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A GRAIN STORAGE PIT OF THE PRE-IMPROVEMENT PERIOD AT INCHKEIL, DUFFUS, MORAY

IAN A G SHEPHERD & ALEXANDRA N SHEPHERD

The carbonised grain

Alan D Fairweather

INCHKEIL CARBONIZED GRAIN REPORT

ALAN D FAIRWEATHER

The great bulk of material examined consisted of Avena (oat) grains and floret parts. Most florets were entire with the caryopsis (grains) invested within the lemma and palea. The majority of such entire florets and the broken parts identifiable were of the cultivated oat (Avena sativa) but there were numbers of entire florets and identifiable parts (especially basal fracture scar) attributable to A.fatua (wild oat) and A. strigosa (the bristle oat).

In addition there were some few grains of barley and wheat. The small numbers indicate an inadvertent contaminant of the crop or a mixing in process of store. The barley grains were often twisted at the base and with a conformation which made them most closely attributable to the hulled, lax six-row type of Hordeum vulgare. Most wheat grains, and there were very few, were of the Triticum aestivum type but one grain was markedly humped and more like T. rigidum (rivet wheat).

Much of the sample was fused in lumps which, when examined and sampled, were found to be a physical conglomeration of the material sampled 'loose'. There was no significant difference between sampled lumps or between the fused material and the loose material sampled. The fusion and condition of the grain indicate damp storage before carbonization. Many grains seem to have been physically compressed and distorted. This was particularly noticeable in the barley grains. Such compression without evidence of impact damage is unlikely below 24% moisture content (mc). (Safe long-term storage of dry grain needs mc of 14%). Although relatively few barley grains were found, the compression which most seem to have suffered (a greater proportion than the oats component) may indicate a different treatment from the large number of oats.

It is possible that mixing occurred after separate treatment of the oats and barley. It is certain, however, that both oats and barley were carbonized together with the occasional wheat grain. The few wheat grains were not compressed.

Many grains showed signs of germination having started (ie size and shape of embryo and 'dimpling' or concavities on grain surface). There were, however, no signs of extensive radical development to form a mat of root hairs. This is consistent with damp storage. Germination may have been stopped before carbonization or by parching (which caused the carbonization of this sample).

Storage in air-tight pits allows some germination to begin but is soon stopped and preservation effected in an atmosphere where O_2 is used up and CO_2 increased. The sides of such pits are often damper and can cause grain to stick. In like manner grain in 'dry store' may be damp against a wall with less free air movement allowing the grains to deteriorate and stick together. Indeed it is possible that such fused grain masses may have been discarded and burned as being inedible, especially if tainted by fungal growth.

There appeared to be occasional very fine strands connecting some of the grains but the presence was not sufficient to state with confidance that the grains were joined by fungal hyphae.

Fusion of grain masses may be caused by:

1 actual germination and root-hair development forming a holding weft;
2 fungal growth producing a weft (mycelia) of hyphae binding grains together;
3 exudates from damp grain forming an adhesive glue between grains;
4 during heating damp grain exudates rich in solutes being concentrated by evaporation on the grain surfaces to form tar-like adhesive.

From close examination of the grain masses fusion would seem to be caused by factors 3 and 4 above.

Stage of processing

The florets had been knocked or threshed from the sheaf and raked and winnowed to remove straw or any other cereal parts other than those of the florets themselves.

Very few small light weed seeds were found. Most frequent were large heavy carpoids which would have been hard to remove from the grains, being in the same size class ie corn cockle (Agrostemma githago) and hairy tare (Vicia hirsuta). It seems probable that the lighter 'seeds' may have been winnowed out. The grains themselves were nearly all unbroken although many were distorted (see discussion above).

The material in the lumps was mainly entire, ie caryopses (grains) invested in the florets (ie with lemma and palea adhering). This indicates that heat was probably applied as parching to facilitate the removal ('shellin') of the lemma and palea from the oat caryopsis. Much of the 'loose' material was also entire but a substantial proportion of floret parts had broken off, freeing the grain.

The lemmas, paleas and awns and their fragments made up nearly all of the fraction less than 0.6mm. Fragments of these parts constituted the greatest volume of the fine fraction, ie less than 0.6mm. The rest of this latter fraction (20%) was made up of fine mineral grains.

