nature genetics

Cereal genetics for human society

The coevolution of staple crops and human society can be traced in the relics of ancient genomes and in population genetic signatures that our interdependence has left on our genomes and those of our crop plants. Patterns of geographical adaptation in the genomes of local crop varieties connect millennia of survival strategies of subsistence farmers with future agricultural improvement in the face of challenges from environmental changes.

Genomes are expensive tools and resources that need a user group in mind to justify the societal investment. We suggest that, by defining the user group as the whole of society, genomes can become a tool to connect scholarship in anthropology and economic botany with evolution, ecology, plant breeding and agronomy. Staple crop genomes are particularly rewarding in this respect, as their associated phenotypes extend into the history and current practices of farming and food uses. By combining scientific mechanisms of plant productivity with farmers' traditional survival strategies and observations, genomics in context can become a key resource for analyzing and understanding how we have lived so far and our prospects for future survival.

Archeologists have long regarded the 'Fertile Crescent' of the Tigris, Euphrates, Jordan and Nile rivers as one of the regions that has had an important impact on the origins of human agriculture and society. Like linguistics, genetic tools lose resolution with time. But unlike languages, wild crop relatives and local varieties (landraces) preserve both ancestral and derived diversity so that crop origins may be inferred (p 1024). Nevertheless, 6,000-year-old barley grains preserved in a hot, arid environment retain sufficient DNA evidence to establish their similarity to regional modern landraces rather than regional wild barley (p 1089). Gene variants fixed in modern barley could be detected in one of the ancient samples—namely, a deletion in *BTR1* that prevents spike shattering and aids in harvesting. From analysis of shared rare variants, the ancient barley grains were found to be most similar to lines from the Upper Jordan Valley, a region proposed to be one of the centers of domestication on the basis of analysis of genetic diversity.

At the same time, whole-exome sequences of people living in the region now often termed the 'Greater Middle East' provide evidence that there remain a number of ancient founder populations in the regions of Persia, the Arabian and Turkish peninsulas, the Syrian Desert and Northeast Africa that include the Fertile Crescent (pp 978 and 1071). Perhaps the parallel strategies of consanguineous reproduction and reliance upon indigenous selfing crops such as barley maintained the deep local roots of these populations in the face of societal upheavals: expansions, conquests and migrations.

A parallel story of crop domestication and societal growth is provided by rice in West Africa. The independently domesticated African rice species *Oryza glaberrima* has a reduction in its common genetic variation that is not present in its wild ancestor. The shape of this bottleneck suggests that people managed or cultivated African rice over a prolonged period from 15,000 to 3,000 years ago, rather than the alternative explanation of a period of rapid adoption of the crop at the point of minimum diversity 3,500 years ago (p 1083). Several genomic regions conferring resistance to soil salinity were identified using genome-wide association studies. These regions correspond to adaptations after domestication that are regionally dispersed in arid and saline areas of West Africa. African rice is often grown as a subsistence crop without input of irrigation or fertilizer, so, as interviews with farmers show, sharing seeds for and the knowledge of which varieties suit the local conditions is key to getting any harvest at all.

Economic and anthropological botany is not just scholarship; rather, like sharing seeds, the study of plants and society is a strategy for our survival. Adding genomics to this discipline provides a shared language and mechanisms to implement this strategy to build agricultural security for future societies. ■