THE GRAIN FROM THE GRANARY[1]

Gordon Hillman

In 1920 three substantial samples of grain were recovered from the building known from this discovery as the Granary (*BSA* 25, 44–49). These samples came to light in the Nauplion Museum in 1969[2] and were studied by Gordon Hillman. He wrote a report but this has not been published. The samples however are worth detailed consideration. The grains themselves are stored at Mycenae under the number BE 6965.

THE GEOGRAPHICAL BACKGROUND to the site itself has importance in understanding the agricultural systems potentially in use. The Mycenae citadel sits on a low, limestone knoll overlooking the valley of the Kephissos. Water supply was presumably solely derived from the year round spring (the so-called Perseia) located E of the site which was further secured by a piped supply bringing the water direct from the spring to a large cistern in the citadel.

Behind the site, to the east and north-east, rise the mountains Hagios Elias and Zara. Vegetation on the mountain slopes would once have been dominated by oaks and been well suited to grazing sheep and goats. It was doubtless also the source of foods like acorns, wild pears and other fruits which, from the frequency of their occurrence in many site deposits could be judged to have been popular fare in some parts of Greece during the Neolithic at least and probably later. Below the site to the west and south, the fertile Plain of Argos stretches out to the

[1] This report was written in 1974 but as it was considered too lengthy for the Annual of the British School it has remained unpublished. Following the recent restudy of all aspects of the Granary, it has seemed suitable to include it here in the relevant fascicule. No serious attempt has been made to update the referencing, though further work has been done in this field. Some of Hillman's original references have proved untraceable for the non-specialist. The report as it stands gives an important and detailed account of the agriculture of Mycenae that has not been superceded. My thanks to Professors Stephen Mitchell and Nicholas Postage for their help. [EBF]

[2] Included in one of the cigar boxes was a small pill box containing five coins (presumably those mentioned *BSA* 25, 39).

coast 18 km away. Today the most conspicuous features of cultivation on the plain are pump-irrigated fruit orchards, olives, figs, cotton, melons and a range of vegetable crops. Most of these crops are today grown for sale in the cities. Overlooking the plain, the low hills of the valley fringe support vineyards much as they may have done in times past. It is also on these low hills that cereals like barley are most conspicuous. In earlier times, however, when local self-sufficiency in basic foodstuffs was more vital than it is now, wheat and pulse-crops like horse-bean doubtless occupied a more important position in valley-bottom cultivation than their modern equivalents do now.

In the immediate vicinity of Mycenae, the limited water supply in the area today excludes the possibility of extensive gravity irrigation (i.e. irrigation without assistance from pumps), and so far, there exists no evidence to suggest that irrigation agriculture played a significant role in the Mycenae economy. However, the relatively dry conditions in the Argolid may well have resulted in years of drought when the possibility of large-scale irrigation would have been all too welcome.

It has in the past been suggested (Carpenter 1966) that the end of LH IIIB and the ensuing LH IIIC periods may have been characterised by severe droughts that persisted for many years. It is unfortunate that this possibility cannot be tested on the basis of the plant remains recovered either from Mycenae or any other Late Helladic site from which the plant remains have so far been published.

The structural context of the grain samples suggests that storage products are involved rather than grain at either an earlier stage of cleaning operations or at a later stage of domestic processing.

The grain hoard could represent either the personal store of an individual family or distinct group, or else the collectivised store of some form of central administration.[3] The size and number of storage vessels would be more appropriate to a large family-sized group than to any central administration responsible for issuing

[3] The status of the Granary in what is generally supposed to be a Post-Palatial economy has been the subject of recent study (French 2009*b*).

rations to large numbers of workers. From the excavator's account it seems that all three samples of grain derive from the same deposit and that each had originally been associated with a different container. The nature of these containers suggests once again that the grain represents storage products: "in the refuse from the first floor which had collapsed into the basement, there were remains of store-jars broken by heat. Of these, only one or two were the ordinary store jars (pithoi) of baked earthenware, the rest — and there were many — were vessels in shape like small tubs about 0.7 m high and 0.5 m in diameter, with thick walls of unbaked clay well-mixed with chaff. Vessels of this type of unbaked clay are still in use in the villages of the Argive plain for storing grain and other produce or household goods, and are called *kotselles*. In the remains of these store vessels — some were also found in the basement itself — were carbonized grains such as vetches, barley and wheat" (*BSA* 25, 48).

THE GRAIN CROPS REPRESENTED

The full list of species identified in these samples appears in Table C. The relative proportions of the different types of grain in these three samples (recovered from a single deposit) cannot be assumed to bear any relationship to their relative importance in the agricultural economy of the settlement of Mycenae as a whole, or indeed any of the associated villages in the area. Even less can we expect that this list represents the full range either of crops grown by the population of Mycenae or of the plants they probably gathered from the wild.

Within the limits of the available evidence, all that can be said that the crop species identified from Mycenae correspond very well with those established for other Mycenaean sites. (For a useful summary of most of the Bronze Age plants identified from Greek sites[4] see Willerding 1973.) However, the Mycenaean plant remains published so far are remarkably scanty and the details of agriculture at that time are not clear. It is therefore worth considering each of the five crops identified from Mycenae against the background of its apparent role in early

[4] Crops not represented in the Mycenae citadel samples but which appear to have been cultivated by Mycenaean settlements elsewhere include lentils (*Lens*), peas (*Pisum*), grass peas (*Lathyrus sativus*) and in the North millet (*Paniceum milliaceum*).

Table C.

	STRUCTURES IDENTIFIED	SAMPLE 1	SAMPLE 2	SAMPLE 3
Triticum boeticum/ T. monococcum 1 grained form (wild or domestic einkorn – intermediate form)	grain	333	1	–
T. monococcum (domestic einkorn)	spikelet forks	110	2	–
T. monococcum (domestic einkorn) 1 grained form	grain	*c*. 28	–	–
T. monococcum (domestic einkorn) 2 grained form	grain	??	–	–
T. Dicoccum (domestic emmer)	lateral spkt forks terminal spkt forks grain: 'normal' type gr: curved-base type	234 24 *c*. 815 *c*. 50	1 – *c*. 120 –	– – – –
Hordeum saltivum var. *tetrastichon* (four-rowed, hulled barley)	cast from grain imprint	–	1	–
H. sativum 4 or 6 rowed, hulled barley	symmetrical grain asymentric grain	} 217	1550 3215	} 15
Vicia ervilia (bitter vetch)	seed	820	3020	880
Vicia faba var. *minor* (horse bean)	seed	1	4	–
Olea europaea (domestic olive)	stone	3	–	2
Ficus carica	seed	2	–	–
Vitis vinifera cf. ssp. *sylvestiris* (grape, apparently wild type)	seed	1	–	–

Table C (continued).

WEEDS ETC.				
Lolium (*multiflorum* type)	grain	8	204	–
Hordeum hystrix	grain	2	–	–
Avena (small, in size range of *A. barbata*)	grain	–	4	–
Gypsophila sp.	seed	–	1	–
? *Chenopodium* (badly damaged)	seed	1	–	–
Trifolium sp.	seed	1	–	–
Vicia or *Lathyrus* (small seeded)	seed	–	1	–
Lithospermum cf. *arvenae*	achene	–	2	–
Onosma sp. (? Modern intrusive)	achene	1	–	–
Cf. *Gloularia* sp.	achene	1	–	–
Galium sp. (small fruited species	achene	8	8	–
Cf. *Asperula*	achene	–	12	–
Indet. (damaged)	seed	–	1	–
Lump of charred ?bread (wrapped in piece of cloth)		–	–	X

agriculture in Greece over a broader time scale. This is also a good point to describe the crops themselves and the sort of foods that might have been produced from them

BACKGROUND OF THE CROPS

EMMER WHEAT — *TRITICUM DICOCCUM*

From the Neolithic through to Classical times (and later), the form of wheat cultivated most commonly in Greece appears to have been emmer. In contrast to the free threshing wheats (bread wheat — *T. aestivum* and macaroni wheat *T. durum*), the grain of emmer is tightly invested in hard glumes and cannot be released by simple threshing; the act of threshing merely breaks the ears of

Fig. G. Emmer wheat (*Triticum dicoccum*).

emmer into its component spikelets. Each spikelet encloses a pair of grains, and these disarticulated spikelets must generally be lightly parched to render the glumes brittle and then beaten (using an oversized pestle and mortar) before the grain can be freed; the grain is then separated from the chaff by the usual winnowing and sieving. With emmer, therefore, the threshing operation is much more time-consuming than for either of the major free-threshing wheats.

