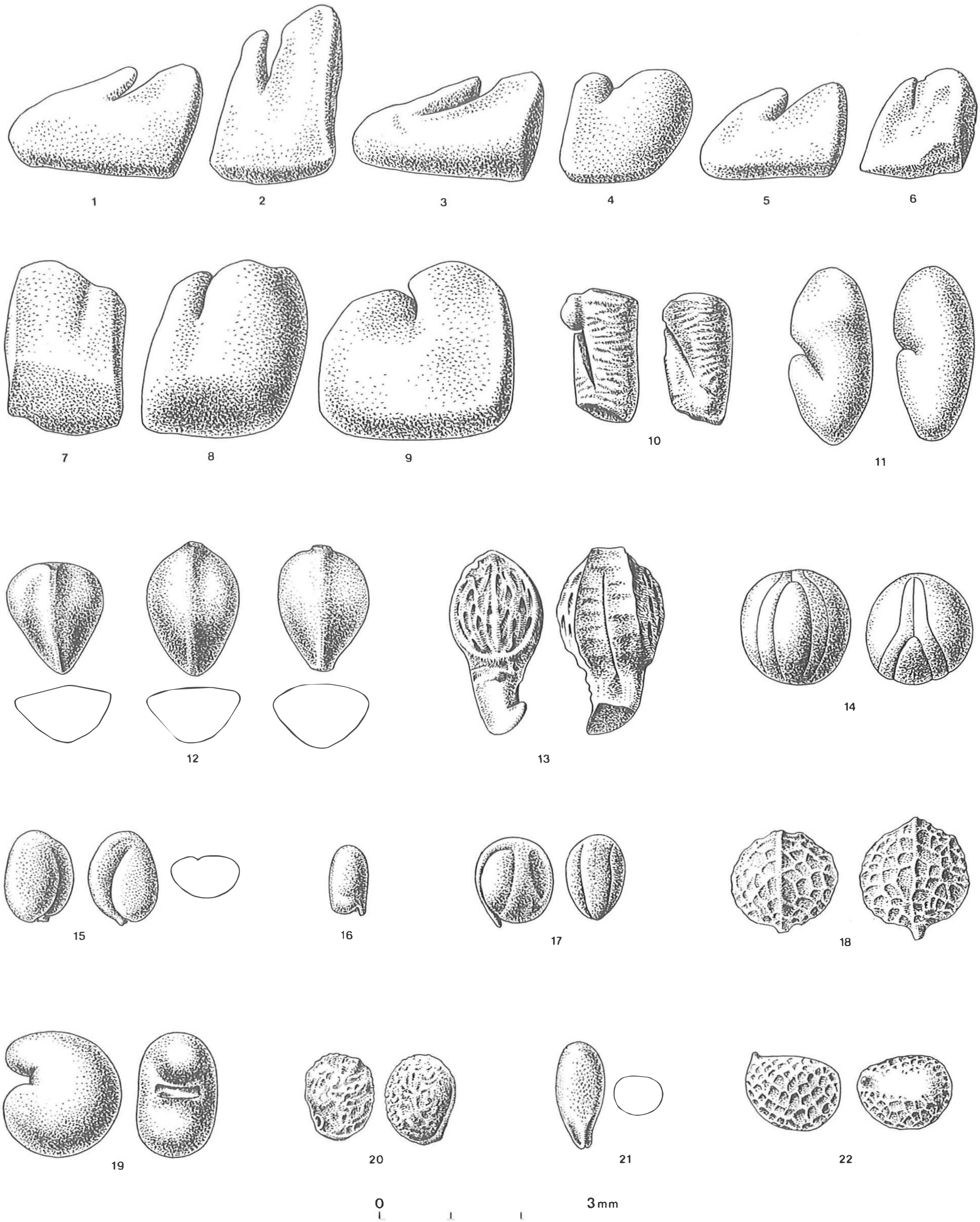

Fig. 2. 1, 2, 3: *Astragalus,* GD 27; 4-9; *Astragalus,* GD 34; 10: *Trigonella astroites,* GD 27; 11: *Trigonella*-type, GD 27; 12: *Scirpus maritimus,* GD 136; 13: *Euclidium,* GD 136; 14: *Brassica*-type, GD 88; 15: Unident. Cruciferae, GD 172; 16: *Malcolmia*-type, GD 171; 17: *Neslia,* seed, GD 173; 18: *Neslia,* capsule, GD 27; 19: Malvaceae, GD 136; 20: *Heliotropium,* GD 166; 21: *Ziziphora,* GD 192; 22: *Glaucium,* GD 176.

Table 2. Dimensions in mm of *Scirpus maritimus* fruits.

		Length	Breadth	Thickness
Ganj Dareh	Min.	1.6	1.3	0.8
136	Aver.	1.74	1.41	0.89
(N = 15)	Max.	1.9	1.5	1.0
Ganj Dareh	Min.	1.4	1.2	0.7
155	Aver.	1.66	1.42	0.88
(N = 16)	Max.	2.0	1.6	1.1
Tell Aswad	Min.	1.3	0.9	
West 1.40	Aver.	1.58	1.15	
(N = 71)	Max.	1.9	1.4	

site for which a fairly great number of *Scirpus* nutlets has been measured).

Scirpus nutlets in Near Eastern prehistoric sites are distinctly smaller than those of *Scirpus maritimus* in West-European archaeological sites (van Zeist & Bakker-Heeres, 1982(1985): 5.11.). Mouterde (1966: pp. 167-168) distinguishes a separate species, *Scirpus tuberosus* Desf., which is reported for fresh-water as well as for more or less saline habitats.

3.7. Gramineae

Hordeum (Barley). The only cereal species established for Ganj Dareh is *Hordeum*. It is represented in a great number of samples. Unfortunately, the preservation is generally poor. More or less complete caryopses are rare and even those have mostly been deformed as a result of the carbonization. By far the majority of the barley remains consists of broken grains and grain fragments. Of complete or almost complete grains the length and the greatest breadth were determined (table 3).

The Ganj Dareh barley is of the hulled type. Relatively well preserved grains point to two-rowed barley. No distinctly lop-sided grains, indicative of six-rowed barley (*Hordeum vulgare*) were found. The grains are all of the straight type. The conclusion of two-rowed barley is supported by the rachis internode remains. In some of them, remains of the stalks of the sterile lateral florets are preserved (fig. 5: 5). In this connection it may be remembered that in barley, each rachis internode bears three florets or one-flowered spikelets. In two-rowed barley only the median floret develops a grain, the lateral ones being sterile. In six-rowed barley, all three florets on one internode are fertile.

In principle two two-rowed hulled barley species come into consideration, *viz.* domestic *Hordeum distichum* L. emend. Lam. and its wild progenitor *Hordeum spontaneum* C.Koch. The Zagros Mountains in Iran is one of the regions in which wild barley forms massive stands in primary habitats (Zohary, 1969; Harlan & Zohary, 1966). Modern grains of wild and domestic two-rowed barley are not difficult to separate. As is clear from figure 4, in which modern grains of *Hordeum distichum* and *H. spontaneum* from Ramad, in western Syria, are illustrated, the grains of wild barley are markedly thinner than those of the domestic type. However, in subfossil carbonized grains this distinction is often less clear, which is largely due to puffing and other deformations of the grain through carbonization. At Ganj Dareh wild-type as well as domestic-type barley grains could be ascertained, albeit in small numbers (table 4). Some of the best preserved specimens of both types are shown in figure 3.

It should be mentioned that the size of the grains provides no clue in distinguishing between wild and domestic barley. A large grain size, such as that of the Ganj Dareh barley, is not necessarily indicative of the domestic species. Under favourable climatic and edaphic conditions *Hordeum spontaneum* may develop grains of a considerable size. Thus, for wild barley grains from the Anti-Lebanon Mountains near the Syrian-Lebanese border the following dimensions were obtained: 9.20(8.3-10.1)×2.84 (2.5-3.2)×1.55(1.2-1.8) mm (number of measured

Table 3. Dimensions in mm and index values of barley grains.

Sample number	Length	Breadth	L/B
37	6.0	2.6	234
46	8.2	3.4	245
69	6.8	2.7	250
75	6.6	2.7	260
80	5.6	2.5	226
110	6.4	3.0	216
122	6.0	2.6	227
122	5.6	2.5	226
129	7.2	3.5	206
129	7.1	2.8	254
136	6.4	3.1	205
Mean	6.55	2.87	232

Table 4. Numbers of morphologically wild and domestic *Hordeum* grains and rachis internodes. Of the majority of the barley grains the type could not be ascertained because of deformation and damage (mostly broken grains).

