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Evidence of grains from the site of Wadi Kubbaniya (Upper Egypt)

A recent study of botanical materials from the site of Wadi Kubbaniya (Stemler and Falk, 1980) illustrates that scanning electron microscopy can be used to obtain more information from palaeoethnobotanical specimens than is possible with light microscopy. However, even with the application of advanced techniques of study of individual specimens, the conclusions that may be drawn are still limited if the sample size is limited. This is because biological populations are highly varied. Hence, very small numbers of archaeological samples do not allow the investigator to describe with certainly the nature of an entire ancient population. Conclusions are especially hard to draw when we are seeking to determine the status of populations that may have been undergoing change as a result of human intervention. Human selection increases the range of variation in populations.

In the case of the botanical remains from Wadi Kubbaniya, the small sample size is probably the result of the fact that the excavators had no expectations of finding plant remains in cultural layers 17,000 years old and so were not systematically searching for them. The plant materials from the site were part of a composite charcoal sample collected by Kim Banks from the side walls of the trench in site 4 just before the trenches were filled with sand at the end of the season's work. The charcoal samples were examined at Cairo university by Dr. Nabil El Hadidi who discovered four grains and one inflorescence fragment. The results of Hadidi's study are the basis for most of the botanical discussion in the report of the site published in *Science* (Wendorf *et al.*, 1979) and are included in an appendix to the site report (Close, 1980).

Hadidi's conclusion was that the barley from the site was domesticated. The basis for the conclusion was the size of some of the specimens which was within the size range of domesticated barley. (Scanning electron micrographs of the barley grains are shown in Figure 1). Unfortunately grain size is not a conclusive indicator of domestication. Many domesticated varieties of barley have larger grains than wild barley, but this is not always the case. There is a race of wild barley, for example,

that presently grows in southwestern Syria, northwestern Jordan, and northern Israel that is characterized by extremely large grain along with robustness in all other features as well (Harlan and Zohary, 1966). This race of wild barley has grains larger than some varieties of domesticated barley. As you can see from figure one, the barley grains from Wadi Kubbaniya are well within the range of variation of wild barley as well as domesticated.

In order to explore the possibility of getting more information from the Wadi Kubbaniya specimens, an additional study was made at the University of California, Davis, using scanning electron microscopy (Stemler and Falk, 1980). The objective of the second study was to more closely examine the single inflorescence fragment in the sample to see if it bore the characteristics of a wild or domesticated cereal. The reason for this approach is that undoubtedly the most clear-cut morphological indicator that a cereal has been fully domesticated is that it has lost its natural ability to disperse its grain (Fig. 2). All wild plants form an abscission or dividing zone between the parent plant and the fruit that facilitates the release of seeds. Progeny are thus free to be carried by wind, water, gravity, or animals, to places far from the parent plant, where they can germinate free of competition from the parent plant and their siblings. Indeed the success of diverse genera of plants can be largely attri-

