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CENTRO CULTURALE DI MILANO

“ L’uomo addomestica la natura? Il frumento nella storia”

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Seminario di Nesbitt (testo in inglese)

After 200 years in which European agriculture has become increasingly intensive, foods ever further removed from their raw ingredients, and consumers ever further removed from producers, city dwellers such as myself are starting to take an informed interest in the production of our food. In part this interest - not always welcomed by industry or scientists - is concerned with how our food is produced today, but it is also reflected in an increased interest in food history and the culture of food. This is in recognition that food is not simply nutrition: it also embodies many aspects of our culture.
Today I want to talk to you about some aspects of the history of wheat. At the request of the organisers I will try to link these to some current issues regarding attitudes to food. The history of wheat is a big subject, reflecting both the central role of cereals as staple foods, and the special position of wheat as the most valued of the European cereals. Today I'm going to concentrate on looking at the domestication of wheat - the process by which it was taken into cultivation by the first farmers. Our knowledge of this has come about through a highly successful collaboration between specialists in archaeology, botany and genetics. Finally, I'll consider whether taking a long term perspective on wheat has any relevance to current day controversies regarding food production. There are lots of topics I won't have time to mention \endash please feel free to raise these in the discussion at the end.

IMPORTANCE OF AGRICULTURE I'd like to start by explaining why it is that understanding the origins of agriculture is regarded as one of the really big questions in archaeology, alongside the evolution of modern humans and the emergence of the first cities. Let's look at what happens when farming communities encounter hunter-gatherers.
2. hunter-gatherers 15000 BC (100%), 1500 AD (10%), 1960 AD (0.01%)
15,000 years ago all humans were hunter-gatherers, dependant on wild plants and animals. That's not to imply that they were in some way primitive or entirely at the mercy of nature. We know from archaeology and from studies of the few surviving gathering communities that an extraordinarily detailed knowledge of plant and animal behaviour is allied to the ability to manipulate vegetation types, mainly through the use of fire. However, even in areas rich in plant foods, the annual productivity of food plants is low, and only low population densities can be supported. The first agricultural societies appear in the Near East c. 10,000 years ago, with farming starting independently and later in China, Mesoamerica and South America. Within a few thousand years farmers had displaced hunter gatherers across the globe. By 1500 AD it is estimated that 10% of the world's population were gatherers; by 1960 0.01% were gatherers, restricted to those areas so cold or so dry as to make agriculture impossible.
3.City wall at Bogazkoy. How was it that agriculture spread so fast? The answer lies in its productivity. Let's look for example at Bogazkoy, the capital of the Hittite empire in central Turkey - typical of the capital of an agricultural society. Massive ramparts dominate the surrounding countryside.
4.Granary at Bogazkoy In the last couple of years massive granaries, 100 m long and 20 m deep have been excavated within the citadel of Bogazkoy.
5. Wheat chaff in granary
Examination of the base and sides of the granary has revealed the dried, crumbling remains of the last stores of wheat, abandoned when the Hittite empire collapsed in 1200 BC.

The granaries are the clue to the impact of agriculture: by growing domesticated plants, and by cultivating soil so as to increase the area growing food plants, agriculture is hugely more productive than gathering. Gathering is the ultimate in low input, low out put food systems, while agriculture rewards ever increasing input of energy (in the form of labour) by higher yields. This means that agricultural societies have the capacity to generate surpluses of food that can be used to employ builders, soldiers, bureaucrats and other aspects of civilisation.

The creation of surpluses also seems to lead inevitably to hierarchial, unequal societies in which surpluses are controlled by small groups. What we think of as the attributes of civilisation - are the attributes of agricultural societies, with large settlement sizes -often cities and high population densities and complex governments. In contrast gatherers past and present live at low population densities, in which the largest settlements are small villages. Societies are relatively equal, and indeed gathering wild foods usually requires social collaboration rather than competition.

We don't know much about the process by which agriculture spread, but there is good evidence from genetics that it was migration of people and not just the idea. Agricultural societies displaced neighbouring gatherers.