Level		E	D-E	D	C-D	C	B
H.spontaneum-type	grains	1	-	-	1	-	2
	internodes	-	1	1	-	-	-
H.distichum-type	grains	1	-	3	-	1	7
	internodes	2	-	2	-	-	-

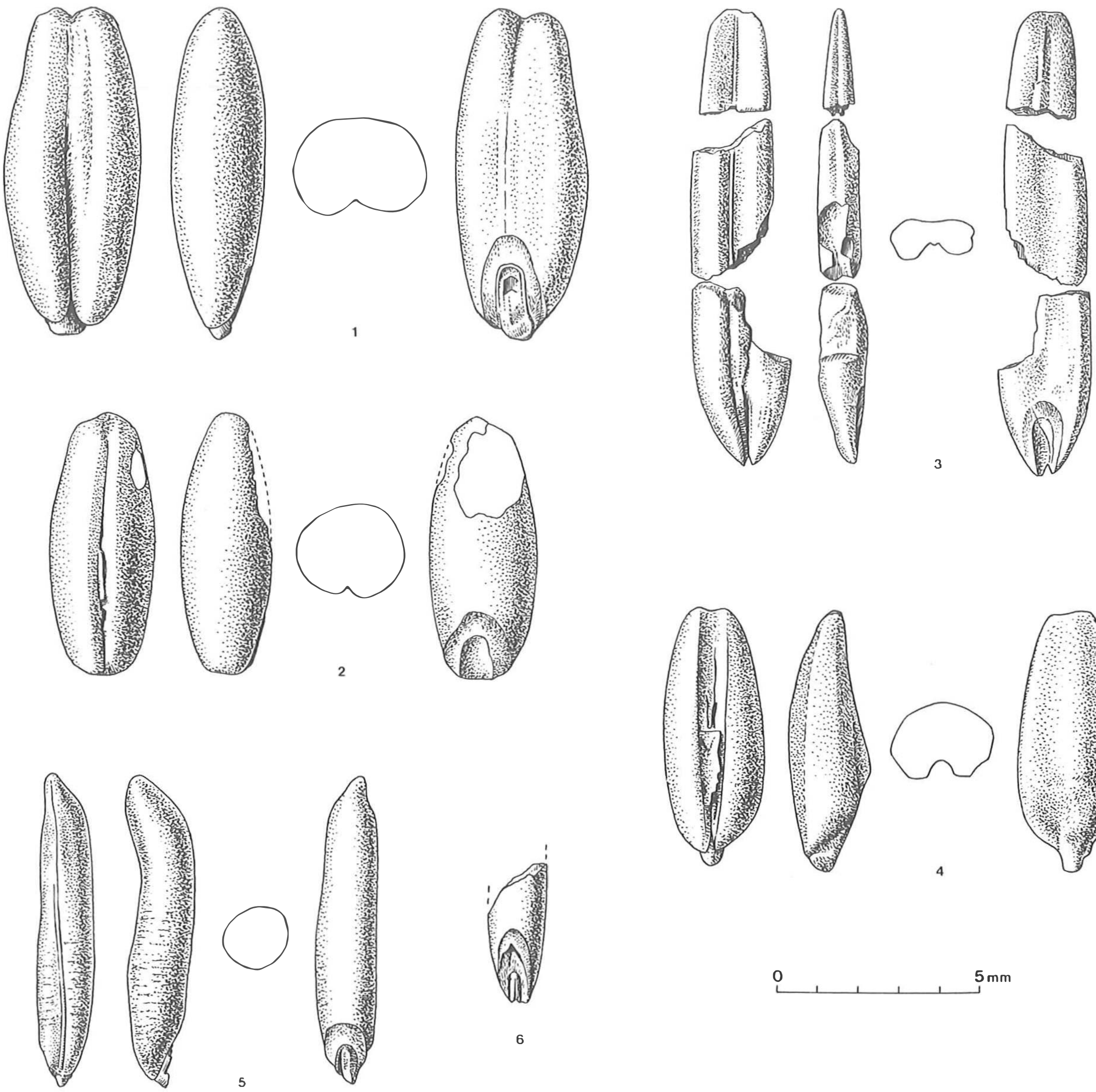

Fig. 3. 1: *Hordeum distichum*-type, GD 46; 2: *Hordeum distichum*-type, GD 75; 3: *Hordeum spontaneum*-type, GD 136; 4: *Hordeum spontaneum*-type, GD 37; 5, 6: *Stipa*, GD 70.

grains: 10) (van Zeist & Casparie, 1968).

The few reasonably well preserved barley internode remains point in the same direction as the grains. Some internodes show an intact articulation scar (fig. 5: 4) which is characteristic of shattering, brittle-rachised *Hordeum spontaneum*. In other internode segments, remains of the basal part of the next internode are attached to it, suggesting that tough-rachised *Hordeum distichum* is involved here. For only few internode remains could it be determined whether they are of the shattering or non-shattering type (table 4). Nevertheless there is convincing evidence that wild as well as domestic barley are represented at Ganj Dareh.

As for the numbers of barley grains listed in table 1, the following should be remarked. It has been mentioned above that mainly broken grains and grain fragments were recovered. As no other kind of cereal than barley has been established for the site, all cereal grain fragments are attributed to *Hordeum*; this is also done if the remains themselves are undiagnostic in this respect. The frag-

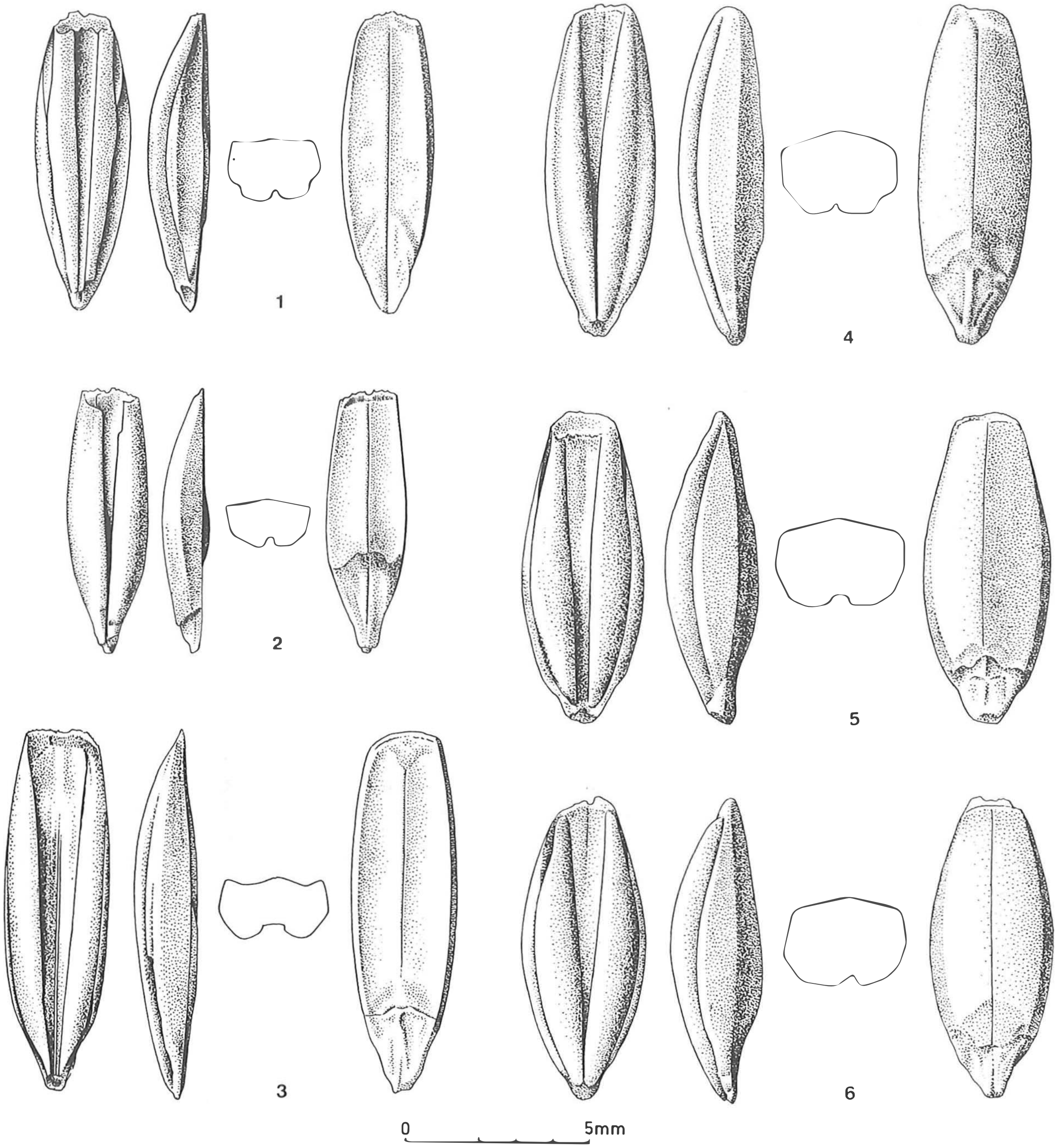

Fig. 4. Modern barley grains from western Syria. 1, 2, 3: *Hordeum spontaneum*; 4, 5, 6: *H. distichum*. After van Zeist & Bakker-Heeres (1982(1985): figs. 18 and 19).

ments have been converted into numbers of grains on the basis of 0.0072 gram per grain, the mean grain weight determined for carbonized hulled two-rowed barley from Ramad (van Zeist & Bakker-Heeres, 1982(1985): table 20). For 4 intact barley grains from sample 136 a weight of 0.03 gram was obtained, suggesting that it is justifiable to apply the Ramad mean grain weight to Ganj Dareh. A plus-sign (+) indicates that only a few cereal grain fragments were found.