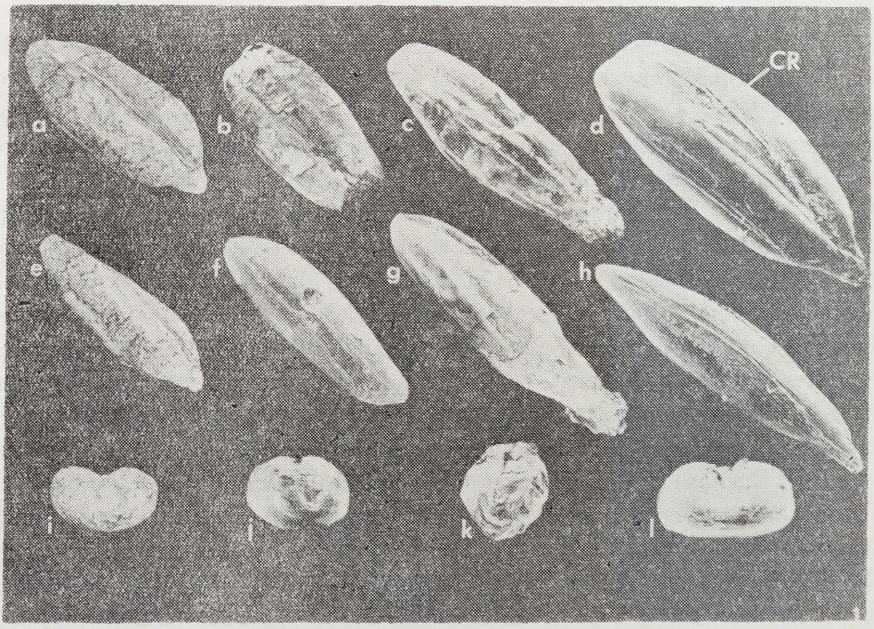

FIG. 1. Archaeological grains from Wadi Kubbaniya (*a-c*, *e-g*, *i-k*). Approx. 3.6 mm long, 1.9 mm wide, and 1.0 mm thick. Views of a charred grain of modern barley, *Hordeum spontaneum* (*d*, *h*, *l*)

a - d: The ventral aspect of the grains. Note the broad, shallow crease (CR), characteristic of barley; *e - h*: The dorsoventral aspect of the grains; *i - l*: Views looking down at the tip of the grain are useful for an appreciation of the relatively great breadth compared to the thickness of the grain of barley

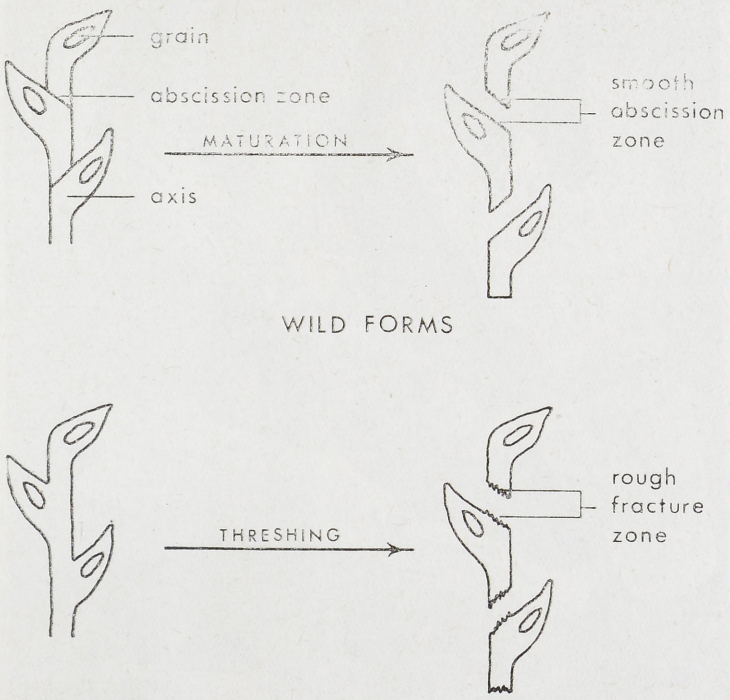

FIG. 2. A comparison of the general appearance of the inflorescence and inflorescence fragments of wild and domesticated members of the tribe *Hordeae*, to which wheat and barley belong. In wild members of this tribe of grasses, the central axis, or rachis, of the inflorescence breaks apart as a result of the formation of abscission zones. A rachis that fragments in this manner may also be referred to as brittle or shattering. Fragments of a wild type inflorescence can be recognized by the smooth regions, or scars, where one unit of the inflorescence was joined to the neighboring unit, or node. In domesticated members of this tribe, the formation of abscission zones is inhibited. Shattering does not occur, so threshing is required to release and process the grain. Fragments of a domesticated member of this tribe can be recognized by the comparatively rough fracture zones where the fragment was mechanically broken from its neighboring nodes. Domesticated inflorescences are referred to variously as non-shattering, non-brittle, or tough

buted to elaborate adaptations for dispersal of progeny that all must begin with the release of the fruit.