In view of this drawback, it might be expected that emmer would have been ousted as soon as the free-threshing wheats became available. However, all the available evidence suggests that emmer continued to be the favoured wheat in most parts of Greece for some millennia after at least one of the free-threshing wheats (probably the bread wheat *Triticum aestivum*) had become available not only in Anatolia but also at Knossos (Evans 1974, Jones 1984) and at Greek mainland sites like Argissa Magula (Hopf 1972, 101, 109), Sesklo (Tsountas 1908, 359), Servia (Heurtley 1939, Hubbard 1979) and perhaps Rachmani (Wace and Thompson 1912, 262). The continued popularity of emmer may suggest

either that the early bread wheats were poorly adapted to cultivation under conditions prevailing in most parts of Greece at that time or else that wheat grain was eaten in a form *other than bread* (e.g. as groats), for which emmer is decidedly superior to the 'bread wheat' *Triticum aestivum*. (For high quality groats in the form of the Turkish *Bulgur*, emmer is decidedly superior even to the best macaroni wheat, *Triticum durum*.[5]) A third possibility is that flat bread (made from emmer) was in fact commonly eaten, but that the superior qualities of bread wheat for making leavened bread remained unrecognised.

Whatever the reason, continued cultivation of emmer comes as no surprise: even today, emmer is still being grown in parts of Anatolia, Afghanistan and, until recently at least, even in countries like Czechoslovakia despite the universal availability of high-yielding bread wheats. In most of these modern examples the reason lies primarily in the continued popularity of cracked wheat or coarse groats as a food: emmer yields a particularly high-quality form of cracked wheat, and in the Kars area of Eastern Anatolia many towns-people are prepared to pay more than twice as much for emmer groats (Tur. *Gernik Bulguru*) as they pay either for the usual groats made from macaroni wheat *T. durum* (Prof. Tosun, pers. comm.).

On the other hand, it could be argued that the relative abundance of emmer in the archaeological record for Greece is no more than an artifact, a result simply of the fact that the traditional oven-parching of emmer prior to de-husking is such that the grain stood a better chance of being charred (and thus preserved) than any grain from free-threshing wheats where oven-parching is unnecessary. But this sort of bias would be important only if the plant remains from the majority of sites had been recovered from deposits associated with parching ovens or ash heaps. In fact, however, a high percentage of the grain so far published from Greek sites (this Mycenae sample included) appears to have been recovered from storage contexts, and all classes of stored grain presumably face an equal chance of being charred as a result of accidental fires. The apparent importance of emmer in Bronze Age Greece cannot, therefore, readily be dismissed as an artifact.

5 I have never yet seen *bulgur* made from bread wheat, *Triticum aestivum*.

Existing evidence has generally been taken to suggest that the wheats (represented primarily by emmer) remained the most widely cultivated cereal only until the late Neolithic and that, by Early Helladic times, wheat had already started to lose ground to barley. By Mycenaean times, therefore, six-rowed barley would, on this basis, have long been established as the major cereal. But while there can be little doubt that barley was an important crop (quite possibly *the* most important crop) in Classical and Mycenaean times (see 'barley' below), the interpretation of the evidence on the declining role of wheat in many parts of Greece between the Neolithic and Bronze Age is still equivocal. No sites that span both periods have been adequately sampled for plant remains, so that details of the apparent transition from wheat to barley cannot yet be studied for any one area and settlement. In addition, too few Bronze Age sites in the prime wheat growing areas of Thessaly have been adequately sampled for plant remains.

Emmer wheat as a food

As suggested above, there are several forms in which the Mycenae wheat may have been eaten. To us, bread is the most obvious wheat product, but emmer products include cracked wheat (boiled), fine groats (eaten as a soup) and even roasted grain. Of the four, roasting is the quickest and most simple way of rendering grain edible, and the roasted (and often part-charred) product '*kavurmaç*' is still commonly eaten in Anatolia and doubtless else-where today though primarily as a snack rather than a main meal. The presentday method of roasting grain is to toss grain from the grain-store into an up-turned *saç* (a concave sheet of metal normally used to bake flat bread) and to agitate it over an open fire. After a minute or so the grain splits open and turns floury. Generally, something more flavour-some is roasted along with the grain, e.g. seeds of the terebinth tree *Pistacia terebinthus*, *Cannabis* seed, chick peas or the seeds of squash. This convenient method of eating grain doubtless has considerable antiquity and certainly had its equivalent χιδρα in Classical Greece (Moritz 1958, 142).

Another form of roasted grain is the Anatolian *firig* (Ar. frikke). To prepare this, sheaves with half-green ears and mile-ripe grain are burned, the part-charred ears picked out of the ashes, the grain rubbed free of the chaff between the hands and the husks blow away leaving the half-roasted, half-ripe grain. This rather indigestible product is, today, eaten generally only as a snack out in the fields and is therefore less likely to be recovered in excavations of habitation deposits.

However, it is sometimes produced on a larger scale on the *harman* (threshing floor) and, in this case, generally eaten with curds (in Grünkernsuppe).[6]

It is also possible to render grain soft and palatable by simply boiling it for half an hour or so. In present-day Anatolia this product is produced in the first step of the *bulgur* making process. But while it rarely provides much more than snacks for those involved in preparing the *bulgur*, it may have played a more important role in times past, this despite its dramatically purgative action on unaccustomed stomachs.

One step up in the complexity of preparation are the cracked wheat dishes. Pliny describes *alica* (groats) made from emmer as having been the staple grain food of the Romans in earlier days before bread became the basic city food, and the origins of this method of preparing emmer doubtless have still greater antiquity than that. In preparing cracked wheat, the bran is first removed; according to Clark and Haswell (1967, 67) "Even the poorest subsistence economies find wheat bran indigestible and mill off 10%"[7] In present day Anatolia, at least, bran removal is achieved by first boiling the wheat, drying it thoroughly in the sun, grinding the freshly re-moistened grain loosely under a massive stone wheel (which is twisted around in an equally massive stone basin), re-drying it and then winnowing away the free bran. Pliny (Nat. Hist. xviii, 116) describes a remarkably similar process for preparing *alica*, though his account lacks any detail. The stripped grain is then cracked into large fragments either in a small, coarse-stoned rotary quern or else by beating it in a large stone bowl with long-headed wooden mallets which are perhaps not dissimilar to the wooden pestle and mortar described by Pliny for cracking emmer wheat (Nat. Hist. xviii, 112). The fragmented grain is then passed through a special sieve (mesh diameter *c*. 1.5 mm) to remove the grounds that are too small and floury from the choice coarse-grits. The Classical Greeks reveal similar preferences in referring to the coarsest grain as 'select grade'.

6 A delicious charred grain product from Lebanon is marketed currently (2010) in the UK in Near Eastern supermarkets under the name 'frikeh' (EBF). Google also quotes various types of 'green wheat' products under this name.