Agrostis-type (Bent grass). This small gramineous fruit-type (fig. 6: 3, 4) occurs quite often, but only occasionally in somewhat greater numbers. Dimensions for 20 specimens from flotation sample 183: 1.07(0.9-1.25)×0.58(0.5-0.7)×0.53(0.45-0.65) mm.

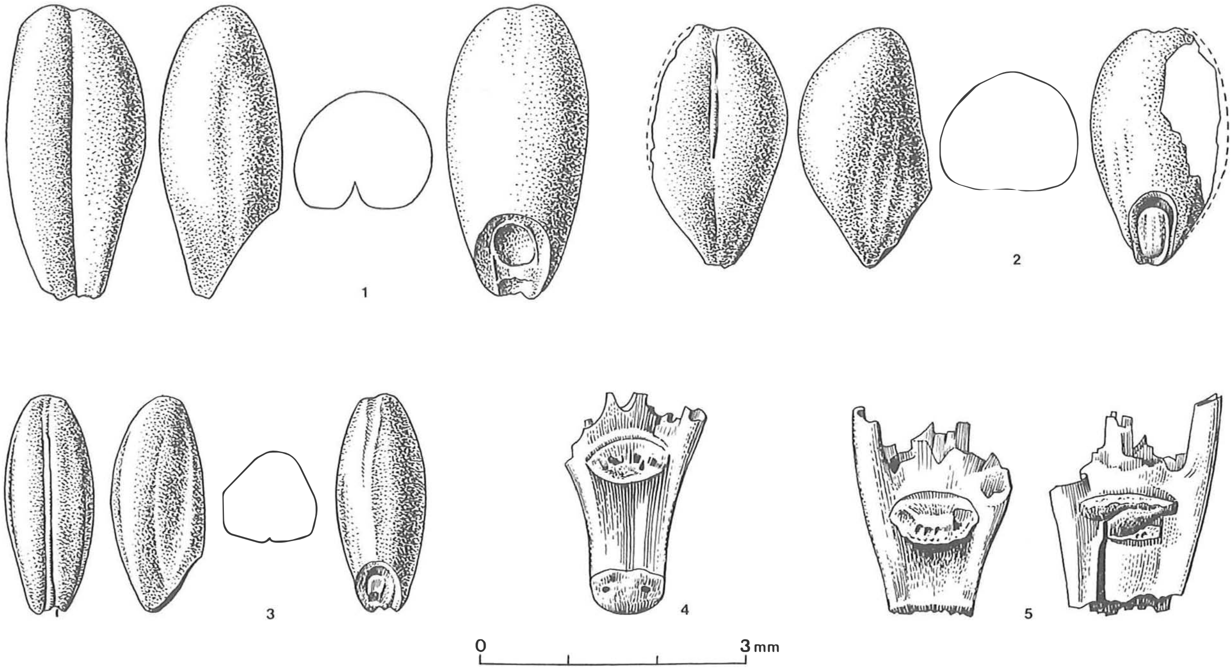

Fig. 5. Triticoid type, GD 70; 2: Triticoid type, GD 36; 3: Triticoid type, GD 183; 4: *Hordeum spontaneum* internode-type, GD 188; 5: *Hordeum distichum* internode-type, GD 183.

Table 5. Dimensions in mm and index values of Triticoid type grains.

Sample number	L	B	T	L/B
36	2.8	1.6	1.4	170
61	3.5	1.4	1.4	244
67	2.8	1.5	1.4	184
69	3.0	1.4	1.4	224
69	3.2	1.3	1.4	250
69	2.8	1.4	1.4	206
70	3.4	1.6	1.4	215
183	2.6	1.0	1.0	246
Mean	3.02	1.40	1.37	217

Because of the linear hilum this grass fruit is indicated here as *Agrostis*-type. *Zingeria trichopoda* (Boiss.)P.Smirn. (Bor, 1970: Tab. 40: 10) could also come into consideration.

Stipa (Feather grass). One complete but distorted specimen of the linear-cylindrical caryopses of *Stipa* (fig. 3: 5) was recovered. Broken *Stipa* fruits were found in a fair number of samples. Even small fragments can be recognized as those of *Stipa* by the circular cross-section and the narrow hilum. The numbers of *Stipa* fruits listed in table 1 are estimates.

Triticoid type. An unidentified gramineous fruit type is indicated here as Triticoid type. Characteristic of this type are the longitudinally curved ventral and dorsal sides. The ventral side is rather flat. Impressions of stiff glumes are visible on the lateral sides (fig. 5: 1, 2, 3). There is a fairly large variation in size and shape (see table 5), so that it cannot be excluded that more than one species is represented. It should be emphasized that the grains differ distinctly from those of modern wild and domestic *Triticum* species.

3.8. Leguminosae

Astragalus (Milk vetch). The *Astragalus* seeds recovered from the Ganj Dareh samples display a wide variation in size and shape (fig. 2: 1-9). The laterally compressed seeds vary from obliquely quadrangular to almost triangular in outline. A characteristic feature is the hilar notch: the indentation in which the hilum is found. Large *Astragalus* seeds are in the range of 3.0×2.5-2.1×2.9 mm, whereas small seed types measure 1.9×1.2-1.7×2.0 mm. The length is the dimension more or less perpendicular to the hilar notch. In poorly preserved, deformed specimens the distinction from other leguminous seed types was sometimes difficult.

Astragalus is an extremely large and taxonomi-

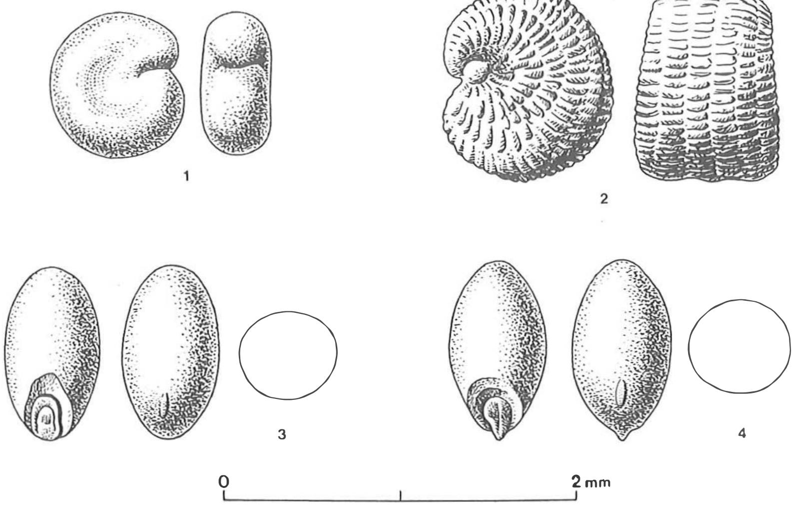

Fig. 6. 1: *Cleome*, GD 141; 2: *Silene*, GD 182; 3, 4: *Agrostis*-type, GD 182.

cally complicated genus; Parsa (1948) mentions more than 550 species for Iran, the majority of which are dwarf shrubs. The Zagros Mountains are very rich in *Astragalus*. Various species must be represented at Ganj Dareh.

Lens (Lentil). Lentils occur rather frequently in the Ganj Dareh samples, but only in small numbers. The greatest dimension of 12 seeds from various samples ranges from 2.1 to 2.8 mm (mean 2.49 mm). This size class corresponds with that of wild lentil. Seeds of *Lens orientalis* (Boiss.) Hand.-Mazz., which is regarded as the wild progenitor of domestic lentil (*Lens culinaris* Medik.), are 2.5-3.0 mm in diameter (Zohary, 1972). The distribution area of this wild lentil species includes the Zagros Mountains in Iran, at 700-1700 m altitude.

Pisum (Field pea). *Pisum* is scarcely represented; only one whole specimen and half of another were found (3.3 and 3.6 mm). Wild pea as well as the domestic type (*Pisum sativum* L.) could be represented here. For the distribution of *Pisum humile* Boiss. et Noë, which has been shown to be the wild ancestor of cultivated pea (Ben-Ze'ev & Zohary, 1973), see Zohary & Hopf, 1973: map 2.

Trigonella (Trigonel). The *Trigonella astroites* seed type is characterized by the truncated upper and lower ends and the transversely wrinkled surface (fig. 2: 10). Dimensions of 12 seeds from sample 27: 1.87(1.6-2.0)×0.92(0.7-1.0) mm. This type which has been reported for various other Near Eastern sites may include various *Trigonella* species.

The taxonomic position of the seeds listed as *Trigonella*-type is not certain. Another leguminous genus than *Trigonella* may be concerned here. Two 'typical' *Trigonella*-type seeds are illustrated in fig. 2: 11. The laterally compressed seeds are elliptic in outline, with rounded upper and lower ends. The surface is finely punctate. Although there is the usual variation in shape and size, it was in general not difficult to separate this somewhat enigmatic seed type from other leguminous seeds. Dimensions of 32 seeds from sample 27: 2.44(1.9-2.9)× 1.27(1.1-1.4) mm.

