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The application of present-day cereal processing studies to charred archaeobotanical remains

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Data from a botanical study of present-day cereal processing in Greece are presented. The most appropriate ways of using these data as the basis for identifying the effects of cereal processing in archaeological material are then discussed.

Introduction

Contemporary low-technology farmers offer a rare opportunity to collect quantitative information on crop composition from a range of directly observable processing activities. The main purpose of this paper is t" make available some of the data from a study of present-day cereal processing on the Greek island of Amorgos. In addition, some suggestions are made about the most appropriate ways of using these data for comparison with archaeological material.

Data collection

The cereals cultivated on Amorgos were all free-threshing, and included wheat (both bread wheat, *Triticum aestivum* L. and macaroni wheat, *T. durum* Desf.) and barley (six-row hulled barley, *Hordeum vulgare* L.). These were often grown together, in varying proportions, as a maslin crop. Samples were collected from winnowing by-products (carried aside by the breeze), coarse-sieve by-products (retained by a sieve which allowed the grain to pass through it), fine-sieve by-products (passing through a sieve which retained the grain) and cleaned products (sieved grain). Ninety-nine samples were taken altogether and sub-samples sorted to give, where possible, a minimum of approximately 300 weed seeds per sample (Jones 1984).

Before quantifying the data, it was necessary to consider which items to count. One possibility was to count all fragments of grains and chaff, and to use these in the calculations of percentages. This could cause problems, however, especially when applied to archaeological material, as the degree of fragmentation may vary between sites and between different contexts within a site. This problem is similar to that experienced by bone analysts using the 'fragments method' of quantification (Uerpmann 1973). One way of standardising bone counts is to count diagnostic zones on each bone (Watson 1979).

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Applying a similar technique to charred cereal remains, one could count only the embryo ends of grains (G. C. Hillman pers. comm.), the glume bases (of glume wheats), or the tops of rachis internodes (for free-threshing cereals), and the nodes of straw. These are the parts of the cereal plant most likely to survive in an identifiable state in charred archaeological assemblages. It should be emphasised, however, that this is not intended as a method for estimating absolute grain quantity, numbers of ears, or numbers of plants represented, but simply as a method of standardising counting to permit reliable comparisons. This method was applied to the samples collected on Amorgos.

Results and discussion

The number of items from each sample is given in Table 6. The wheat and barley figures are given separately, but the figures for bread wheat and macaroni wheat are combined as it was not always possible to distinguish the grain from these two species. As all the barley was six-row (three grains per rachis node) and the wheats had an average of approximately three grains per spikelet (and so per rachis node), and as the two cereals were processed in exactly the same way (see Jones 1984 and Halstead and Jones in press, for more detail of the processing sequence), it is not unreasonable to calculate the relative proportions of grains, rachis internodes and weed seeds for both genera together.

Glume wheats (e.g. emmer, *T. dicoccum* Schtibl., and spelt, *T. spelta* L.) were not grown on Amorgos and require a different processing sequence to free-threshing cereals (Hillman 1981; 1984): the glumes and rachises of free-threshing cereals are removed at an earlier stage in the processing sequence than those of glume wheats (but the glume bases of free-threshing cereals are rarely preserved archaeologically). Sometimes, however, glume wheats and free-threshing cereals have been treated together in calculations of the relative proportions of grain, chaff and weed seed. While this is a very convenient way of expressing the composition of samples and lends itself easily to visual presentation in the form of a 'triangular diagram', it can be misleading when both free-threshing cereals and glume wheats are involved. For example, as rachis internodes of free-threshing cereals (e.g. barley) tend to occur less frequently on archaeological sites than the glume bases of glume wheats (e.g. emmer; Green 1981), there is a danger that the relative proportions of grain and 'chaff' will, instead, reflect the relative proportions of the two types of cereal (Jones 1987).

Unfortunately, in mixed samples, it is not possible to calculate the relative proportions of grain, chaff and weeds seeds for glume wheats and free-threshing cereals separately, as it is impossible to determine which weed seeds were associated with which crop species. Perhaps the best way to overcome this problem is to adopt a multivariate approach (cf. Jones 1984; 1987). Rather than trying to reduce the variation in sample composition to summary percentages from which a triangular diagram can be constructed, the ratio of grain to chaff can be calculated separately for each crop species. The ratio of total grain (or chaff) to weed seed can then be calculated independently, as can the ratios of straw to grain (or chaff), and the percentages of different weed types. Arguably, this is the only satisfactory way of dealing with a mixture of glume wheats and free-threshing cereals. However, at sites with only one type of cereal, it may be possible to make some use of simpler summary statistics.

By comparing the percentages in Table 6, one can get an idea of the proportions which characterised each type of (by-)product on Amorgos. So, the winnowing by-products had about 50% or more rachis internodes and, with five exceptions, more weed seed than grain. The coarse-sieve by-products had more than 30% rachis internodes, with varying proportions of grain and weed seed, while the fine-sieve by-products had more than 50% weed seed and very few rachis internodes. Cleaned (sieved) products had more than 80% (and usually more than 95%) grain with a very low proportion of rachis internodes.