6. Adam & Eve leave garden of Eden Agriculture was an irreversible step for humankind, and it is not surprising that the beginning of farming is sometimes likened to the loss of innocence in the Garden of Eden. But there is a key difference to the discovery of the forbidden fruit: farming was not discovered, but rather forced on humans. We know from studies of recent gatherers that gathering is a stable, comfortable way of life, sometimes referred to as the "original affluent society". Gatherers have always known that if you plant a seed it will grow; they also know its cultivation will be hard work best avoided. Why did the very first farmers start farming?

WILD CEREALS

Scientific research into agricultural origins started in the late 19th century, with the realisation that a crop must be descended from a wild ancestor. However, finding the wild ancestor was not always to prove so straightforward. In some cases, such as sesame, broad bean and common millet, a wild ancestor has not yet been found.

7. monococcum

However, for most crop plants we can identify a wild ancestor, often very similar in appearance to the crop, genetically closely related, but (unlike crops) well adapted to a wild habitat. For example, by 1900 the wild ancestor of einkorn wheat, Triticum monococcum \endash piccolo farro) had been identified.

8. boeoticum on hillside

Wild einkorn wheat grows throughout the fertile crescent, on hillsides and also in disturbed areas such as roadsides.

9. wild wheats in oak parkland

Wild einkorn and other wild cereals form dense, natural stands - more than enough to support low population densities of hunter-gatherers.

When archaeologists started searching for the earliest farming villages in the 1950s, the question arose of where to look. Not as clear cut as one might think - claims for independent origins of agriculture have been advanced for the Balkans, the western Mediterranean, Morocco and Egypt. We can now rule this out, for reasons that I'll explain. However, a natural desire to find the earliest farming on one's own territory has often led archaeologists to make unsupported claims.

10. distribution of wild cereals. But in the 1950s investigations into the current day distribution of wild ancestors showed clearly that most were confined to the fertile crescent in the Near East. [point out wheat and barley]. Note the shape of the fertile crescent - the foothills of the great ring of mountains surrounding the Arabian desert.

11. wild pea

The wild ancestors of other Neolithic crops = pea, lentil, chickpea, flax are also located in the fertile crescent.

To me its an extraordinary fact that so many of the temperate crops - wheat, barley, peas - that are today so widespread have their origin in a relatively small part of the Near East. This ability of the Near Eastern crop complex to spread east and west, to areas with similar temperate climates (in the southern hemisphere too) has done much to underwrite what has been termed as ”ecological imperialism”, the spread of European colonisers and their crops from the 16th to 19th centuries.

SETTLEMENT BEFORE AGRICULTURE What have archaeologists found in the fertile crescent? Let’s look first at sites that predate agriculture, in other words sites before 10,000 years ago.
12. Landscape around Hallan Cemi
One site that I have worked at is Hallan Cemi in southeast Turkey. It’s set in open oak woodland that is a classic habitat for wild cereals. Evidence from seeds and charcoal strongly suggests that the vegetation was similar 10,500 years ago, though less affected by grazing.
13. Round house
Until recently, it was assumed that gatherers were simple people who had to live mobile lives, following the annual cycle of plant ripening in different environments. We now recognise that this view is based on today’s hunter-gatherers, who live in the driest, most marginal environments. In fact in temperate environments such as California, gatherers in the recent and distant past lived in permanent, sedentary settlements. These are substantial buildings, clearly occupied year round.
14. Round house
15. Auroch skull
They are packed a wide range of discarded objects, some of ritual significance, such as this wild cattle skull found placed against a wall.
16. Bone toggles
Some objects are of great beauty, such as these bone toggles.
17. Grinding stones. And some objects of purely practical use, such as these grinding stones. What was being ground on these stones?

