How Fast Was Wild Wheat Domesticated?

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The earliest cereal gathering has been dated to 19,000 years before the present (yr B.P.) (*1*) in the Near East. The origins of agriculture have been dated to between 10,500 and 9500 yr B.P. for the region of southeastern Turkey and northern Syria (*2*), where wild wheats [einkorn, *Triticum boeoticum* Boiss and emmer, *T. dicoccoides* (Körn) Aschers and Graebner] still grow today. Wild cereals with dehiscent ears shatter at maturity into dispersal units called spikelets, identifiable by their smooth abscission scars (Fig. 1, A to C). The first domestic cereals arose from mutants, which have indehiscent ears with spikelets that do not shatter but separate when threshed, identifiable by jagged scars (Fig. 1, D and E).

The earliest indehiscent domestic wheat has been recognized in archaeological levels dated to ~9250 yr B.P. How long was wild wheat cultivated before this date? Estimates vary from less than 200 (*3*) to at least several hundred years (*4*). We examined 9844 ancient charred spikelets from four archaeological sites located in northern Syria and southeastern Turkey dating between 10,200 and 6500 yr B.P. to evaluate how quickly domestic wheat emerged. Most of the specimens were damaged by fire or when the wheat was threshed, but 804 were identifiable. The earliest site, which was dated to 10,200 yr B.P., produced no definite domestic spikelets; however, on the three younger sites, domestic spikelets increased progressively. The number of terminal spikelets also increased. In wild populations, terminal spikelets fall first, because the ear disarticulates from the top down; so with increasing indehiscence, terminal spikelets become more frequent (*5*). An independent study of barley—which was domesticated in the same way—at two sites near Damascus (*6*) demonstrated that 30% of the spikelets that were dated to 9300 to 8500 yr B.P. were domestic, and by 8500 to 7500 yr B.P., the number increased to 60%. The combined results (Fig. 1F) indicate that indehiscence took over one millennium to become established. Selection for large cereal grains was slow. Measurements taken from ancient grains demonstrate that the size of wheat and barley grains remained essentially the same between 9500 and 6500 yr B.P. (*7*). Grain size depends more on the position on the ear and environmental conditions than on genetic diversity.

If early farmers harvested after the ears began to shatter, indehiscent mutants would be rapidly adopted. But farmers probably harvested before the spikelets fell to avoid loss, so indehiscence was not advantageous. Furthermore, when crops failed, farmers would have had to gather from the wild. These two practices lowered the probability of the rare indehiscent mutant being selected. Fast artificial selection, as opposed to slow natural selection, was improbable, because domestic traits such as indehiscence and lack of dormancy are not readily visible. Cultivation of wild cereals between 10,500 and 9250 yr B.P. has been posited on the basis of finds of field weeds (*8*) and because many gathered plants were abandoned in favor of wheat and barley, which on some sites were found outside their natural habitats. These findings were not compatible with rapid domestication. We argue that wild cereals could have been cultivated for over one millennium before the emergence of domestic varieties. Domestication was a series of events occurring at different places over thousands of years, during which wild wheat persisted in cultivated fields (it still occurs today as a weed in Turkey). Our data require consolidation, but combined with the data for barley, they support a gradualist domestication model, suggesting that we should examine the possibility that agriculture arose soon after humans adopted a sedentary existence in the early villages of the Near East (*5*).

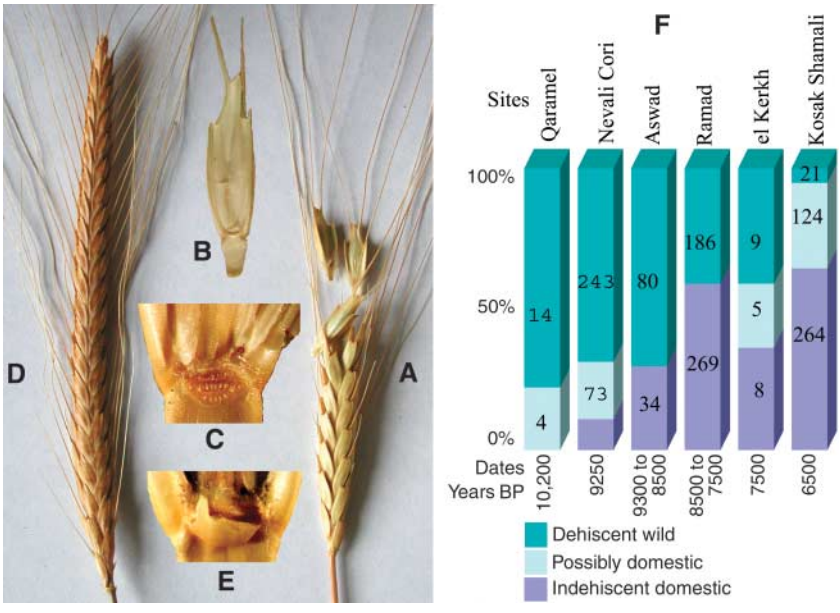

Fig. 1. Modern examples of dehiscent wild einkorn wheat ear (**A**) and spikelet (**B**). Detail of spikelet with smooth wild abscission scar (**C**), indehiscent domestic ear (**D**), and detail of spikelet with jagged break (**E**) are shown. The bar chart (**F**) gives relative frequencies of subfossil finds with the absolute figures. Records from Aswad and Ramad (*6*) are of barley; the other four sites are of wheat. For full data of both studies, see table S1.

References and Notes

1. All dates are in noncalibrated ^{14}C years before the present.
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5. The full set of data and references for the sites are available as supporting material on *Science* Online.
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Supporting Online Material

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Table S1
References

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