3.9. Papaveraceae

Glaucium (Horned-poppy). A small number of *Glaucium* seeds was recovered, mainly from level E samples. Shape, size (c. 1.3×1.1 mm) and reticulate surface pattern (fig. 2: 22) correspond with those of *Glaucium corniculatum* (L.)Rud., but other Iranian *Glaucium* species may also come into consideration. This is the same seed type as the *Glaucium aleppicum*-type described for Ramad, but the latter species is not reported for the modern flora of Iran (Cullen, 1966).

3.10. Rosaceae

Amygdalus (Almond). Particularly level E samples yielded fairly large numbers of almond fruit-stone fragments, but never enough to equal at least half an almond (on the basis of 0.9 gram per fruit stone; *cf.* van Zeist & Bakker-Heeres, 1982(1985): 5.24.). Wild almond must have been quite common in the Ganj Dareh area.

3.11. Typhaceae

Typha (Reedmace). A few impressions on baked clay (hand-picked samples 11, 12 and 42) are most likely of *Typha* stems. Similar impressions have been established for Tell ed-Dēr, in Mesopotamia (van Zeist, 1984).

4. THE CHARCOAL IDENTIFICATIONS

The examination of the charred wood remains was carried out under a binocular stereo-microscope, at magnifications of 12 to 100 times, and under a high-powered incedent-light (dark field) microscope, at magnifications of 40 to 400 times. For the identifications use was made of the wood reference collection in the B.A.I. and of the wood atlasses of Greguss (1945), Grosser (1977) and Schweingruber (1978). Frequently poor preservation hampered or prevented the identification.

4.1. *Celtis* (Hackberry)

Ring porous. In transversal section the large pores in the earlywood are usually somewhat clustered, while the small pores sometimes display a flame-like pattern in the ground tissue. The rays vary rather in width, from 2 to 8 cells wide, while occasionally uniseriate rays (one cell wide) are present. In radial section the ray cells are procumbent rectangular. The vessels are markedly short, with spiral thickenings and simple perforation plates.

4.2. *Pistacia* (Pistachio)

Ring porous. In transversal section usually one ring of rather large pores in the earlywood. The pores are somewhat smaller than in *Celtis*. Many vessels of the earlywood are filled with tyloses. The small pores in the latewood are often arranged in radially oriented files. The vessels have spiral thickenings; the simple perforation plates are often difficult to observe. The vessels are not conspicuously short as in *Celtis*.

The rays are usually 4-5 cells wide. Upright or square ray cells, mostly margin cells, contain in part still a crystal. The charcoal identified as *Pistacia* shows most resemblance to the wood of *Pistacia atlantica*.

As at first no satisfactory separation between the charred wood of *Celtis* and *Pistacia* could be made, in the flotation samples (table 6) these types are lumped *(Pistacia/Celtis)*. Both types are present in the flotation samples. For the hand-picked charcoal samples (table 7) it could be determined with certainty whether it is *Celtis* or *Pistacia*.

4.3. *Populus/Salix* (Poplar/Willow)

Uniseriate rays (one cell wide), small vessels of approximately the same size in the earlywood and

Table 6. Charcoal in flotation samples. Volumes in millilitres. Volumes of less than 1 ml are indicated with a plus-sign.

Level	Provenance code	Sample number	Unit	Integrity code	Celtis/Pistacia	Salix/Populus	Prunus rays 4-5	Prunus rays 7-8	Rhamnus	Volume identified	Total volume
A	I	49	507	3	+	-	-	-	-	+	+
A	III?	1	77	3	+	-	+	-	-	+	1
A	III	3	52	5	+	-	-	-	-	+	+
A	III	24	230	4	4	-	-	-	-	4	48
A	III	39	374	4	+	-	-	-	-	+	1
A	III	53	504	2	+	-	-	-	-	+	52
A-B	I	61	542	6	+	-	+	-	-	+	27
A-B	III	41	381	6	+	-	-	-	-	+	2
B	I	67	648	1	10	-	-	-	-	10	312
B	I	68	648	1	+	-	-	+	-	+	60
B	I	75	649	1	2	-	+	-	-	2	80
B	I	100	741	1	12	-	-	+	-	12	175
B	III	9	101	1	35	-	-	-	-	35	45
B	III	15	121	1	15	-	2	3	-	20	20
B	III	35	311C	1	3	-	-	-	-	3	80
B	III	36	311C	1	2	-	-	-	+	2	33
B	III	37	304	2	+	-	+	-	-	+	23
B	III	38	311D	1	3	-	+	-	-	3	64
B	III	44	429	2	2	-	-	-	-	2	13
B	III	47	415	4	+	-	-	-	-	+	11
B	III	69	651	1	+	-	+	-	-	+	13
B	III	70	651	1	+	-	-	-	-	+	19
B	III	71	651	1	1	-	-	-	+	1	9
B	III	74	606	4	+	-	-	-	-	+	7
B	III	84	644	4	3	-	-	-	-	3	50
B	III	93	658	2	+	-	+	-	-	1	23
B	III	95	729	1	+	-	-	-	-	+	5
B	III	108	741	1	+	-	-	-	-	+	3
B	IV?	23C	20	2	-	10	-	-	-	10	18
B	IV	32	267	3	+	-	-	-	-	+	6
B	IV	43	424	4	3	-	2	-	-	5	12
B	IV	55	515	5	1	-	-	-	-	1	15
B	IV	80	647	2	2	-	+	+	+	2	55
B	IV	86	672	1	+	-	-	-	-	+	21
B	IV	87	672	1	1	-	-	-	-	1	35
B	IV	88	644	4	1	-	-	-	-	1	45
B	IV	89	693	1	+	-	-	-	-	+	3
B	IV	90	693	1	+	-	-	-	-	+	6
B	IV	92	695	1	+	-	-	-	-	+	+
B	IV	97	693	1	1	-	-	-	-	1	17
B-C	I	98	703	6	1	-	-	-	-	1	14
B-C	IV	94	658/681	6	1	-	-	-	-	1	30
B-D	III	29	308	6	4	-	-	-	-	4	55
C	I	45	431	4	6	-	+	+	-	6	12
C	I	46	437	2	+	-	-	-	-	+	16
C	I?	111	797	2	+	-	-	-	-	+	1
C	III	72	597	1	+	-	+	-	-	+	7
C	III	76	613	2	+	-	-	-	-	+	6
C	III	96	706	4	+	-	-	-	-	+	4
C	IV?	23B	20	2	18	-	-	-	-	18	25
C-D	III	17	191	6	1	-	1	-	-	2	2
C-D	IV	124	683	6	+	-	-	-	-	+	12
C-D	IV	126	1039	6	+	-	-	-	-	+	2
D	I?	102	708	2	5	-	+	+	-	6	170
D	I	185	1434	1	3	-	-	-	-	3	30
D	III	77	621	4	1	-	-	-	-	1	21
D	IV	13	23	5	+	+	-	-	-	+	+

Table 6 (continued).

Level	Provenance code	Sample number	Unit	Integrity code	Celtis/Pistacia	Salix/Populus	Prunus rays 4-5	Prunus rays 7-8	Rhamnus	Volume identified	Total volume
D	IV	116	846	2	+	-	-	-	-	+	+
D	IV	119	885	4	+	-	-	-	-	+	11
D	IV	129	1079	4	9	-	+	+	-	10	195
D	IV	183	1399	4	+	-	-	-	-	+	8
D-E?	III	122	1029	6	1	-	+	+	+	2	32
D-E	IV	16	202	6	-	-	4	-	-	4	4
E	II	132	1144	1	1	-	4	1	-	6	82
E	II	136	1104	1	1	-	+	+	+	2	45
E	II	138	1062	1	+	-	+	-	-	1	2
E	II	139	1023	2	+	-	+	-	-	+	7
E	II	140	1126	1	-	-	+	+	-	+	16
E	II	162	1295	1	+	-	+	+	-	1	6
E	II	165	1321	1	2	-	-	-	-	1	16
E	II	172	1289	1	2	-	-	-	-	2	8
E	II	174	1305	1	1	-	-	-	-	1	3
E	III	123	1041	2	+	-	+	+	-	+	18
E	III	192	1518	2	2	-	-	-	-	2	20
E	III	193	1530	2	3	-	-	-	-	3	52
E	III	194	1536	2	3	-	-	-	-	3	35
E	III	196	1556	2	1	-	-	-	-	1	5

Table 7. Hand-picked charcoal samples. Volumes in millilitres.