TABLE 1

Estimate of species represented in grain sample

	(10%	Avena fatua	wild oat
95%	(80-90%	Avena sativa	oat
	(10%	Avena strigosa	bristle oat
	5% (	Hordeum vulgare (lax six-row, hulled)	bere, barley
	(	Triticum aestivo compactum	wheat
	(	T. cf turgidum	rivet wheat

Percentage of 'seeds' found other than above

	58	Agrostemma githago	corn cockle
	1	Chrysanthemum segetum	corn marigold
	1	Galeopsis tetrahit agg.	hemp nettle
	10	Polygonum aviculare agg.	knot grass
1%	2	Polygonum cf persicaria	redshank, persicaria
	3	Spergula arvensis	corn spurrey
	30	Vicia hirsuta	hairy tare
	5	Vicia sp	tare type seeds

			% VOLUME
2mm	Agrostemma, Avena cf sativa, Hordeum triticum Vicia		63
1mm	Avena strigosa, A. fatua		19
0.6mm	Awns lemmas paleas Spergula	chaff	7
0.6	broken parts of awns lemmas paleas etc.	Light chaff	11

The light chaff fraction (lemmas paleas) could not easily be removed before parching (probable stage of carbonization), whether accidental or deliberate, as these parts adhere tenaciously to oat grains.

The most common 'weed' species was probably Avena fatua (wild oat) but its actual frequency is not easy to judge from grains alone. The presence of

diagnostic floret parts, especially the distinctive fracture-scarred bases, were noted and when whole florets were encountered in the mass. From this it is estimated that perhaps as much as 10% of Avena grains were fatua.

The status of Avena strigosa is probably that of a crop impurity as diagnostic parts of the floret encountered would indicate a similar proportion of the Avena fraction as for fatua, ie about 10%.

The grains of the above two Avena species would be expected to fall within the size range of 1-2mm with few larger. Avena sativa's grains would be mainly in the larger size range: 2mm.

Both A. fatua and A. strigosa were more frequent than Hordeum or Triticum. Of course A. strigosa was a crop in its own right able to produce grain from poor exhausted land and would have been widely grown 'pure' at the time of carbonization.

Agrostemma githago (corn cockle) accounted for 48% of weed 'seeds' encountered other than Avena; the most frequent impurity throughout. It is hard to clean out of a grain sample as the size and density of the seed is similar to cereal grains. It was a very common problem prior to the 19th century and more sophisticated mechanical cleaning methods. The seed contains variable proportions of glycosides; the saponin content may lead to a susceptibility to leprosy according to Godwin (1976). At any rate large numbers of seeds make meal and flour unpalatable or even inedible.

Vicia hirsuta (hairy tare): 30% of weed seeds encountered were those of tare. 'It is the worst weed that is' declared John Fitzherbert in his Boke of Husbandry 1523 (ex Salisbury 1961). It is a scrambling, choking, weed which competes vigorously with crops and seriously interferes with harvest. The seeds encountered were often attached to remaining sod parts by which the species was identified. The size makes cleaning from grain difficult.

Another Vicia sp was present with larger seeds but these were not identified to species level: possibly V sativa ssp angustifolia. Polygonum aviculare agg. Polygonum cf persicaria (knot grass and

redshank): 10% and 2% of weed 'seed' occurrences. Knot grass in its various forms is a common weed of arable land. It is low and prostrate and is difficult to hand-weed out of a crop once developed. It interferes with drying of the sheaves at their base.

Polygonum fruits with some perionth parts adhering were found and were most closely comparable to persicaria. Comparatively few fruits were found. In some ways this is surprising as it is a common weed.

Spergula arvensis (corn spurrey) was found in about 3% of 'seeds' encountered. In larger numbers this would indicate an acid-impoverished soil. Incidences were, however, surprisingly low for this common weed.

Galeopsis tetrahit agg. (hemp nettle) represented only 1% of 'seeds'. This is a very low incidence and one might have expected more. It is in the same size class as Agrostemma and one could conclude that it has not been cleaned out but was infrequent in the crop.

Chrysanthemum segatum (corn marigold) had 1% representation, again very low.

The paucity of species in the small-size class could indicate some sieving/winnowing of the crop as more would be expected in this size class. However, soil conditions and rigorous weeding may have kept a clean crop.

In summary:

1 The sample is Avena sativa with an admixture of A. fatua and A. strigosa and occasional grains of Hordeum and Triticum.

2 The grain has been threshed and raked or winnowed to remove straw and parts other than florets.

3 Carbonization occurred before 'shellin' (the removal of lemma and palea by parching). Carbonization probably occurred as a result of over-parching. It may be the result of burning discarded material or cleaning the grain pit by fire.

4 Other species represented were few but the majority of 'seeds' found were large and in a size class similar to the grains and hard to remove. These species were corn cockle (Agrostemma githago) and hairy tare (Vicia hirsuta). Only eight species other than Avena, Hordeum and Triticum were found.