7 Not only do *kururmac*, *firig* and other such 'snacks' present clear exceptions to this statement but those of us who eat muesli consisting of uncooked crushed grain complete with bran know it to be patently untrue.

This refined, crushed wheat is then ready for cooking either like rice or as a porridge. As mentioned above, the best and most sought-after cracked wheat is still that made from emmer in the few areas where this crop is still grown. It is quite possible that the Mycenaeans ate their emmer prepared this way, though they would presumably have used saddle querns (or pestle and mortar) rather than rotary querns to do the cracking.

A similar though finer form of groats can be used as a basis for soups, particularly yogurt soup — as eaten in Anatolia (and Northern Greece) today. In the latter case, a mixture of groats and yogurt are squeezed into balls which are dried — as *tarhana*. These rock hard balls have the advantage of being storable for long periods and can consequently provide yogurt soups in winter when milk and yogurt supplies are poor. The groats can be prepared in the same way as cracked wheat except that the grain is not boiled and dried before the first grinding. Alternately the finer groats from *bulgur* production are used. Today, macaroni wheat *T. durum* is used, but emmer would doubtless have done just as well if not better, and it was certainly the wheat used to provide the equivalent, finer grade of groats recorded by Pliny (Nat. Hist. xviii, 112).

Simple peeled wheat grain (uncracked) is also perfectly edible if boiled for half an hour or so and forms the basis of a delicious and sometimes very elaborated dish called *aşure* in Alevi villages of Anatolia. In this case, the boiled and subsequently dried wheat grains are stripped of their pericaps using a type of wheel called the *seten*, just as in the first stages of *bulgur* preparation (Hillman 1984, 135).

At which point bread became the favoured wheat product is unknown. Moritz (1958, 150) suggests that bread first became widespread in Imperial Roman times, and that most of the bread was by that time made of the better adapted 'bread wheat' *T. aestivum*, with emmer bread a relative rarity. For pre-classical periods there is little evidence either way, though it is perhaps suggestive that all the earliest references to cereal-based foods suggest that products *other* than bread are involved. However, bread wheats make an early appearance in Anatolia (Helbaek 1964) and certainly make up the bulk of the food stores in the Phrygian destruction levels at Gordion. Bread making at Gordion was surely well established to judge from the close association of the grain stores with large-scale grinding

facilities involving a long work-bench of large saddle querns and also large ovens of the sort used today in Anatolian villages to bake semi-leavened bread. This pattern of association was found in each of the megara excavated so far (barring the stables) in the 'Palace Quarter' of the city (De Vries, pers. comm.).

To prepare fine flour for bread-making, much more efficient grinding is necessary, of course, and, if any more than the coarsest fragments of bran are to be removed, then sieves with very fine meshes have to be available. Saddle querns can apparently produce reasonably fine flour (given the right wheat), and even though flour-sifting at Mycenae is unlikely to have achieved the remarkable sophistication recorded for Imperial Rome (Moritz 1958, 164–76), the manufacture of sieve-meshes necessary for removal of the worst of the bran was surely within the scope of Mycenaean technology whether the meshes were made of wool or, better, from linen or hair from the tails of horses.

Any or all of these emmer foods may therefore have been eaten at Mycenae, though some form of groats seems the most likely candidate. Direct evidence from sites of this period is obviously needed.

EINKORN WHEAT — TRITICUM MONOCOCCUM

The wild form of this wheat (*Triticum boeoticum*) grows in parts of North Greece both in truly wild situations and also as a weed of cereal crops (see Harlan and Zohary 1969). Despite this, the domestic form (*T. monococcum*) almost certainly arrived in Greece from Anatolia and Syria/Palestine where it had evolved under cultivation some millennia earlier.

Einkorn bears a superficial resemblance to emmer wheat and like emmer it has to be parched and pounded to release the grain. But in contrast to emmer, existing evidence suggests that einkorn made only a limited contribution to the food economy of many parts of Greece. Thus while einkorn was evidently a crop in its own right at Late Neolithic Sitagroi (Renfrew 1973, 163) and again at Late Neolithic Nea Nikomedia in Macedonia (van Zeist and Bottema 1971, 52–67), the einkorn recorded from other sites like Ghediki (Renfrew 1966, 24) and Argissa Magula (Hopf 1962, 104, 109) is perhaps best interpreted as a mere contaminant of emmer crops, even though the remains evidently represent the morphologically domestic form in each case.

In the Mycenae wheat sample, less than one quarter of the grain is einkorn, and in terms of spikelet and grain morphology it is again of the domestic type. For the fields that produced this batch of grain therefore, the einkorn may either have been deliberately sown as part of a mixed crop or else may have been no more than a weed. Certainly, mixed crops of emmer and einkorn (with einkorn making up between a half and a quarter of the sown grain) were cultivated in North-Central Anatolia until quite recently, particularly on poor soils where there was a greater risk of crop failure. (In dry years, the inclusion of the more drought-resistant einkorn boosted what would otherwise have been a hopelessly low yield — Prof. Tosun, pers. comm.). On the other hand, domestic forms of einkorn such as the type identified from Mycenae can be a weed of crops in just the same way as the morphologically wild form (Percival 1921). But if the einkorn in the Mycenae wheat was a weed, it would not necessarily have worried the farmers unduly as the standard threshing, parching and pounding which has to be applied to emmer would at the same time have released the einkorn grain which could then be treated in the same way as emmer. But this assumes that the ears of this weed einkorn were as tough-rachised as the ears of the emmer crop in which it grew. If, however, the einkorn ears had fragile rachises (more like the wild type) then they would have shattered at harvesting and fallen to the ground, thereby spawning yet another generation of weeds for next year's crop and contributing nothing to the Mycenae granaries. In this case the einkorn would have been a serious pest and could have been eradicated only by careful weeding of the fields.

The presence of einkorn in the stored emmer grain demonstrates that much, at least, of the einkorn was sufficiently tough-rachised to have been harvested along with the emmer crop. The morphology of the spikelet forks also indicates that the harvested ears (of einkorn) were semi-tough at least, though they are far from uniform in this respect — perhaps as a result of introgression from stands of wild einkorn growing nearby. Thus, *if* the Mycenae einkorn was a weed, then it was probably tolerated by farmers in much the same way as some Anatolian farmers tolerate massive infestation of their wheat fields by weed-rye (which is again tough-rachised); in both cases the weed contributes to the overall grain-yield of the infested fields. However, the rarity of fragile-rachised einkorns in the stored grain does not exclude the possibility that there was plenty of it growing in the fields.