Let’s look at how we know about the ancient plant foods being eaten at these sites
18. Bulgur making
19. Bread making
Traditional village life always involves the use of fire in processing foods - roasting nuts for example, bulgur making or bread making. The role of fire is vital because uncharred seeds will not survive more than a few weeks in temperate or tropical countries - they will germinate, decay or be eaten. Charred, black seeds are almost pure carbon and are relatively indestructible. Charred seeds and charcoal change colour, but retain their shape, allowing identification under the microscope.
20. Charred emmer grains
Some wheat grains to show quality of preservation
21. Ash heap
Seeds that have fallen into the ashes of the fire will be charred, then thrown onto an ash heap such as this in eastern Turkey.
22. Central area, Hallan Cemi, eastern Turkey
Or, at Hallan Cemi there was a central cooking area surrounded by the round houses. Fire-cracked stones, used in cooking (no pottery, so needed to put stones in hide bags), with ashes, charred seeds, bones mixed in.
23. Burnt almonds
In some cases also find large quantities of seeds preserved when e.g. a house burns down. But this is relatively rare.
24. Flotation machine
For recovery of material mixed with ashy soil, there was a major technical development in the 1960s, the invention of the flotation machine. This works on a very simple principle - charred seeds and charcoal float, soil sinks. so archaeological soil is tipped in...

25. Flot - close-up
And the flow of water through the tank carries the seeds onto a sieve. The flotation machine is now used by archaeologists around the world and guarantees good recovery of seeds.
26. Grass-harvesting, Mali
The seeds from Hallan ,emi suggest that gatherer diet 10,000 years ago had similarities with gatherer diets today. Wild grasses are important, though less so here than at smilar sites in the Levant. Wild grass seed is still an important resource across a huge belt of sub-saharan africa, for example in Mali. Note the harvesting by beating into baskets - wild cereals would have been harvested in a similar fashion.
27. California - acorn mush
Another parallel is the huge range of plant foods used - up to 150 species. This includes many seeds such as acorns, which we would not think of as food today. However ethnographic evidence, e.g. from 19th century California or indeed 20th century Sardinia shows that acorns are a fat rich and highly storable foodstuff.

WHAT HAPPENED IN THE NEOLITHIC?
Now let's look at what happened at the beginning of farming. Let's look in more detail at the process of domestication. What is the difference between wild and domesticated wheats?
28. Wheats
The wheats divide into 3 groups. First, wild wheats, primarily wild einkorn and wild emmer. Note how the ear has broken up. This is the most important characteristic of wild ancestors in general: they are adapted to distributing their seeds. In contrast, in a crop only those seeds not dispersed from the plant will be harvested. There is thus a strong selection pressure for genetic changes that result in seed being retained at harvest, not being dispersed. The genetic change controlling this character is one or two genes, so domestication can occur easily. Note also the differerence between hulled wheats, such as einkorn & emmer (farro), and the naked wheats such as bread wheat or mcaroni wheat. The naked wheats are so called because the grains thresh cleanly out of the ear. These are a later development, first appearing about 1000 years after einkorn and emmer were domesticated.
29. Wild vs domesticated monococcum \par \par The changes in the cereal ear are enormously helpful in detecting domestication on ancient seed remains. Lets look at the changes in wild einkorn. Note the arrow-shape and barbs of the seed packet, designed to ensure the seed is embedded in the ground. Note most of all the difference in the scar at the point at which the seed packets join to each other: clean in wild einkorn, where the seed packets naturally separate, and torn in domesticated einkorn where the seeds only separate if threshed apart.
30. Barley spikelets embedded
Here are seed packets of wild barley embedded in the ground. This is vital to escape being eaten by the ants that are such active scavengers in the Near East
31.Barley scars \par \par Of all the characteristics that separate wild and domesticated cereals, the scar is the most useful. Here we can see torn and wild scars from barley at an early site in Isarel, wild type (torn) and domesticated type (untorn). There are other differences: domesticated cereals usually have larger seeds. But this kind of difference is usually less clear in the early days of domestication.
32. Neolithic sites
Overall the pattern is clear: the earliest farming villages are indeed in the fertile crescent, dating to c. 9500 years ago. Radiocarbon dating has shown clearly how farming villages are later in date the further they are from the fertile crescent.
33. Jericho There are still many details to resolve. For example, Jericho is often cited as one of the world's earliest agricultural sites.. However, full publication of the material (dug in the 1960s) in the 1980s showed that only a few fragments of grain could be securely dated to the earliest Neolithic, and that these could be of wild grain.