	Level	Sample number	Unit	Integrity code	Pistacia	Celtis	Salix/Populus	Total volume
(Probably)	A	14	518	2	1	-	-	1.5
architectural	C	17	597	1	-	-	40	55
	C	18	597	1	-	-	5	5
	C-D	34	766	6	-	-	9	30
	D	21	630	2	-	-	20	20
	D	22	630	2	-	-	40	40
	D	40	961	2	-	-	32	40
Function	A-B-C-D	78	1372	7	-	2	-	2
unknown	B-D	2	352	6	10	-	-	14
	C-D	49	683	6	20	-	7	86
	D	47	1016	4	-	-	50	50
	D	52	1015	4	60	-	-	60
	D	53	1015	4	40	-	-	40
	D	70	1155	5	10	-	-	10
	D	73	1434	1	-	-	10	10
	D	79	1483	4	-	15	-	15
	D	85	1596	4	-	4	-	4
	E	72	1413	2	20	-	-	25

latewood (diffuse porous), simple perforation plates and large pits in the ray-vessel intersections. Particularly the earlywood vessels have a wavy wall which is especially visible in radial section. The distinction between *Populus* and *Salix* was problematical because the rays gave a different picture in tangential and radial sections. In one and the same piece, in tangential section only homogeneous rays (characteristic of poplar) could be observed, whereas it looked as if in radial section 5 or 6 rows of large bordered pits are present in the margin cells at the ray-vessel intersections, suggesting heterogeneous rays (characteristic of willow). As in many cases it could not be determined satisfactorily whether *Populus* or *Salix* is concerned, this charcoal type is indicated here as *Populus/Salix*.

4.4. *Prunus*-type (Cherry)

Ring porous, the larger vessels in the earlywood always solitary. In radial section the slightly heterogeneous rays consist of storied, almost square cells. Conspicuously small pits in the ray-vessel intersections. Multiseriate rays are predominant, but uniseriate rays occur as well.

On the basis of the ray width a separation within the *Prunus*-type was possible. One type has rays of 4 to 5 cells wide, whereas another type with rays of 7 and more (up to 10) cells wide could be established. The vessels of both types have spiral thickenings and simple perforations. The available literature indicates that the *Prunus*-type with rays 7-10 cells wide could be of *Amygdalus* (almond). As for the other type, with rays 4-5 cells wide, various rosaceous genera come into consideration.

4.5. *Rhamnus* (Buckthorn)

The charcoal pieces attributed to *Rhamnus* are characterized by the flame-like grouping of the greater pores in transversal section. The separation between the wood of *Rhamnus* and *Daphne* (daphne) was based on whether or not a distinction could be made between the pores and the ground tissue. In *Rhamnus*, the pores distinguish themselves clearly from the ground tissue in transversal section, whereas in *Daphne*, the smaller pores surrounding the larger ones cannot be distinguished from the ground tissue.

5. THE VEGETATION IN THE VICINITY OF THE SITE

5.1. Palynological considerations

The charred plant remains from Ganj Dareh provide information on trees, shrubs and herbs which were found in the area. Along a more indirect way a reconstruction of the vegetation may be inferred from palynological evidence. Unfortunately, no palynological information is yet available for the Kermanshah area, but only from somewhat further away (see fig. 1). The pollen diagram prepared from a sediment core from Lake Mirabad, c. 150 km southeast from Kermanshah, covers the last 10,000 years. The pollen evidence obtained for Lake Zeribar, near Marivan, c. 175 km northwest of Kermanshah, goes back to 40,000 B.P. (van Zeist & Bottema, 1977).

The conditions around Lake Zeribar, at c. 1300 m above sea-level, correspond rather well with those in the Ganj Dareh area, at an elevation of c. 1400 m. Both sites are situated in the so-called Zagros oak-forest belt, which extends at elevations of 700-800 m up to over 2000 m. Lake Mirabad, at c. 800 m above sea-level, lies near the lower border of the Zagros oak-forest belt. At present, in many areas of the oak-forest belt, only scattered remains of this vegetation type are left, if the forest has not virtually disappeared as a result of human interference.

As the Holocene sections of the Mirabad and Zeribar pollen diagrams show a largely identical development of the vegetation, it seems justified to draw inferences from these pollen records for the Holocene vegetation history of the Ganj Dareh area. For our discussion we are particularly interested in the early phases of the Holocene.

The pollen evidence clearly indicates that in the early Holocene the present-day natural forest cover had not yet established itself in the Zagros Mountains. In the eighth millennium B.C. a forest-steppe, that is, a steppe with scattered tree growth, was found in the Zeribar area and very probably also in the Ganj Dareh area. The vegetation was primarily a steppe, in which, according to the palynological evidence, Gramineae (grasses), *Rheum* (rhubarb), *Plantago* (plantain), Compositae, Cruciferae (mustard family) and various other herbs played a role. If *Artemisia* (wormwood) was already found in the early Holocene forest-steppe it must have been of minor importance. The trees and shrubs included *Pistacia* (pistachio), *Acer* (maple), *Amygdalus* (almond) and probably *Quercus* (oak). *Salix* (willow) and *Tamarix* (tamarisk) occurred along streams.

In the early Holocene, the climate must have been less favourable for tree growth than nowadays. As it is unlikely that temperature was the limiting factor one must assume that dryness prevented a more luxurious tree growth. The early Holocene climate of western Iran must have been relatively warm and dry (van Zeist & Bottema, 1977).

5.2. The archaeological plant remains

The above picture of the early Holocene vegetation refers to the Lake Zeribar area. How do the results of the palynological examination compare with the archaeobotanical evidence obtained for Ganj Dareh? Trees and shrubs as well as herbaceous plants are represented among the Ganj Dareh plant remains, and the first question is whether inferences can be drawn on the density of the arboreal component. In other words, was there a steppe with very scattered trees and shrubs, or was there rather predominantly a forest cover? The rather frequent occurrence of the seeds of leguminous taxa, such as *Astragalus* (milk vetch) and *Trigonella* (trigonel), suggests that there was at most open tree growth. Moreover, if the early Holocene vegetation had been comparable to the present-day Zagros oak-forest, *Quercus* (oak) and *Acer* (maple) should have been rather well represented in the charcoal record. However, both types are altogether absent. It seems fair to conclude that the archaeological plant remains confirm the conclusion arrived at in the palynological examination, *viz.* that a forest-steppe occurred in the vicinity of the site.

Pistacia was probably an important component of the forest-steppe. At least this is suggested by the great quantities of pistachio nutshell remains. The proportion of pistachio in the charred wood remains must also be quite considerable (tables 6 and 7). As has been mentioned above (4.4.) the rosaceous wood types cannot be identified to the genus level, but one of the types includes *Amygdalus* (almond), shell fragments of which have been found particularly in level E deposits. Some charcoal has been identified as that of *Rhamnus* (buckthorn), indicating that this shrub was present in the Ganj Dareh area.

At least some charcoal could definitely be attributed to *Celtis* (hackberry), but no remains of the edible fruits of this tree have been found. On ecological ground *Celtis* could very well have formed part of the forest-steppe. It should be mentioned that this tree is not recorded in the Zeribar and Mirabad pollen profiles.

Willow (*Salix*) and/or poplar (*Populus*) must have occurred in wet places along streams. *Tamarix* (tamarisk), another arboreal constituent of riparian vegetation, is conspicuously absent. The charred wood of this shrub can easily be identified as such. Apparently, tamarisk was absent or rare in the Ganj Dareh area. *Scirpus maritimus* (*S. tuberosus*) must have been a constituent of the stream-valley vegetation. This species is not necessarily an indicator of saline habitats, as it is found in a fresh-water environment as well (see 3.6.).

The other herbaceous plant taxa demonstrated for Ganj Dareh could all have formed part of a steppe vegetation. Leguminous genera, such as *Astragalus, Trigonella, Medicago* (medick) and *Scorpiurus* (caterpillar), include common steppe plants. Similarly, Cruciferae, which are represented at

Ganj Dareh by various seed types, are common constituents of steppe vegetation. A very characteristic steppe grass recorded at Ganj Dareh is *Stipa* (feather grass). The other grasses, fruits of which were found, were most probably also steppe species. It should be remembered here that in natural steppe vegetation, grasses play a prominent role. Due to overgrazing, grasses have to a great extent been replaced by unpalatable species in most of the present-day steppe. Wild barley (*Hordeum spontaneum*) is a natural constituent of forest-steppe vegetation. It may be pointed out here that according to the Zeribar pollen record grasses played a very prominent role in the early Holocene upland vegetation of the Zagros Mountains.

Several plant taxa which may be expected for forest-steppe vegetation are not represented in the Ganj Dareh charred seed record. It may be no surprise that *Artemisia* (wormwood) fruits have not been found, because it is unlikely that the fragile fruits would survive carbonization. Carbonized *Artemisia* fruits have equally not been reported for other archaeological sites from a steppe-like environment. Moreover, the relatively low *Artemisia* frequencies in the early Holocene section of the Zeribar pollen record indicate that wormwood was not particularly common in the vegetation of that time. The absence of Chenopodiaceae seeds at Ganj Dareh suggests that representatives of this family were at most of minor importance in the forest-steppe vegetation. Appreciable numbers of chenopodiaceous seeds have been found in various other archaeological sites, indicating that the seeds of this family do get carbonized. Although Umbelliferae (parsley family), *Plantago* (plantain) and small-seeded Compositae are probably seriously under-represented in the charred seed record of archaeological sites, their absence at Ganj Dareh is nevertheless surprising. According to the Zeribar pollen evidence these taxa should have been quite common in the early Holocene vegetation. Consequently, either the composition of the upland vegetation at Ganj Dareh differed markedly from that at Zeribar or the charred seed record provides a very incomplete and distorted picture, prominent plant taxa not being represented.