In fully domesticated cereals, as a result of human selection, the ability to release seeds has been lost. Domesticates have been selected for altered forms of the genes involved in the formation of abscission zones, so the separation of grains from the plant does not take place until the inflorescence is mechanically broken by some sort of threshing process. The inability of domesticated cereals to release their progeny makes them fully dependent on man for their propagation. For man this characteristic makes each head of grain a conveniently harvestable package of food. Domesticated cereals can be harvested long after maturity without fear that grain will

FIG. 3. Five views of the wheat inflorescence fragment from Wadi Kubbaniya. The paired ascending portions are the glumes that enclosed the grains. The descending portion is the rachis, which formed part of the central axis of the inflorescence. This fragment is a single node of an inflorescence. The break in the rachis allows us to see the excellent preservation of cell structure. The fragment is 5.2 mm long, 3.9 mm wide, and 1.5 mm thick

be lost. This is a great advantage to the cultivator because in this way the grain can be allowed to stand in the field until it is sufficiently dry at harvest to be stored without serious damage by fungi.

If we define a fully domesticated cereal as one that has been modified by human selection so that it has lost its natural ability to disperse its grain, then we must investigate the grain-bearing portion of the plant, the inflorescence, in order to deter-

mine whether a cereal found in an archaeological deposit is wild or domesticated. Fragments of the inflorescence of a wild cereal will have smooth scars where abscission zones were formed to facilitate seed dispersal. Fragments of a domesticated cereal will have rough fracture zones where the inflorescence broke as a result of threshing (see Fig. 2).

With all this in mind the single inflorescence fragment from Wadi Kubbaniya was studied with the scanning electron microscope. Photographs revealed the absence of a smooth abscission zone suggesting that the fragment might have come from a domesticated plant (Fig. 3). Unfortunately one more factor became apparent that prevented us from considering the evidence as conclusive. When we compared the Wadi Kubbaniya inflorescence fragment with extant cereals, we found the following:

1. The fragment appears most similar to wild diploid wheat (rather than barley as was suggested by the first study of the material – Fig. 4).

2. In wild wheats harvested before the grain is fully mature, the abscission zones are not fully developed, so an immature inflorescence breaks with rough fracture zones similar in appearance to those of domesticated wheats (Fig. 5).