34. ‚The earliest certain farming sites are sites in northern Syria and southeast Turkey, such as ‚ayšnŸ, and don't after all belong to the very earliest period of the Neolithic. It looks as if having already rethought the link between sedentism (permanent settlements) and farming, we also need to reconsider the link between the Neolithic and farming, previously thought to begin at the same time. BUT one thing Is clear: look at this site and the size of the buildings. The great increase in size of settlements and their density in the Near Eastern countryside demonstrates the increased productive power of agriculture.

Why? The story as I've outlined it is of the where and when of wheat domestication - what of the why? There is good agreement that the begining of farming is in some way related to the climatic changes after the most recent ice age ended, c. 13,000 years ago. During the last ice age most of the Near East was virtually uninhabited steppe.. But the climate got better - warmer and wetter. Pollen evidence clearly shows that, as you would expect, woodland and wild cereals spread and became more abundant. So this does not fit well with the idea I mentioned at the start of my talk that hunter-gatherers were forced to adopt agriculture, e.g. by some kind of food shortage. Two plausible explanations exist. One is that the increased availability of food upset the equilibrium that gatherers had established with their environment.

Gatherer groups today maintain stable populations through various mechanisms, often relating to nutrition and delayed weaning of children. As more food became available, these mechanisms may have broken down, leading to higher population and an increased demand for food. An alternative explanation, now very popular, is that a cold period c. 10,000 years ago may have suddenly reduced the increased food supplies to which gatherers were becoming used. I'll offer a cautionary note: archaeologists are heavily swayed by current day concerns. For example, in the 1960s when overpopulation was a major global concern, population increase was often proposed as the main factor. I'm suspicious of the fact that in the 1990s, when climate change entered the global agenda, it suddenly became the most popular explanation. The fact that agriculture started several 1000 years later in the Americas suggests we should be cautious about looking for easy links between climate change and human history.

CONCLUSIONS

It is arguable than the advent of biotechnology means that another agricultural revolution is on its way. I don't make any special claims for insights from archaeology - as I've mentioned, it is susceptible to influences from current day fashions in thought. But I will suggest that one lesson we could draw is of unexpected impacts. What started as the small-scale cultivation of wild plants in a small region led to domestication, and a remarkably rapid transformation of most of the inhabited world. It is not easy to assess the positive and negative aspects of the destruction of gatherer lifeways and their replacement by farming, but obviously the spread of agriculture was a bad thing for many people, even if ultimately good for their descendants.

Nutritionists are increasingly questioning the suitability of an agricultural diet for humans who are still living in essentially upper palaeolithic bodies,. Farming has seen a great reduction in food diversity (from 150 plant species to 10 for Neolithic farmers), although recent research suggests dietary diversity may be essential for the supply of micronutrients. Some nutritionists also blame our dependance on wheat, with its easily digestible starch (high glycemic index) to be responsible for today's epidemic of diabetes and heart disease. Although we cannot turn back the clock and return to being gatherers, we may want to modify our diet.

The Green Revolution of the 1960s was somewhat similar in being highly sucessful in increasing yields, more than matching a doubling in population, but in having unexpected impacts such as decrease in dietary diversity and adeline in consumption of wild leafy vegetables, now recognised asimportant in nutrition.

In the case of GMOs we are in the unusual possition of being able to predict that unexpected consequences will occur (in part based on our previous experiences as I have described). What I personally feel, and it is aview widely shared by the general public and by scientists, is that before

GMOs move from the laboratory to the field, we should do the research necessary to reduce the impact of the unexpected. Unlike the first Neolithic farmers, we do have the ability to predict and control our futures.