When comparing these figures with data from archaeological samples, it should be borne in mind that the thoroughness of winnowing and sieving may vary, depending on the strength of the breeze, whether the crop is intended for animal or human consumption, and so on. Even more significantly, the quantity of weed harvested with the crop may vary greatly. Moreover, the ratio of grain to rachis internodes will not always approximate to 3:1 as it did for the material collected on Amorgos. Finally, caution is necessary as some of these components (e.g. grain) are more likely to be preserved by charring than others (e.g. rachis internodes; Boardman and Jones forthcoming). Nevertheless, these figures provide some guide to what might be expected for each type of (by-)product. The percentages can also be used to construct triangular diagrams (cf. van der Veen 1985), which can be used in visual comparison with archaeological samples of free-threshing cereals only (Fig. 14). More information could be included in the percentages by adding numbers of straw nodes. Above all, where possible, the types of weed seeds (classified according to their size, aerodynamic properties, etc. - cf. Jones 1984; 1987) should be used as a check on conclusions based on relative quantities of weed, chaff and grain.

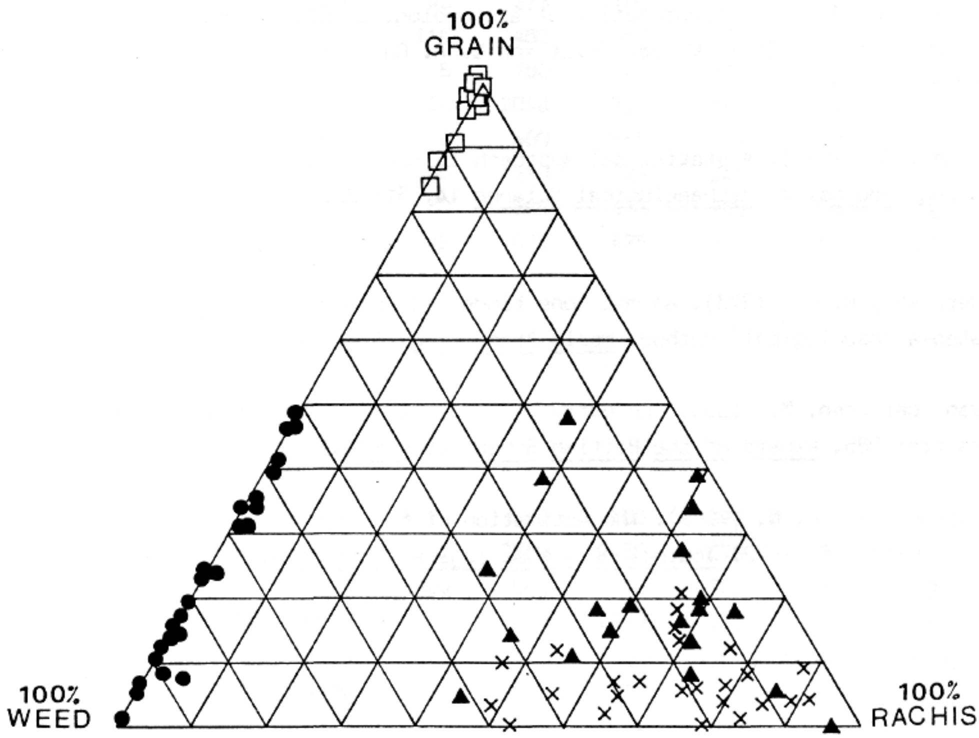

Figure 14. Diagram showing the relative proportion of grains, rachis internodes, and weed seeds in crop processing products and by-products for free-threshing cereals. Key: cross - winnowing by-products; circle - fine-sieve by-products; triangle - coarse-sieve by-products; square - cleaned products.

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Table 6 (opposite and p. 96). Composition of free-threshing wheat and barley samples from Amorgos. Key: GRAIN = number of embryo ends; RACHIS = number of internode tops; STRAW NODES = number of cereal straw nodes; WEED SEED = number of weed seeds. Percentages calculated for total GRAIN+RACHIS+WEED SEED.

The complete data set on which this table is based is available at the time of publication by electronic mail via the Archaeological Information Exchange established by Sebastian Rahtz at the Department of Electronics and Computer Science, University of Southampton. Electronic mail messages to INFOSUK.AC.SOTON.CM with the subject line **aie-amorgos** will be mailed back with the data (leave the message blank). A key to the data is mailed back if the subject line is **aie-amorgos-key.**