6. MEAN SEED FREQUENCIES

One of the aspects of the evaluation of the palaeobotanical data concerns the comparison between the habitation levels distinguished at Ganj Dareh. Do the seed contents of these levels possibly point to changes in the plant husbandry or/and in the environmental conditions? For such a comparison the mean seed-type frequencies per level have been determined. To this purpose for each of the seed types the numbers found in the samples from one particular level have been added up and thereupon the relative frequencies are expressed as percentages of the sum of all seeds and fruits per level. Only samples which could with certainty be attributed to one particular level have been included in this operation. The mean frequencies for levels B, D and E are presented in table 8. No mean percentages have been determined for levels A and C because these levels include too small numbers of samples (see table 1). The seed-type frequencies per level will come up for discussion in 7.1. and 7.2.

One should also consider the possibility that between types of archaeological deposits or features there are differences in seed content. To examine whether there are such differences, mean percentages have been determined for the four groups of provenances distinguished here (section 2). All the samples from a particular provenance group are included in the calculation of the mean proportions, also those samples which could not be attributed to a specific level (B/C, D/E, *etc.*). In addition, mean percentages per provenance group and per level have been determined (table 8).

In table 8 the mean numbers of seeds per sample for levels B, D and E are also presented. Levels E and D show no significant difference with respect to the mean number of seeds, but the average number of seeds in the level B samples is markedly lower. Comparisons between average numbers of seeds can only be meaningful if the volumes of the soil samples from which the seeds and fruits were recovered are known. In that case it is possible to determine the seed concentrations per volume of soil. Only for samples of the 1974 season had the approximate weight been determined in the field. As these samples are from D and E levels, they allow us to obtain some information on the average sample volume for these levels. The samples weighed from about 16 to 0.5 kg (1 kg of soil corresponds to a volume of about 1 litre). Samples of the 1974 season, not weighed because of their small volume, have been given here an arbitrary weight of 0.5 kg. This leads to an average weight of 4.4 kg per sample for level D (19 samples, 84.5 kg) and 4.1 kg per sample for level E (29 samples, 120 kg). These figures point to almost equal mean sample volumes for both levels, at least as far as the 1974 samples are concerned. The total numbers of seeds and fruits in the weighed (1974) level D samples is 356 and in the weighed level E samples 448.5. This leads to an average number of seeds per kg of soil of 356/84.5=4.2 for level D and of 448.5/120=3.7 for level E. Thus, the average numbers of seeds per sample (table 8) and the mean seed concentration figures both point in the same direction, *viz.* no significant differences between levels D and E.

The mean number of seeds in the level B samples

Table 8. Mean seed frequencies per level and provenance group. For explanation, see section 6.

		Hordeum	Agrostis-type	Stipa	Triticoid type	Unident. Gramineae	Lens	Astragalus	Medicago	Melilotus-type	Scorpiurus	Trigonella astroites	Trigonella-type	Vicia	Unident. Leguminosae	Pistacia	Amygdalus	Euclidium	Neslia	Malcolmia	Brassica-type	Unident. Cruciferae	Silene	Bellevalia	Galium	Glaucium	Heliotropium	Scirpus maritimus	Ziziphora	Unidentified and other seeds	Σ seeds	Number of samples	Seeds/Sample
Level	B	50.4	19.6	3.8	2.5	2.3	3.4	6.8	0.4	0.4	–	–	0.4	1.6	0.4	3.8	+	0.7	–	–	1.1	–	–	–	–	0.4	–	1.1	–	1.3	280	30	9.3
	D	6.1	32.6	0.2	0.9	0.6	1.8	17.9	0.4	–	0.2	3.0	1.9	0.3	4.7	14.0	+	–	–	–	0.2	0.6	1.5	0.9	0.1	–	0.2	9.4	0.2	2.3	470½	27	17.4
	E	10.3	9.4	0.6	0.3	1.3	1.6	15.2	0.2	–	0.2	0.5	0.5	0.2	2.2	33.2	0.2	1.6	0.8	0.5	–	0.3	1.1	–	0.2	0.8	0.9	16.3	0.2	1.7	638	33	19.3
	E[1]	2.3	12.3	0.6	0.2	0.4	1.8	9.6	0.2	–	0.2	0.6	0.4	0.3	2.9	41.8	0.2	1.4	1.0	0.6	–	0.4	1.4	–	0.3	1.0	1.0	17.4	0.2	1.1	487½	32	15.2
Provenance group	I	37.1	9.1	–	3.0	3.0	7.6	12.1	–	–	1.5	–	–	4.5	4.5	7.6	+	3.0	–	–	1.5	–	–	–	–	–	–	3.0	–	2.3	66	14	
	II	12.4	7.6	0.6	0.2	1.4	1.0	15.8	0.2	–	–	0.6	0.6	0.1	2.6	33.7	0.2	1.2	0.8	0.6	–	0.4	0.4	–	0.3	0.8	0.8	15.9	–	1.9	502	20	
	III	24.3	16.5	2.0	1.5	1.3	3.3	14.0	0.6	0.2	0.2	2.5	0.4	1.3	3.3	15.1	+	0.4	–	–	0.4	–	1.3	0.6	0.3	0.1	–	8.2	0.2	2.0	522½	54	
	IV	9.9	21.8	0.2	0.7	0.6	0.6	15.6	–	–	0.4	3.6	7.6	0.3	19.9	8.7	+	0.2	0.6	–	0.2	0.4	0.9	0.2	–	0.2	0.4	5.8	0.2	0.9	816	34	
Level/ provenance group	B III	66.4	3.4	7.0	3.4	3.0	3.4	2.7	0.7	0.7	–	–	0.7	1.0	0.7	3.7	+	–	–	–	0.7	–	–	–	–	–	–	1.3	–	1.3	149	14	
	B IV	27.7	53.2	–	1.1	2.1	0.5	8.5	–	–	–	–	–	–	–	2.1	–	–	–	–	2.1	–	–	–	–	1.1	–	–	–	1.6	94	12	
	D III	0.5	20.1	–	1.0	–	2.9	29.1	1.0	–	–	5.8	0.5	–	7.3	17.0	+	–	–	–	0.5	–	1.0	1.5	0.2	–	–	9.2	–	2.4	206	13	
	D IV	9.6	43.2	0.4	0.8	1.2	1.0	9.4	–	–	–	0.8	3.1	0.6	2.0	11.6	+	–	–	–	–	1.2	2.0	0.4	–	–	0.4	9.8	0.4	2.4	255	12	
	D IV[2]	13.9	10.7	–	0.7	1.4	0.7	16.4	–	–	–	1.4	5.7	–	3.6	18.2	+	–	–	–	–	1.4	1.4	0.7	–	–	0.7	17.9	0.7	4.3	140	11	
	E II	12.4	7.6	0.6	0.2	1.4	1.0	15.8	0.2	–	–	0.6	0.6	0.1	2.6	33.7	0.2	1.2	0.8	0.6	–	0.4	0.4	–	0.3	0.8	0.8	15.9	–	1.9	502	20	
	E II[3]	2.0	10.9	0.6	–	0.3	1.1	8.5	0.3	–	–	0.9	0.6	0.1	3.7	46.1	0.1	0.9	1.1	0.9	–	0.6	0.6	–	0.1	1.1	0.9	17.5	–	1.1	349	19	
	E III	1.8	15.8	–	1.8	2.6	8.8	14.0	–	–	–	–	–	1.8	–	22.8	+	3.5	–	–	–	–	7.0	–	–	–	–	15.8	1.8	2.6	57	9	

1. Sample 136 not included
2. Sample 183 not included
3. Sample 136 not included

(9.2) is only about half of that in those from levels D and E (17.4 and 19.3). If the average sample volume of the level B samples was about the same as that of the level D and E samples, the lower average number of seeds would imply a lower seed concentration in the level B deposits. It is questionable whether the assumption of comparable average soil volumes may be made. Moreover, one should be cautious in drawing conclusions in terms of plant husbandry from differences in seed concentration. For other sites it could be established that there are differences in numbers of seeds and fruits per volume of soil between phases within one site. However, deposits from the same archaeological level but from different areas in a site may also display different seed concentration values (van Zeist & Bakker-Heeres, 1982(1985): 6.3.).

7. THE PLANT HUSBANDRY

7.1. (Potential) crop plants

From the presence of morphologically domestic-type barley, *Hordeum distichum*, one may conclude that barley was cultivated by the inhabitants of Ganj Dareh. It is the only cereal species represented in the site. No remains were found of wild or domestic emmer wheat. Sample 136 from a firepit in level E yielded a non-shattering *Hordeum* rachis internode and among the barley grains in this sample, *H. distichum*-type specimens occur. Consequently, it may be assumed that already in the first stages of the habitation barley was grown here.

There is evidence not only for domestic barley, but also for wild barley, *Hordeum spontaneum*. In addition to barley cultivation, stands of wild barley in natural habitats may have been harvested by the inhabitants of the site. Wild barley could possibly also have occurred as a weed in and along the domestic barley fields. It could further be speculated that, at least in an early stage, the crop of the Ganj Dareh farmers was a mixture of wild and domestic type barley. In that case the proportion of shattering barley should have decreased in the course of time and finally wild-type barley should have disappeared entirely from the seed-corn. In theory, it is possible that barley cultivation in the Kermanshah sector of the Zagros Mountains started with the wild species from which the domestic type subsequently developed. The concept of plant growing may have been introduced from elsewhere but not the associated crop-plant species.