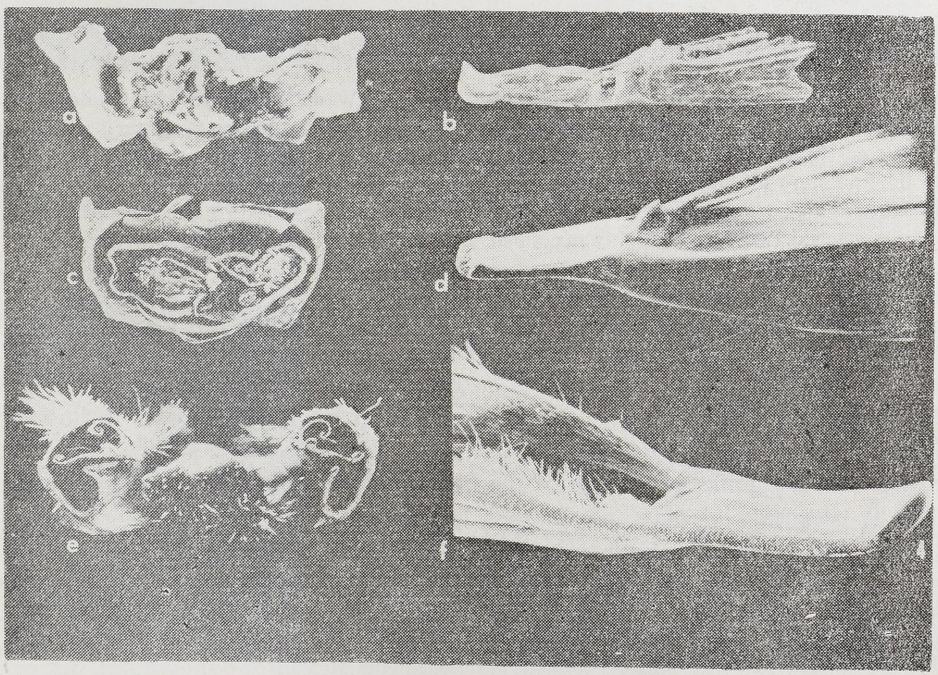

FIG. 4. A comparison of the Wadi Kubbaniya inflorescence fragment (*a* and *b*) with modern wild diploid wheat (*c* and *d*) and modern wild barley (*e* and *f*)

a, *c* and *e* are views of sections through the glumes of wheat and the lemmas and paleas of barley showing the parts of the plant that enclose the grains; *b*, *d*, and *f* are views of one node of an inflorescence. The longest dimensions of the portions of the plants shown are as follows: $a = 3.9$ mm, $b = 5.2$ mm, $c = 3.2$ mm, $d = 6.5$ mm, $e = 3.8$ mm, and $f = 8.4$ mm

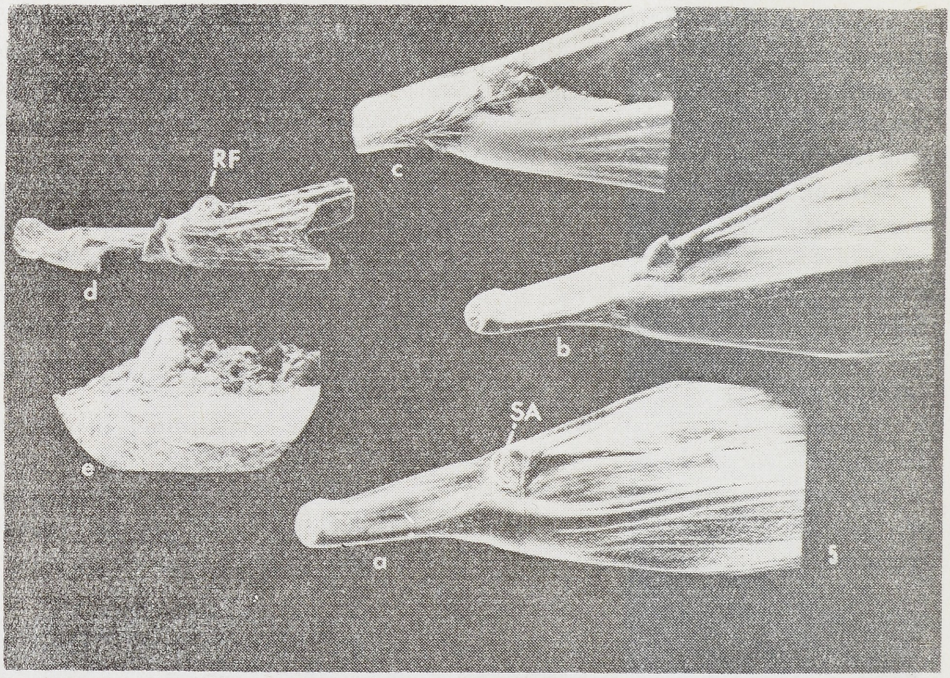

FIG. 5. A comparison of the inflorescence fragment from Wadi Kubbaniya with a wild diploid wheat and domesticated diploid wheat. Wild diploid wheat harvested when the grain is mature (*a*) has a smooth abscission zone (*SA*) where the next portion of the inflorescence used to be attached. In the immature wild diploid wheat (*b*), in the domesticated wheat (*c*), and in the archaeological wheat (*d* and *e*), we see a rough fracture zone (*RF*) where the next node of the inflorescence was attached. View *e* is a highly magnified view of the rough fracture zone in view *d*