	WHEAT		BARLEY		STRAW	WEED	%	%	%
	GRAIN	RACHIS	GRAIN	RACHIS	NODES	SEED	GRAIN	RACHIS	WEED
winnowing	36	156	222	980	280	743	12	53	35
by-products	0	1220	20	420	4300	327	1	83	16
	16	744	108	840	460	735	5	65	30
	108	1266	8	70	377	388	6	73	21
	82	786	4	34	95	388	7	63	30
	76	1798	88	1570	525	167	4	91	5
	40	306	8	200	165	357	5	56	39
	60	322	108	206	310	104	21	66	13
	6	508	0	228	110	669	0	52	47
	50	152	136	1800	725	255	8	82	11
	112	1692	175	1160	240	96	9	88	3
	42	462	124	256	280	170	16	68	16
	8	310	4	126	125	225	2	65	33
	42	498	40	282	280	301	7	67	26
	8	103	22	370	90	464	3	49	48
	24	1920	60	332	550	317	3	85	12
	40	568	44	474	450	263	6	75	19
	20	116	45	223	190	298	9	48	42
	10	192	116	460	260	158	13	70	17
	4	924	6	780	280	464	0	78	21
	8	112	92	2040	750	160	4	89	7
	34	786	150	400	460	167	12	77	11
	12	420	60	1210	325	341	4	80	17
	40	914	60	500	430	270	6	79	15
	84	444	245	820	475	271	18	68	15
coarse-sieve	375	625	4125	3050	100	1388	47	38	15
by-products	875	4560	800	2210	2450 -	679	18	74	7
	364	572	820	660	1240	722	38	39	23
	136	8064	0	800	2270	273	1	96	3
	8120	14650	100	180	1220	1199	34	61	5
	616	4180	192	2920	2640	1786	8	73	18
	552	2336	360	992	1640	556	19	69	12
	108	1306	276	660	743	1190	11	56	34
	79	860	31	280	286	1356	4	44	52
	440	1410	1700	8500	2650	2457	15	68	17
	568	1184	696	2800	1690	1383	19	60	21
	1100	3732	372	1320	1410	815	20	69	11
	412	1270	260	900	530	1025	17	56	27
	9800	14300	1400	2450	2250	530	39	59	2
	286	1230	140	144	371	1180	14	46	40
	172	310	264	348	450	660	25	38	38
	30	2360	350	3450	4080	564	6	86	8
	300	1068	92	464	814	687	15	59	26
	2	2	430	2400	1080	555	13	71	16
	796	1708	304	888	788	406	27	63	10

fine-sieve	29	0	115	0	0	590	20	0	80
by-products	15	16	16	2	0	321	8	5	87
	32	0	27	0	0	330	15	0	85
	179	0	3	0	0	209	47	0	53
	98	4	2	0	0	503	16	1	83
	96	0	56	0	0	296	34	0	66
	270	1	59	0	0	374	47	0	53
	27	0	5	0	0	426	7	0	93
	34	0	5	0	0	601	6	0	94
	34	0	220	1	0	263	49	0	51
	36	0	43	0	0	529	13	0	87
	96	11	78	2	0	369	31	2	66
	150	15	53	2	0	375	34	3	63
	99	0	49	0	0	290	34	0	66
	18	0	51	0	0	537	11	0	89
	253	6	58	0	0	339	47	1	52
	54	0	17	0	0	328	18	0	82
	3	0	16	4	0	1076	2	0	98
	82	1	27	0	0	359	23	0	77
	103	0	1	0	0	332	24	0	76
	82	7	64	2	0	308	32	2	67
	35	0	29	2	1	346	16	0	84
	22	10	110	0	0	412	24	2	74
	169	3	72	0	0	354	40	1	59
	20	0	65	2	0	151	36	1	63
	15	5	17	3	2	315	9	2	89
	126	5	111	0	0	339	41	1	58
cleaned	1400	0	18600	55	7	304	98	0	1
products	63500	18	58800	18	7	462	100	0	0
	6800	1	23700	20	4	377	99	0	1
	99990	10	4110	1	2	384	100	0	0
	70450	65	6530	23	3	405	99	0	1
	22870	40	78120	60	3	240	100	0	0
	9070	1	15200	5	0	436	98	0	2
	25730	24	39370	13	2	367	99	0	1
	11580	13	3880	6	0	582	96	0	4
	66	8	35650	50	13	279	99	0	1
	1 0420~	25	15660	4	16	343	99	0	1
	9300	65	19700	2	20	669	98	0	2
	17370	90	12090	11	32	478	98	0	2
	770	4	2480	1	3	422	88	0	11
	4250	0	8370	2	0	336	97	0	3
	65600	68	46500	15	5	303	100	0	0
	19300	46	1 5500	4	15	399	99	0	1
	288	29	4340	10	19	412	91	1	8
	32200	32	30700	7	25	513	99	0	1
	15440	3	470	0	4	704	96	0	4
	14860	28	24030	7	12	276	99	0	1
	1530	25	1230	22	12	485	84	1	15
	2120	65	25420	68	38	384	98	0	1
	65140	8	52300	4	8	375	100	0	0
	995	4	49910	32	1	321	99	0	1
	10420	23	26970	27	2	331	99	0	1
	18140	34	21700	30	7	412	99	0	1