Einkorn wheat as food

Einkorn grain can be rendered edible in just the same ways as described above for emmer. This is just as well, as it is so commonly mixed with emmer grain — as in this Mycenae sample. In second century Asia Minor it was evidently usual for the population to eat einkorn both 'boiled in water', as groats, rather than ground, and baked as bread. Galen of Pergamon,[8] in his treatise On the Properties of Foodstuffs, recalls an episode from his youth, when he "came upon some rustics who had had their meal and whose womenfolk were about to bake bread (for they were short of it). One of them put the wheat into the pot all at once and boiled it. Then they seasoned it with a moderate amount of salt and asked us to eat it… We ate it with gusto, and felt a heaviness in the stomach as though clay seemed to be pressing on it. Throughout the next day we had no appetite because of indigestion… I therefore asked the rustics whether they themselves also ever ate boiled wheat, and how they were affected. They said that they had often eaten it under the same necessity that we had experienced, and that wheat prepared in this way was a heavy food, difficult to concoct" (Galen VI, 499). The treatise as a whole has extended discussions of varieties of wheat and other cereals, including further observations based on Galen's own experiences in Macedonia and Asia Minor. Flour from varieties of einkorn (*tiphai*) and emmer wheat (*olyrai*) was used for bread-making in the country districts: "Each [i.e. emmer and einkorn] occurs in quantity in Asia, especially in the hinterland of Pergamon, since the country people always make bread from them since the wheat is taken to the cities" (Galen VI, 518). Galen observed that the type and quality of cereal grain varied from region to region. Thus bread made in Thrace and Macedonia was black, unwholesome and fibrous, being made from a grain called *briza*, that is rye (Galen VI, 514). The cities of Bithynia relied on a grain called *zeopyros*, which he judged to be as much superior to *briza* as it was inferior to naked wheats (Galen VI, 515). One of the problems with even the best einkorn bread was that it did not stay fresh for long: "After one or two days (and much more on subsequent ones) a person eating this bread thinks that a lump of clay reposes in his stomach. But when still warm it is eagerly sought by city-dwellers, who take it with some cheese of the country, which they call sour-milk cheese … But bread

[8] Professor Stephen Mitchell (who assisted Hillman with the original version of this report) has kindly supplied these versions of the relevant information from Galen.

three or four days old is already distasteful even to the country people, is more difficult to concoct, and is slower to pass in the stomach" (Galen VI. 519).

(The translations are from Owen Powell, *Galen. On the Properties of Foodstuffs, Introduction, Translation and Commentary* (CUP 2003); the citations are to the pages of volume VI of the old standard edition of Galen by C. G. Kühn, reprinted Hildesheim 1965).

HULLED, SIX-ROWED BARLEY — *HORDEUM VULGARE*

Hulled, six-rowed barley has been identified from well over half of those prehistoric sites in Greece where any attempt was made to recover plant remains at all.[9] Some of the earliest finds published so far are from aceramic levels at Argissa Magula (Hopf 1962, 106) and middle Neolithic levels at Sitagroi (Renfrew 1973, 162). But it has been suggested that despite this early foothold, all varieties of barley remained distinctly secondary to wheat in economic importance throughout most of the Neolithic and that some time during the Bronze Age, hulled, six-rowed barley emerged as the principal cereal in most parts of Greece. But as indicated above, the present evidence from plant remains for most parts of Greece is so scanty that interpretation in terms of general developments of this sort is difficult at the moment. Different areas may have experienced different trends at different points in time. However, the importance of barley by Mycenaean times (in certain areas at least) has some historical corroboration (in as far as the Linear B rendering of specific crop names is decipherable with any certainty). The Pylos tablets in particular appear to indicate not only that barley grain was eaten by humans (rather than fed only to animals) but that the rations given to male workers contained more barley than wheat (Chadwick 1976, 109).[10] Certainly by classical times the Greeks were well known as eaters of pearl (i.e. peeled) barley grounds

[9] By contrast, records of other forms of barley are rare: naked, six-rowed barley has been recorded from Late Neolithic/Early Helladic and Middle Helladic levels at Lerna (Hopf 1961 and 1964) and from Early Neolithic at Nea Nikomedia (van Zeist 1971); hulled two-rowed barley from Aceramic levels at Sesklo and Early Ceramic Neolithic levels at Soufli (Renfrew 1966); naked two-rowed barley from Aceramic levels at Ghediki (Renfrew 1966).

[10] The problem of the identification of the ideograms for cereals in Linear B was discussed at length by Hillman at the Mycenaean Seminar in London in February 1978 but unfortunately not even a summary of this paper has been published.

Fig. H. Barley (*Hordeum vulgare*).

which were apparently consumed unbaked as 'kneaded things' *μᾶζα* (maza), indeed, this barley product appears to have been the staple food for much of the population (see Moritz 1958, 147). Galen too speaks of barley providing human food and mentions that "some races — for example in the Cyprus countryside — use barley meal to make bread even though they harvest more wheat" (vi, 497). On the subject of barley bread, Pliny (xviii, 74) adds that it "was much used in earlier days but has been condemned by experience and (barley grain) is now mostly fed to animals". Columella (II ix 14) also praises "*hexastichum*" as animal fodder but adds that it "is more wholesome for humans than bad wheat; and in times of scarcity there is nothing better for guarding against want". Galen refers to pearl barley (? groats) as a standard item of a gladiator's diet (vi, 529) and Pliny recounts that "the Greeks prefer it to any other grain for porridge" (Nat. Hist. xviii, 73). More recently, barley groats were still being eaten in parts of Anatolia and were prepared in much the same way as cracked wheat except that the grain was simply soaked to loosen the husk prior to the first grinding. Galen (vi, 495) refers to a similar process of soaking and milling used for producing

pearl barley in his day, as does Pliny in his account of the production of barley porridge, though Pliny's description seems to be over-abbreviated and the procedures for dehusking and cracking the barley appear to have been amalgamated.

The form in which barley would have been eaten at Mycenae (or any other Mycenaean settlement) is unknown, and a similar range of possibilities exist as for emmer wheat but with the addition of 'maza'. Whether or not the Mycenaeans regarded foods made from barley as inferior substitutes for equivalent foods made from wheat is unknown of course. Certainly, later societies in this region have generally regarded barley as either famine food or as food fit only for the poor, for slaves, or for animals.

How much (if any) of the Mycenae barley is likely to have been fed to livestock is impossible to estimate. In the dry Argolid, the problem of trying to keep working oxen in a state of reasonable health between late summer and spring (i.e. the period when green fodder is in short supply) must have been all too familiar to the Mycenaeans, and some supplementary grain feed may well have been provided. Certainly, the desirability of providing supplementary feed, not only for oxen, but also for pigs and sheep, was well recognised by Classical authors like Cato and Columella, though their ideals were not put into practice by all of their contemporaries (Whyte 1970, 199–223 and 282, 306). Allocations of any supplementary grain feed to sheep and goats will presumably have depended on the value that the Mycenaeans attached to milk products, as well as on the state of grain supplies for human consumption and oxen feed. (Both humans and oxen can be assumed to have taken precedence over pigs, sheep and goats.)

There is some evidence to suggest that the barley recovered from Mycenae had been grown as a mixed crop together with bitter vetch (see below). This would add weight to the argument for it having been intended as feed for animals, though cereal-pulse mixtures of this sort have occasionally been used for bread, even in recent times.

From the available evidence, it is therefore patently impossible to estimate the relative contribution of the ancient barley crop to the food economy at Mycenae. Under the conditions which are likely to have prevailed at Mycenae, cultivation of six-rowed hulled barley would not have required irrigation. Indeed, one of the

advantages of barley is that it can produce tolerable yields where most wheats would fail.

BITTER VETCH — *VICIA ERVILIA*

The bitter vetch is a bushy little annual with small, pale-pink flowers and pods about 2 cm long containing three or four angular seeds. These seeds — like those of most vetches — contain a bitter substance which is harmful to humans (and oxen) if consumed in large quantities but which is water-soluble and can be removed by prolonged boiling. Unlike some other leguminous crops, bitter vetch does not need to be irrigated even when conditions are fairly arid as in parts of the Argolid, and it will produce some sort of seed crop on even the poorest soils.