Since we do not know whether the inflorescence fragment from Wadi Kubbaniya was part of a plant that was immature or fully mature, we cannot state with confidence whether it was part of population of domesticated plants or wild plants. If the inhabitants of the site were harvesting plants growing wild or were sowing and harvesting seed of wild grains (thus cultivating undomesticated grains), we would expect that a significant portion of the harvest would consist of immature heads. This is because wild plant populations have individual plants reaching maturity throughout the growing season, in contrast to fully domesticated populations in which selection has favored maturity of most individuals at the same time. What is needed in the case of wheat to demonstrate that a population was domesticated, is a significant number of inflorescence sections, or nodes, joined together or with rough fracture zones, with some spikelets containing grain to indicate maturity. It was hoped that more evidence of ancient cereals could be found when the Combined Expedition returned to Wadi Kubbaniya in the spring of 1980.

During the return visit to the site, part of the original team, including Kazimierz Szczepanek and Hanna Więckowska but not including Kim Banks, with the additional help of Dr. Maria Hopf of the Römisch-Germanischen Zentralmuseum in Mainz and Ann Stemler searched charcoal deposits of site 4 where the charcoal samples had been collected. Unfortunately in the few days available on the site, no more plant specimens were found. Since the sample in which the grains were found was a composite we do not know exactly where in the depositional layers of site 4 the plant material occurred. Thus we may not have searched the exact portion of the site where the grains were deposited. However, the absence of grains in the layers we did search suggests that cereals were not the major source of food for the inhabitants of the site. This conclusion is consistent with the evidence of very primitive grindstones and very small mortars which, if used to process cereals, would have allowed processing of only small quantities of grain at any one time.

Finding wheat on the site, whether it was morphologically wild or domesticated is in itself intriguing because at the present wild wheats are found in areas far to the north, in the foothills of the mountains of southwest Asia (Harlan and Zohary, 1966). Palaeoclimatic evidence suggests that the climate at Wadi Kubbaniya during the time of occupation was cold and hyperarid (Wendorf *et al.*, 1979) but it is questionable that wheat might have occurred as part of the natural flora.

More botanical material must be found on the site and studied if we are ever to know whether the inhabitants of Wadi Kubbaniya were gathering or cultivating populations of morphologically wild cereals or whether they were growing truly domesticated cereals. The evidence as it now stands does suggest that the interaction between human populations and wheat and barley that resulted in domesticated cereals may have begun much earlier than was previously thought and that the people involved in the domestication process may have occupied a larger or perhaps a different area than was previously thought (Ucko and Dimbleby, 1969).

On a less theoretical level, a lesson to be learned from the Wadi Kubbaniya experience and other sites (Hansen and Renfrew, 1978; Noy *et al.*, 1973) is that one should always be alert to the possibility of finding plant remains at even the oldest sites. Students from palaeothnobotanical laboratories should be involved in excavations to search systematically for plant remains and to follow the study through to publication of detailed photographs and detailed analyses of the botanical material found.

Let me close with a plea for understanding by archaeologists of the limited conclusions that can be drawn from small palaeoethnobotanical samples. When archaeologists ask their cooperating botanists whether tiny, charred, broken, and distorted bits of botanical material represent wild or domesticated cereals, they should not be too disappointed if they do not receive a simple, definitive, one-word answer and perhaps should be skeptical if they do! We must not be led to wide ranging and possibly erroneous conclusions based on dangerously fragmentary evidence.

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Note

Two series of studies have been performed on the cereal grains from the site of Wadi Kubbaniya since this manuscript was completed. The first series done by electron spin resonance spectroscopy indicated that the maximal temperature to which the grains had been subiected before burial was only 150°C. Tbis temperature would bave been too low to have brought about the charring that would have been required to preserve the grains from decomposition through millennia of seasonal flooding. The second series of studies involved direct C–14 dating of the cereals by the tandem accelerator mass spectrometer at the University of Arizona at Tucson. These studies indicate that the cereals themselves are much younger that the charcoal and other artifacts from the site.