The small numbers of barley grains and rachis internodes for which the type could be determined do not point to a decrease in the proportion of morphologically wild barley in the course of the habitation (table 4). The data presented in table 4 allow no other conclusion than that wild barley could maintain itself in the Ganj Dareh area, either in the wild or as an admixture to domestic barley. It will be clear that in evaluating the possible role of barley in the economy of the site no distinction can be made between wild and cultivated.

Table 8 suggests a marked increase in the proportion of barley in the charred seed record from the lower levels (D and E) to level B. No significance should be attached to the fact that the mean barley percentage for level E is somewhat higher than that for level D. If level E sample 136, with an exceptionally great number of barley grains, is left out, the *Hordeum* frequency is only 2.3%. It seems fair to assume that between levels E and D there was no great difference in the proportion of barley in the plant husbandry. As for level B, a value of 50% demonstrates that in this habitation phase barley must have played a prominent role in the vegetable diet. The increase in the proportion of barley was not only a relative one (due to a decrease of other seed types), but there was also an increase in the absolute numbers of barley grains. Relative to levels D and E, in level B the mean number of seeds per sample is distinctly lower, which could imply that fewer seeds and fruits were brought in. In spite of the decrease in numbers of seeds per sample (and probably per volume of soil), the average number of barley grains per sample increases from 2.0 and 1.1 in levels E and D, respectively, to 4.7 in level B.

Lentils were consumed by the inhabitants of the site from the earliest occupation on. The question whether wild-growing or cultivated lentil is involved here cannot be answered with certainty. As has already been mentioned (3.8.), the size of the Ganj Dareh lentils corresponds with that of wild *Lens orientalis*. This does not necessarily imply that the lentils were collected in the wild. One should consider the possibility that lentil was grown, but that the seeds had not yet acquired the size of the domestic form. In this connection reference should be made to aceramic Neolithic Çayönü, in southeastern Turkey: presumably cultivated lentils from levels dated to around 7000 B.C. measure 2.1 to 3.0 mm (mean 2.53 mm) (van Zeist, 1972). In addition, it should be mentioned that Dr. R.N.L.B. Hubbard found two lentil imprints in brick from level D of Ganj Dareh measuring 3.2-3.3 mm.

Level B shows a higher mean lentil percentage than levels D and E, but the average number of lentil seeds per sample is almost the same for the three levels, *viz.* about ⅓ specimen per sample. As chances for cereal grains to be carbonized are assumed to be better than those for pulse crop seeds, the seed frequencies may give a false picture of the economic importance of lentil relative to barley. On the other hand, experience has shown that charred lentils can be quite numerous in archaeological deposits, suggesting that if this crop played an important part, its seeds may have been preserved in considerable numbers.

From the extremely scarce representation of *Pisum* one may safely conclude that peas – wild or cultivated – were at most a minor food at Ganj Dareh.

7.2. Wild food plants

A great number of wild plants may have served as food for the Ganj Dareh inhabitants. The chances for plants of which the vegetative parts were consumed to be preserved in archaeological deposits are almost negligible. Only wild plants the seeds or fruits of which were gathered for human consumption have a fair chance of being represented in settlement layers. On the other hand, the presence of the remains of edible wild seeds and fruits is not yet convincing evidence of their intentional harvesting.

This last remark certainly does not apply to the pistachio nutshell remains. There can be no doubt that the highly nutritive fruits of this tree were of considerable economic importance. They must have constituted a highly valued source of vegetable fat. The mean percentages suggest a diminishing of pistachio in the course of the habitation. Could this imply that in later stages there was a heavier reliance on animal fat? Wild almond (*Amygdalus* spec.) must likewise have been a source of vegetable fat, but judging from the frequencies of the nut remains its importance was much smaller than that of pistachio. *Pistacia* and *Amygdalus* both formed part of the forest-steppe, which is supposed to have been the natural vegetation of the Ganj Dareh area in early Holocene times (almond-pistachio forest-steppe).

More problematical is the possible role of small leguminous seeds. In particular *Astragalus* (milk vetch) seeds are quite numerous. From the large numbers of small leguminous seeds in the Bus Mordeh phase at Ali Kosh, Helbaek (1969) concluded that these seeds had been collected by the early farmer-gatherers for human consumption. One should certainly not reject the possibility that small-seeded wild Leguminosae contributed to the diet of the inhabitants of Ganj Dareh. The fact that in level B the proportion of small leguminous seeds is lower than in levels D and E could indicate that the economic importance of these potential wild food plants had decreased. Only the mean *Vicia* (vetch) percentage is higher in level B, but this could be due to an increase in the acreage of cultivated fields: various *Vicia* species occur as weeds in fields.

Wild grass fruits could likewise have been gathered. However, the majority of the wild grass caryopses consists of *Agrostis*-type fruits, hardly 1 mm long (3.7.). One wonders whether it would have been attractive to gather these small fruits as a supplementary food, unless the grass species concerned was really very common and easy to harvest.

Another enigmatic fruit type with regard to its potential as human food is *Scirpus maritimus* (sea club-rush). The nutlets of *Scirpus* are rich in starch and for that reason a potential food. However, there are no reports of these fruits being used as human food in modern or near-modern times. *Scirpus* could have been used for thatching or as litter and in this way the fruits could have been brought into the settlement.

Recently dung fuel as a potential source of charred seeds in archaeological sites has been suggested (Miller, 1982; Miller & Smart, 1984). Some of the seeds and fruits pass through the digestive tract of sheep, goat, cattle and other animals undamaged. The animal dung may be burned as such or made into dung cakes. The burning of dung, a common practice in areas with a scarcity of wood, may result in the charring of seeds and fruits incorporated in the animal droppings. Although wood was available in the vicinity of Ganj Dareh, it may not have been enough to meet the demands for fuel. According to the analysis of the animal bones, it was only from level D onwards that a form of goat husbandry was practised (Hesse, 1982). This would imply that at least for level E, animal dung does not come into consideration as a possible source of charred seeds. The rather high frequencies of *Astragalus* seeds could possibly be explained as the result of the collecting of woody perennial plants as firewood. Part of the seeds still adhering to the plants could have escaped being burned to ash.

A discussion of the potential economic importance of wild food plants represented in prehistoric sites must remain unsatisfactory. Only circumstantial evidence could give a clue as to their actual use by prehistoric man. On the other hand, the mean percentage values of levels E, D and B clearly point to a shift from a heavy reliance on wild food plants to a strongly increased importance of plant cultivation.

7.3. Mean percentages per provenance group

The mean percentages per provenance group may provide information on possible differences in the composition of the plant remains between different types of deposit or feature. From table 8 it appears that the *Hordeum* values differ significantly between provenance groups, that the *Agrostis*-type percentages in III and IV are about twice as high as in I and II, and that *Pistacia* and *Scirpus maritimus* have by far the highest values in II. One should be cautious in assuming that these differences reflect variations in the mean seed composition of the archaeological deposits or features. This would be the case if the five habitation levels were equally represented in each of the provenance groups. However, group II includes only level E samples; level E is not represented in group I, but in this group the proportion of level A and B samples is relatively great. It will be clear that this uneven representation of the various levels in the provenance groups makes it difficult to determine to what extent the differences are indeed related to the type of archaeological context. To avoid this problem mean percentages have been determined for provenance groups within each of the levels B, D and E (table 8). The disadvantage of this method is that for each level, the number of samples is large enough to justify the calculation of mean percentages in only two of the provenance groups. In this way, group I (hearth, oven) is not represented at all.

Groups II and III of level E differ mainly from each other in respect to the mean *Hordeum* and *Pistacia* values. If sample 136 with the relatively large number of barley grains is left out, both groups show almost the same *Hordeum* percentage, but the difference in *Pistacia* values is even more pronounced. One wonders whether the firepits in level E had something to do with the processing of pistachio fruits, or whether the nutshells or shell fragments were thrown in the pits, *e.g.* to kindle the fire? It is unlikely that the firepits were used for roasting barley as otherwise more rachis internodes would have been found.

Differences in mean percentages between groups III and IV of levels D and B cannot easily be explained in terms of differences in activity areas and such like. It is likely that most of the plant remains in the deposits of these provenance groups are not *in situ* and that they are of mixed origin. As has already been mentioned, the distinction between groups III and IV is sometimes rather arbitrary. Moreover, differences between both groups in levels D and B do not always point in the same direction. Thus, barley is scarcely represented in III of level D, whereas for level B the mean *Hordeum* value in III is much higher than in IV. The effect of an anomalously large number of seeds of a particular type in one sample on the mean percentages is again evident. If for group IV of level D, sample 183 with a very large number of *Agrostis*-type fruits is left out, the mean *Agrostis* value drops from 43.4 to 10.8% and mean percentages for various types, such as *Hordeum*, *Astragalus*, *Pistacia* and *Scirpus*, increase markedly. Similarly the relatively high *Stipa* value in III of level B is brought about by 10 *Stipa* grains in sample 70.