Remarkably few Greek mainland sites have produced remains of bitter vetch. The earliest Greek record seems to be from Early Neolithic Levels at Nea Nikomedia in Macedonia, though the few seeds (which are scattered through a number of deposits) appear to derive from stray weeds rather than from a deliberately-sown crop (van Zeist 1971, 536). (Bitter vetch is very common as a weed of crops, and it is difficult to distinguish between the seeds of primitive cultivated forms and the seeds of weedy and wild forms, when samples derive from different areas or different time-horizons.) Quantities of 'vetch' sufficient to indicate deliberate cultivation were recovered from Middle and Late Neolithic levels at Sitagroi and from Late Neolithic levels at Dikili Tash (Renfrew 1973, 163) though it is not clear whether 'vetch' indicates bitter vetch or another species of *Vicia*. Outside Macedonia, the only mainland records to date are from Lerna in the Argolid (just 42 seeds from Early Helladic II, Hopf 1961 and 1964), Mycenaean Orchomenos in Boeotia (Willerding 1973, 233) and the House of the Sphinxes outside the citadel at Mycenae (Wace 1958, 12 n. 32).[11] The present hoard of 800 seeds of bitter vetch is a welcome addition, particularly as deliberate cultivation of this particular batch of seed (in which no other cultivated grain is present in any quantity) seems difficult to doubt although other possibilities do exist (see below). However, the seeds of this pure hoard of supposedly cultivated seeds are tiny when compared to even the smallest of present-day

[11] Bitter vetch has, however, been recorded from Minoan levels of at least three Cretan sites: Slavokambos, Phaistos and Nirou Chani.

Fig. I. Bitter vetch (*Vicia ervilia*).

cultivated forms. Indeed, they only just overlap the lower end of the range of the bitter vetch seeds from Neolithic Nea Nikodemia (van Zeist 1971, 536). Seeds of the bitter vetch were also present in both the Mycenae wheat sample and the barley sample. The vetch seeds from the wheat sample are even tinier than those from the pure sample and are perhaps best regarded as the contribution of weeds growing in the wheat fields. (Other possibilities are discussed under 'composition of the samples' below.)

It is impossible to decide whether the Mycenaeans actually ate their bitter vetch or fed it to livestock. Today, it is grown specifically as fodder for animals. This practice is particularly common in mountainous areas with harsh winters (e.g. Anatolia) where bitter vetch provides regular winter feed for cattle and oxen. (Sheep and goats are generally given barley instead.) But even in lowland Greece where supplementary winter feed is not so necessary, vetch is still fed to draught animals during periods of intensive work (see van Wertsch 1972). Certainly, both Columella (II x 34) and Pliny (xviii, 139) indicate that bitter vetch was standard feed for oxen in their day. However, Pliny also makes two references to bitter

vetch being eaten by humans, firstly as a medicine (it cured Caesar Augustus — of what he does not say), secondly as a leaven: "when barley bread used to be made, the actual barley was leavened with the (sour) flour of bitter vetch or chickling (xviii, 139 and 103 respectively).

As a food for humans, bitter vetch suffers from the disadvantage of needing to be thoroughly boiled to remove the poisonous, bitter substances before it can be eaten in any quantity. But the high toxicity of manioc has not prevented the South American Indians from using it as their staple diet (most forms of manioc contain a cyanide compound), nor has it prevented some Czechoslovak groups from eating the 'destroying angel' fungus *Ammanita* prepared in such a way as to render it relatively innocuous. In the first cases, at least, the elimination or destruction of the toxins involves procedures considerably more complex than mere boiling. This problem need not therefore have prevented bitter vetch from being eaten in times past.

Helbaek (1961, 81) felt that the bitter vetch recovered from Beycesultan may have been eaten as human food on account of the fact that the bitter vetch had been stored alongside edible grains like lentil and bread-wheat. The same association of bitter vetch with more conventional human grain foods in the same store could also be noted for the Mycenae 'Granary', but we are really none the wiser as regards the intended use of the bitter vetch. After all, one could cite households in present-day agricultural settlements where a single grain-store serves both for human foods and animal feed, and other households where the converse is true. Storage arguments are therefore not necessarily significant.

The possibility that barley and bitter vetch were grown together as a mixed crop and the resulting grains stored as a mixture may well weigh in favour of the Mycenae bitter vetch having functioned as fodder. Perhaps the best summary of the issue is Galen's statement the "vetches are cattle feed except in times of need" (vi. 546). But this statement was made in perhaps less hard-pressed times a full millennium after the Mycenaeans cultivated the sample of bitter vetch described here.

HORSE BEAN — *VICIA FABA* VAR. *MINOR*

The horse bean is the ancestor of the mazagan bean and present-day broad bean.[12] It would have been particularly attractive as a pulse-food as the seeds are large and devoid of the bitter substance that is found among many of the other members of the genus *Vicia*. As a crop, however, it is relatively demanding in that it requires moist, fairly fertile soils and irrigation during and after flowering would have been necessary in at least the dryer parts of the Argolid. In these demands the horse bean contrasts with other ancient pulse crops like chick pea, lupin, lentil and bitter vetch which can all tolerate relatively poor, dry soils. But as regards the bean remains from Mycenae, this moisture demanding feature of the horse bean cannot be used to demonstrate either that the Mycenae area was experiencing unusually damp conditions at this point in time, or that the Mycenaeans were practising large-scale irrigation; even in really arid regions with annual rainfall as low as 200 mm, damper hollows or breaks in slopes can often be found where moisture-demanding crops can be grown without irrigation. Alternatively, a small spring can feed a large irrigated garden.

Existing evidence — such as it is — suggests that the horse bean made a relatively late appearance as a crop in Greece. The earliest published record is from Lerna in deposits that bridge the Late Neolithic and Early Helladic I (Hopf 1961) and in broadly equivalent levels at Sesklo (Tsountas 1908, Renfrew 1966, 30). But it is not until EH II levels at Lerna that the horse bean was recovered in numbers sufficient to indicate that it had been cultivated as a crop in its own right. From this point onwards, bean cultivation in Greece appears to have been widespread. For remains from the Mycenaean period however, only Iolkos has so far produced a convincing hoard (a total of 550 seeds from four deposits, Renfrew 1966) while Iria (Willerding 1973) and Orchomenos produced only a few grains for which any form of cultural interpretation is difficult.[13] The few grains from Mycenae were mixed with a mass of barley grains and may represent seeds from the odd 'weed' in the barley fields or, more likely, spill or dregs from earlier storage in this same vessel.

[12] For a detailed account of the history of the horse-bean and its relatives see Hopf and Zohary 1973, and Schulze-Morel 1972.

[13] The horse bean has also been recorded for Minoan levels of four sites in Crete: Knossos, Herakleion, Hagia Triada and Nirou Chani.

Horse beans may have been eaten in a variety of ways involving both green pods and the ripe (or unripe) seeds. Galen (vi, 531) may well have been referring to the unripe seeds when he states "Not only do most people eat them raw, but also cooked with pig's meat or with goat or sheep in the countryside. And realising the windy nature of these, others mix in onions when they prepare thick soup". Bean pottage receives mention by Pliny who also refers to bean flour having been used to make bread or at least being added to bread "to increase the weight" (xviii, 117–18). Bean bread appears to have still greater antiquity in the form of *minda para apris*, a bread mentioned in Hittite texts and apparently distinguished by its ability to induce flatulence (Hoffner 1974, 174). Mycenaean preferences as regards bean-foods remain unknown.[14]

Thus, by the time that these five grain crops were grown at Mycenae, they already had a long history of husbandry and evolutionary development in Greece and before that in Anatolia and beyond. All aspects of their cultivation, processing and methods of rendering them palatable had already been subjected to millennia of experimentation. Mycenaean crop husbandry may therefore have been fairly advanced, though the details of agricultural developments during the Mycenaean period cannot possibly be assessed from the evidence so far available from Mycenaean sites, whether in terms of the crops and their economic importance or even in terms of the tools used in their cultivation and in the processing of their harvested grain. Excavation has not yet yielded the necessary information.

ANTI-FLATULANTS?

The Mycenae tablets make reference to eight 'spices' or 'condiments', several of which are thought to have been imported from Egypt, Syria, or some other oriental provenance (Chadwick 1958, 107), presumably at some expense. The tablets indicate no particular usage though several are (or were) well known as condiments. However, it may be significant that five of the eight have long been renowned for their ability — when used as condiments — to counter the flatulent effect of a diet rich in legumes, figs or coarse meal, foods which may well have formed the bulk of the diet at Mycenae.

[14] Though it would be tempting to suggest that they used the fava bean in the delicious meze so fashionable today.

The five spices — as deciphered from Linear B — are the shoots of penny royal, coriander seed, (or perhaps carroway), cumin seed, celery seed and fennel seed. (The four seeds are all members of the family Umbelliferae which includes other stomach-settlers like dill and aniseed.) The quantities in which these spices were measured (? for retail) may reflect something of the extent of their use; cumin, celery and fennel seeds were measured in units varying from 0.5 to 4 litres, and coriander in vast units of 24 litres (Chadwick 1958).

Today, we value spices of this sort strictly for their flavouring ability, though extract of dill is still used in gripe-water. However, our needs can be expected to have differed from those of the Mycenaeans; legumes and coarse meal feature less frequently in our diet and we can certainly not match the Mycenaeans for consumption of figs. The Pylos tablets, for example, refer to the rations of women being composed of equal parts of wheat and figs which were presumably dried (Chadwick 1976,108).

In times of coarser diet, the medicinal, anti-flatulent properties of these five spices were well appreciated, even in Britain (see de Mediolano 1608, also Pliny Nat. Hist. xix, 161; xx, 153, 157.192.217) and even today seed from one of the hogweeds — another member of the Umbelliferae — is apparently a standard additive in legume dishes in Iran, specifically with this anti-flatulent effect in mind. Mycenaean trade in — or cultivation of — these five spices may therefore have been prompted — in part at least — by the medicinal property which all five have in common and may have an ancestry reaching beyond the Mycenaeans, as charred seed of coriander has been identified from Middle or Late Neolithic Sitagroi.

COMPOSITION OF THE SAMPLES

The composition of the samples offers some implications for the types of husbandry practised at Mycenae.

Sample 3 — the bitter vetch sample

The fifteen grains of barley present in this sample can probably be interpreted as spill from the barley store (sample 2), while the two olive pits probably came from the floor onto which the bitter vetch store spilled when the building

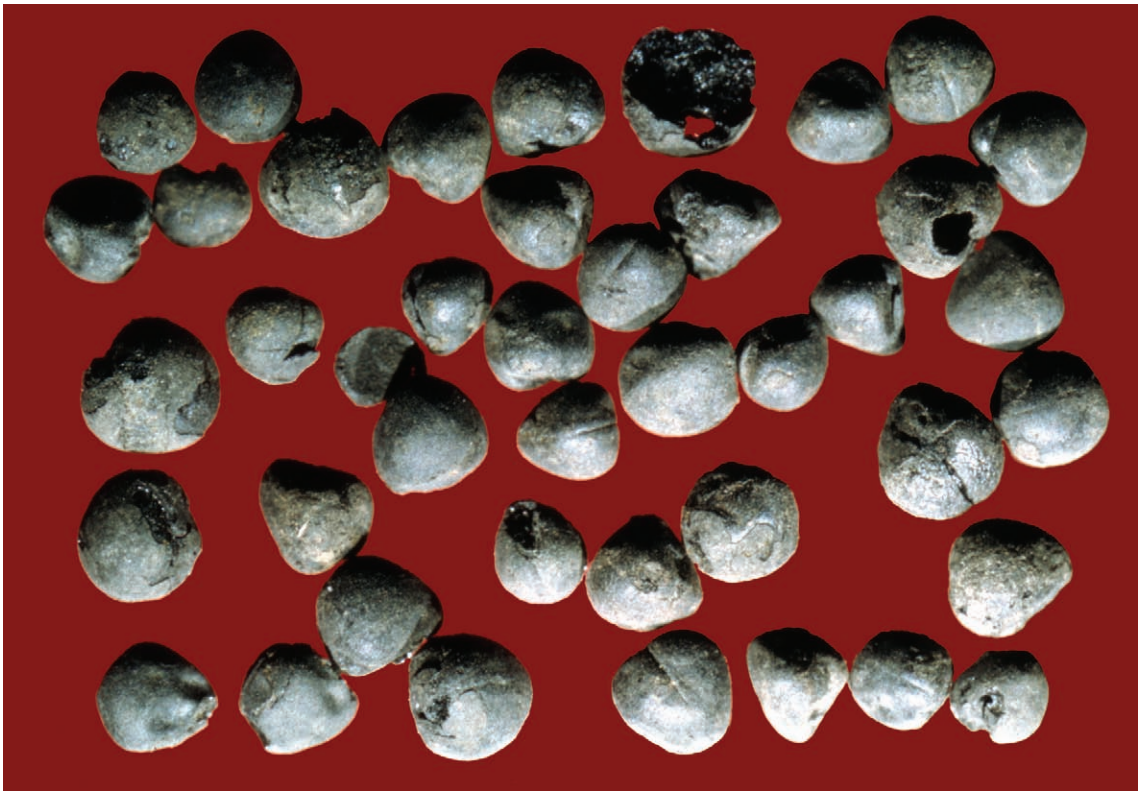

Fig. J. Bitter vetch (*Vicia ervilia*).

collapsed. (See Wace's description of the context of the grain finds, *BSA* 25, 48–9.) This sample of bitter vetch is otherwise entirely free from weeds of any kind.

The available evidence suggests that this sample of bitter vetch had been cultivated as a crop in its own right. However, while the average size of the seeds in this sample is very small compared to present-day cultivated forms or even some of the Neolithic forms,[15] the seeds of what is probably best interpreted as a weed form of bitter vetch present in the wheat sample are significantly smaller still. This difference suggests that the pure sample of bitter vetch is something more than a weed form, namely a crop, though seed size is an unreliable criterion and the other possibilities must be examined.

[15] E.g. the seeds of bitter vetch from Aceramic Neolithic Can Hasan III in Anatolia are substantially larger than these from Mycenae (Hillman n.d.).

The purity of this sample is best explained as a product of the method of harvesting which is likely to have been applied to this supposed crop, namely — uprooting the individual plant with the bare hands. This method is still used for bitter vetch today and often results in seed stores as pure as this Mycenae sample. This sort of purity could also have resulted from selective gathering of the wild form of this vetch. However, one would have expected the seeds of a wild form to be at least as small as the seeds of what was presumably a weed form present in the wheat sample; instead the seeds of this pure sample are much larger.

A third possibility is that this batch of bitter vetch represents weed seeds separated during cleaning of the cereal grain and subsequently stored to be fed to livestock or fowls (or perhaps eaten by humans). Storage of weed seeds (whenever they are free of poisonous or barbed seeds) is certainly common practice in present-day Anatolia; coarse weed seeds and other coarse contaminants (separated by a coarse sieve) are normally kept as feed for oxen, while the small weed seeds and 'tail grain' (separated by finer sieves at a later stage of cleaning) are kept for domestic fowl. However, the size range of these seeds is such that they could not have been separated from wheat by sieving alone, and only partially separated from barley Also, the sample is much too pure to represent sieve-separated weeds.

But it could still be argued that the sample represents contaminants separated from the grain by hand-sorting. Even in present-day peasant communities, hand sorting often provides the only means of eliminating those seeds which, by virtue of their similar size to the food grains, cannot be eliminated by sieving alone, and it is not unusual for large numbers of a single weed species to be separated at this final stage of cleaning.