There seem to be no consistent or significant differences in mean seed percentages between provenance groups III and IV, which will be no surprise. The firepit samples (group II) are characterized by a predominance of *Pistacia* remains. There are no indications of a specific composition of the plant remains in the group I samples. The high mean barley value for this group is due to the fact that a relatively large proportion of the samples is from the upper levels.

7.4. The use of wood

Just as for the seeds, mean percentages per level and per provenance group have been determined for the charcoal remains recovered from the flotation samples (table 6). The volume percentages (table 9) have been calculated as follows. The volumes of the identified charcoal types in the samples of a particular level or provenance group have been added up. Thereupon, the mean volume percentages relative to the total volume of the identified charred wood remains have been determined. For practical reasons, volumes of less than 1 ml (indicated in table 2 with a plus-sign) have been given an arbitrary volume of ½ ml. In addition to the mean volume percentages, in table 9 the numbers of samples in which a particular wood type was found are given between brackets.

The wood resources must have been exploited by the inhabitants of the site for three main purposes, *viz.*, for building material, for heating and for the manufacture of utensils. The flotation samples provide no direct information on the possible use of wood for construction purposes. The origin of charcoal in deposits, such as room fill, occupational debris and ashy soil, is uncertain. On the other hand, according to the field notes, various hand-picked charcoal samples are probably derived from architectural elements (table 7). It is striking that with one exception the architectural samples consist of *Populus/Salix* (poplar/willow), which wood type is scarcely represented in the flotation samples. It seems that poplar or willow was preferred for construction purposes. Poplar particularly yields straight, long poles. As for the scarcity of poplar/willow in the flotation samples, it should be taken into account that this charcoal type is rather soft, which may unfavourably have affected its preservation.

Provenance groups I and II provide direct information on the types of wood that were used as fuel, because the samples concerned are from features where wood was burned for heating. The samples from fireplaces did not yield one piece of poplar/willow charcoal, but the other wood types established for Ganj Dareh are all represented. There is a striking difference between the mean proportions for the firepits of level E and those for prove-

Table 9. Charcoal from flotation samples. Mean volume percentages per level and provenance group. For explanation, see 7.4.

		Number of samples	Celtis/Pistacia	Salix/Populus	Prunus rays 4-5	Prunus rays 7-8	Rhamnus	Volume identified in ml
Level	A	6	93 (6)	–	7 (1)	–	–	7
	B	32	82 (31)	8 (1)	6 (8)	4 (4)	1 (3)	127
	C	7	95 (7)	–	4 (2)	2 (1)	–	28
	D	8	89 (8)	2 (1)	4 (2)	4 (2)	–	22½
	E	14	63 (13)	–	25 (7)	11 (5)	2 (1)	28½
Provenance group	I	12	91 (12)	–	4 (4)	4 (4)	–	45½
	II	9	47 (8)	–	36 (6)	14 (4)	3 (1)	18
	III	33	88 (33)	–	7 (11)	4 (3)	1 (3)	105
	IV	22	69 (20)	17 (2)	11 (4)	2 (2)	1 (1)	61½

nance group I (ovens, fireplaces and kilns) which includes samples from levels A to D. *Prunus*-type wood is quite common in the firepit samples, whereas the *Pistacia/Celtis* (pistachio/hackberry) wood type has a much lower mean value than in provenance group I. In view of the great numbers of *Pistacia* nutshell remains in level E samples, it is unlikely that not enough pistachio wood would have been available. The high proportion of *Prunus*-type charcoal in the firepits could point to a deliberate selection of firewood. It is tempting to assume that, at least to some extent, *Pistacia* (and *Celtis*) were spared from cutting because of the valuable fruits.

There are no conspicuous differences in the mean charcoal proportions between provenance groups I, III and IV. The lower mean *Pistacia/Celtis* percentage in group IV is largely occasioned by the comparatively large volume of *Salix* charcoal in sample 23C.

A comparison between levels is handicapped by the fact that three out of five levels include only small numbers of samples. Considering the low statistical reliability of the data for most of the levels, there seem to be no significant differences between levels A, B, C and D. There are no indications for shifts in the exploitation of the wood resources either due to changes in the composition of the arboreal vegetation or to changes in the preference of prehistoric man for particular wood types. Only the mean charcoal proportions of level E differ markedly from those of the other levels.

8. FINAL REMARKS

Two aspects of the Ganj Dareh plant husbandry will be reviewed briefly in this final section. The first concerns the seasons during which the various levels of the site were occupied. Because of the absence of architectural remains in level E it has been hypothesized that during this phase there was only seasonal occupation of the site, while later a greater degree of permanency prevailed. The question arises whether the floral remains permit us to say something in this connection. The charred seed remains point to a greater reliance on wild food plants, in particular pistachio and almond, in level E than in the succeeding levels. However, this is not in itself proof of seasonal habitation. The absence of poplar/willow charcoal from level E is probably connected with the absence of solid houses in which these trees were used as construction materials. It must, indeed, have been unattractive at this altitude to spend the winter in huts, tents or other light dwellings. Be this as it may, the vegetable remains cannot tell us whether there was seasonal or permanent occupation of the site during level E or any other level.

If the site was occupied seasonally, however, it must have been during at least the warmer half of the year. At an altitude of about 1400 m maturation of barley occurs in late May to early June. Consequently, the occupants should have returned in May at the latest. Pistachio fruits could be gathered in mid-summer, while the sowing of barley should have been done in early autumn, at the beginning of the rainy season. This leads to a minimum occupation period from May to October.

The second aspect involves a comparison of the plant husbandry at Ganj Dareh with that of other Early Neolithic sites in the Zagros Mountains. How do the Ganj Dareh floral remains compare with those of other sites? What role might Ganj Dareh have played in the development of plant cultivation? So far only a few Early Neolithic sites (8th and 7th millennia B.C.) in the Zagros Mountains and adjacent regions have been studied archaeobotanically. The location of these sites is indicated in figure 1. The presence or absence of cultivated plants and some potential wild food plants in the sites concerned is shown in table 10.

The most striking difference between Ganj Dareh and the other sites listed in table 10 is the absence of emmer wheat (*Triticum dicoccum*). It is

Table 10. Domesticated plants and potential wild food plants in some early Neolithic sites (fig.1). r = rare, + = present, ++ = common, +++ = very common, x = present (no quantitative data available). All Kosh: Helbaek (1969); Jarmo: Helbaek (1959), Watson (1983); Çayönü: van Zeist (1972).

	Ali Kosh (Bus Mordeh phase)	Ali Kosh (Ali Kosh phase)	Ganj Dareh	Jarmo	Çayönü	
Hordeum spontaneum	} ++	} ++	} ++	x	r	Wild barley
Hordeum distichum				x	-	Two-row hulled barley
Hordeum vulgare coeleste	+	+	-	-	-	Naked barley
Triticum boeoticum	+	r	-	x	r	Wild einkorn wheat
Triticum monococcum	r	r	-	x	+	Einkorn wheat
Triticum dicoccoides	-	-	-	x	+	Wild emmer wheat
Triticum dicoccum	++	++	-	x	+	Emmer wheat
Lens	-	r	+	x	++	Lentil
Pisum	-	-	r	x	++	Field pea
Vicia ervilia	-	-	-	-	++	Bitter vetch
Cicer	-	-	-	-	r	Chick-pea
Lathyrus	-	-	-	x	r	Grass pea
Small-seeded wild legumes	+++	++	++	-	++	
Wild grasses	++	++	+	-	+	
Quercus	-	-	-	x	+	Oak (acorns)
Pistacia	+	+	++	x	+++	Pistachio
Amygdalus	-	-	+	-	+	Almond

not likely that the climatic conditions at Ganj Dareh were unsuitable for wheat cultivation. Did the Ganj Dareh people choose not to grow emmer wheat or were they ignorant of this valuable crop? In this connection it should be mentioned that the inhabitants of Çayönü did not grow barley nor did they gather wild barley (and wild einkorn wheat) which must have been quite common at not too great a distance from the site (van Zeist, 1972). Some kind of selective process seems to have been in operation. It is a bit curious that the Ganj Dareh people would have preferred barley above wheat although the latter provides a much better flour for making bread (if, of course, bread making was the aim of the inhabitants). It is probably too far-fetched to speculate that barley was grown primarily for animal fodder as happens nowadays. The fact that during the whole of the Neolithic occupation of Ganj Dareh no other cereal than hulled two-row barley was grown might indicate that there were few or no contacts with other farming communities possessing a more varied crop-plant assortment.

It may be that the site was rather far away from centres of plant domestication and that as a consequence its occupants did not profit from developments elsewhere. At Ganj Dareh, plant cultivation may never have played such a prominent role as it did in sites such as Çayönü and Jarmo. Hunting, collecting and goat herding may have been more important here. The main significance of Ganj Dareh for the development of plant cultivation may have been that plant growing was extended to higher elevations. Other Early Neolithic sites for which plant cultivation has been attested are situated at lower altitudes. Although from the point of view of crop-plant assortment Ganj Dareh certainly did not take the lead, the site may have played an important role in the process of the spread of plant cultivation into widely varying environments in Southwestern Asia.

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