Examples here are *Cephalaria*, weed rye and corn cockle — *Agrostemma githogo* in wheat, large-seeded forms of *Galium aparina* in barley. Except when the seeds are poisonous or barbed, they are again put into storage as feed for livestock or domestic fowls. The bitter vetch from Mycenae may therefore represent weed seeds separated by hand-sorting in the final stage of grain cleaning, though the still smaller size of the seeds of the supposed weed form of vetch in the wheat sample (sample 1) weighs against the seeds of this pure sample having come from a mixed form.

The most likely of the several possibilities therefore seems to be that the hoard of bitter vetch from Mycenae represents a crop cultivated in its own right.

Sample 2 — the barley sample

In the sample of *c*. 4800 barley grains, there were *c*. 3000 of bitter vetch, *c*. 120 grains of wheat and a large number of weed seeds.

The seeds of bitter vetch in this barley sample show a distribution of sizes that matches the pure sample (sample 3) very closely. This may suggest either that they represent spill from the main (pure) store of bitter vetch, or else that the vetch in this barley sample had been deliberately sown with the barley as part of a mixed crop. Alternatively, the bitter vetch may have been a weed in the barley crop, though the large size of the seeds in this sample relative to the vetch in the wheat sample suggests that this possibility is less likely. The first possibility can neither be demonstrated nor refuted on the evidence available, though the practicability of the second possibility can at least be assessed in the light of more recent practices.

Mixed cropping involving barley and various forms of legume was evidently not uncommon in Classical times at least, though the provision of green fodder appears to have been the primary objective, particularly as regards the legume component which was commonly grazed throughout much of the autumn and winter, in some areas anyhow (see Whyte 1970, 209–18). Doubtless many of the legumes grew on to provide a grain yield together with the cereal, though grain harvested from the legumes appears to have been a secondary consideration.

Growing mixed crops strictly for their grain has present-day equivalents however. In Anatolia, for example, the Mycenae mixture of bitter vetch and barley is commonly sown together and harvested as a grain crop. But even though both crops are generally harvested at the same time and by the same method of uprooting with bare hands,[16] plants of the two crops are uprooted separately, kept

[16] In addition to harvesting with bare hands, the barley component is occasionally uprooted by grasping a group of culms with one hand and wrenching at the base of the culm with a blunt, long-necked sickle which is held in the other hand. Earth clinging to the roots is then knocked off with the back edge of the sickle.

in separate heaps, threshed and winnowed separately, cleaned separately and then stored separately to be fed to entirely different classes of animal: barley to sheep and goats, bitter vetch to cattle and oxen (winter feed in both cases). The straw from the separate threshing operations is also kept strictly separate in storage as the vetch straw can be fed to livestock while the barley straw is unsuitable for fodder and is generally used as fuel or as temper for sun-dried mud-brick. (The brittle awns of the barley ears stick in the animals' throats.)

The existence of this mixed sample from Mycenae (assuming it was a product of mixed cropping) suggest that these present-day reasons for keeping the barley and vetch separate did not apply at Mycenae at that time. Indeed, several differences in practice are indicated, differences that may well reflect patterns of use different from those of the present-day. Firstly, the two types of crop were evidently threshed together (even if they were harvested separately, which I doubt). Secondly, mixed threshing would have mixed the edible straw from the bitter vetch with the relatively inedible straw from the barley which suggests either that the bitter vetch straw was not valued very highly as a supplementary animal feed, or that the awns from the Mycenae barley were soft enough for their livestock to eat them with impunity.

Thirdly, mixed storage of the two grain types suggests either that they were both intended for the same class of livestock or that they were both intended for human consumption. The latter seems less likely because of the different types of operation that are necessary to render either type of grain palatable: (i.e. if they had both been intended as human food, then it would have been more sensible to keep either type separate from harvesting onwards). Though here again, there are exceptions recorded in recent times; certain villages in West Anatolia have been noted where mixed stands of cultivated barley and wild vetches and peas were harvested together and the mixed grain ground to make bread. (I do not know whether the vetches concerned are bitter or not.)

The barley sample includes a number of weed seeds though this level of contamination is not inconsistent with harvesting effected by hand-pulling the individual plants; a few weeds are inevitably caught-up with the barley at least. All the weed seeds are small, and most of them could ultimately have been eliminated by prolonged sieving with something like the present-day peasant

wheat sieve with its *c*. 2.5 mm mesh. However, the number of small seeds in this sample cannot be taken as indicating that no sieving of this sort had taken place. Before sieving begins, grain from carelessly harvested barley (even though hand-pulled) commonly includes fairly large numbers of seeds from a wide range of species and the sieved, stored grain often ends up with just as many weed seeds as this Mycenae sample. In fact, it seems quite probable that this sample had been sieved with both coarse and fine-meshed sieves.

Sample 1 — the emmer wheat sample

This sample included a number of grains of einkorn and *c*. 370 spikelet forks of both einkorn and emmer. It would appear that the einkorn — which made up *c*. 30% of the grain — may either have been a highly adapted (relatively rough-rachised) weed in the emmer crop or, more likely, part of a mixed crop. Also present amongst the 1250 wheat grains were 217 grains of barley, 820 seeds of bitter vetch and the occasional seed of horse bean, olive, fig and vine and a few small weed seeds.

The olive stones, fig seeds and single grape pip presumably came from the floor onto which the grain spilled when the building collapsed, and much of the barley may have been spill from the barley store. The bitter vetch cannot, however, be dismissed on this basis. The seeds of the vetch in this sample are much smaller than those from either the barley sample or the pure sample so evidently do not derive from either of these other stores. Their heavy concentration in the wheat grain could be taken to indicate that this sample was a product of mixed cropping. However, the small size of the vetch seeds implies that they do not belong to the presumed cultivated form present in samples 2 and 3 which in turn implies that they were not intentionally sown with the wheat. But despite this difference in size, it is not impossible that this small seeded form represents one of a wide range of domestic forms that were grown in the Mycenae area at that time. The possibility of mixed cropping therefore cannot be eliminated altogether.

It is much more likely however that the bitter vetch was just a bad weed in the wheat fields at Mycenae. Even today, it is not uncommon to find wheat so badly infested with legumes that the wheat crop is barely visible at all. Thus, if the wheat is sown in an area that is too damp and shaded, the vetches *Vicia nöeana* or *V. hyrcanica* can take over. If, on the other hand it is too stony and dry, weed

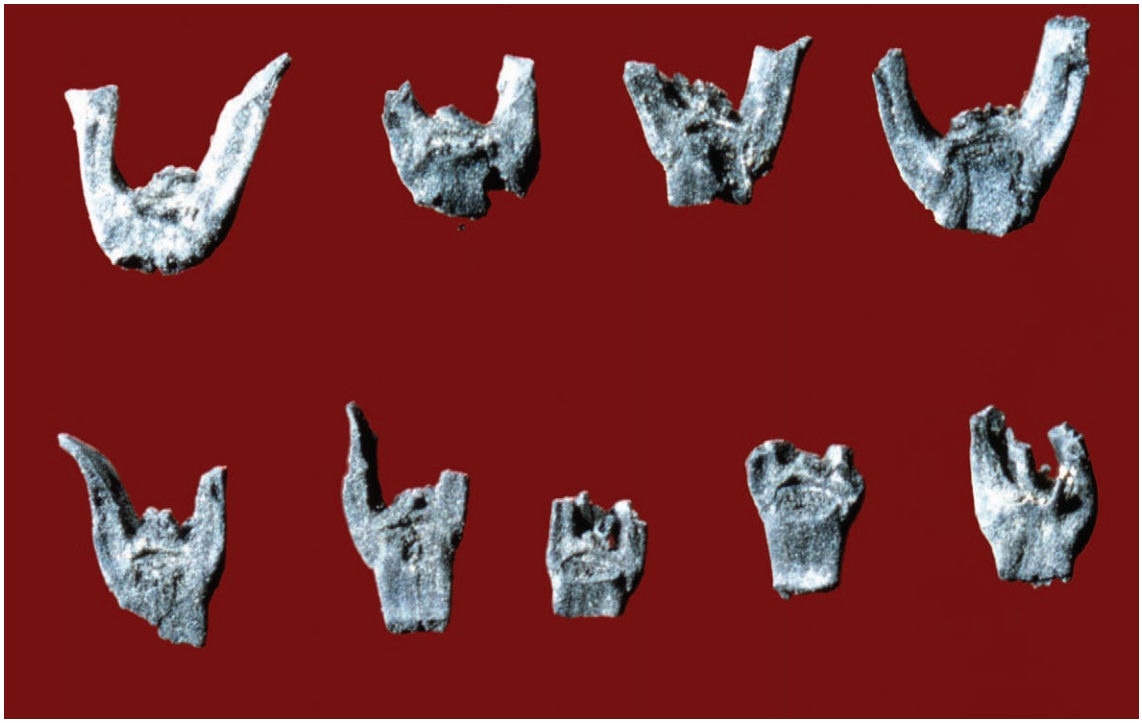

Fig. K. Einkorn wheat (*Triticum monococcum* and ?some *Triticum boeoticum*).

Fig. L. Einkorn wheat (*Triticum monococcum*).

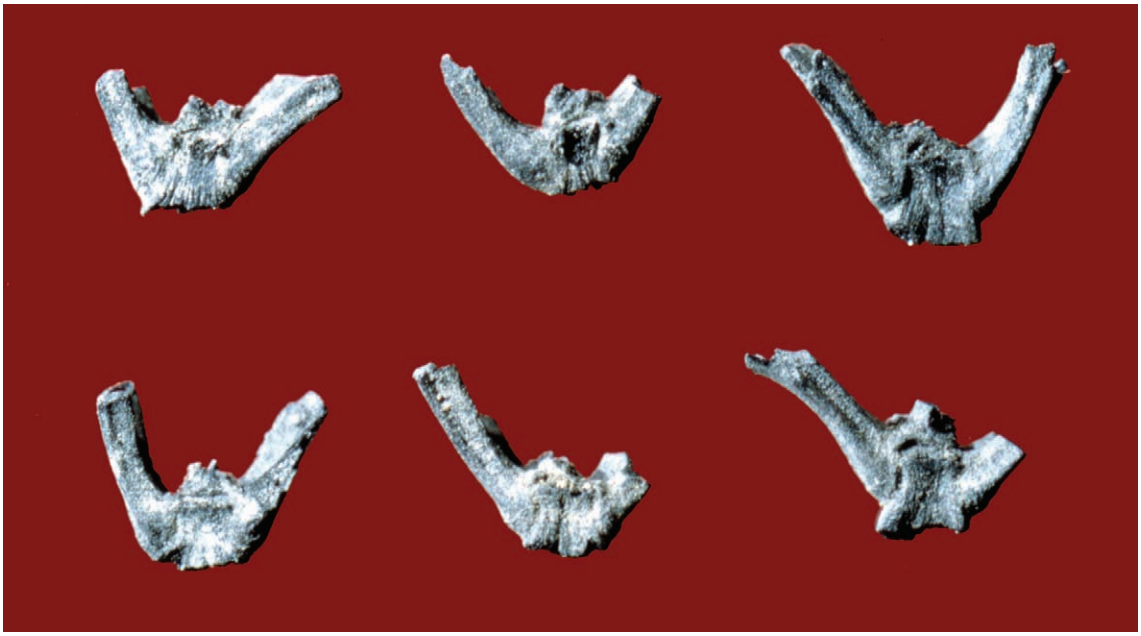

Fig. M. Emmer wheat (*Triticum dicoccum*).

Fig. N. Emmer wheat (*Triticum dicoccum*).

forms of bitter vetch can form a dense under-story beneath the scanty canopy of wheat. This is probably what had happened to this particular batch of wheat at Mycenae.

The relatively small number of weed seeds indicates either that the grain had been thoroughly cleaned with sieves before being put into storage or else that the wheat fields had been well weeded, or both. A third interpretation is that the wheat grain may have been harvested by cutting the ears separately from the straw rather than cutting low with the sickle and taking straw (and weeds) together with the ears. Today at least, emmer wheat that has been harvested with straw is threshed — to break up the ear into its component spikelets, forked and winnowed to remove the straw together with a few light weed seeds, generally (but not always) parched to render the husks brittle, pounded to remove the husks, then winnowed again to separate the grain from the light chaff (mainly husks). However, the grain at this stage would normally still include the majority of the spikelet forks (the hard, basal part of each spikelet), vast numbers of weed seeds (unless the fields had been well weeded), occasional stones and the denser nodes of the straw (if the form of threshing applied breaks up the straw). Indeed, it is not uncommon to find fifty different species of weed seed in a mere kilo of grain sampled at this stage of operations, and several of the species will each be present in large numbers.[17] Separating these contaminants from the grain necessitates sieving;[18] there is no other way available to peasant societies except sorting by hand. Today at least cleaning operations start with a coarse-meshed sieve designed to allow all the grain to pass but to retain any larger contaminants like the seeds of *Lisaea*, *Turgenia*, *Echinophora* and *Chrozphora*. The absence of contaminants of this size-class in the Mycenae wheat sample suggests that — *if* it had been harvested with its straw but not been thoroughly weeded — then it had almost certainly been coarse-sieved.

[17] This figure is based on a study of large numbers of 2 kg samples taken from each stage of traditional sequences of grain-processing applied to each of a number of indigenous crops grown under various forms of traditional husbandry (see Hillman 1972 and 1973). I have yet to complete the full analysis outlined in these two published notes.

[18] The winnowing basket can also be used to separate some of the large, less dense contaminants. This is achieved by swirling the contents around in the basket so that the unwanted fractions drop over the distal rim. Contrary to suggestions made elsewhere, it does *not* eliminate the fine weed seeds unless they have a very low density.

Before being taken into storage, the grain would normally be sieved at least once with a medium-fine sieve designed to retain almost all the grain but to eliminate all the smaller weed seeds and spikelet forks together with varying amounts of 'tail grain' (under-sized grain which is commonly malformed). However, only the most diligent sieving succeeds in eliminating all the contaminants that could theoretically pass through the sieve and, today at least, one kilo of sieved grain ready for storage can still contain thirty species of weed seed, and a good number of spikelet forks. Most of these weed species will now be present in much-reduced numbers, though those seeds whose smallest dimension is close to those of wheat will still be found in impressive quantities.

Against this background it is possible to suggest that if the Mycenae wheat was harvested together with its straw, then it had almost certainly been sieved with a medium-fine meshed sieve (as well as with a coarse mesh earlier on), though the number of spikelet forks suggests that the sieving had not been very thorough. But on the other hand, it is not so heavily contaminated that it could be regarded as a secondary product composed of tail corn, spikelet forks and weed seeds (these 'waste fractions' are commonly put into storage as animal feed); the grain is too well formed as well as too clean. Neither does it fit the sort of composition one would expect from a sample of spikelets that had been accidentally charred in the parching ovens; the context is wrong and the ratio of spikelet-forks to grain is too low. (Two-thirds of the forks are missing).

The composition of the Mycenae wheat sample, therefore, fits the storage context of the find perfectly well. It had almost certainly been sieved (though not very thoroughly) or else it was harvested by cutting the ears separately from the straw. Before being processed further, e.g. as groats, it would doubtless have been cleaned again by sieving and/or hand sorting.

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