Why Foragers Become Farmers: Development and Dispersal of Food Producing Economies in Comparative Perspective

Andreas Zimmermann

Institute for Prehistoric Archaeology, University of Cologne, Weyertal 125, D 50931 Köln, Germany
e-mail: a.zimmermann@uni-koeln.de

Abstract: To understand the transformation from foragers to farmers it seems promising to integrate several theoretical approaches. To do so it is first necessary to distinguish different conceptions of evolution. Next, we have to think about what food producing is. Is it already burning the forest to improve hazelnut harvest or is it only dealing with domesticates like maize and wheat? In the end, we have to care for a debate between two important theoretical directions of today. Processual Archaeologists identified adaptation and political economy as important behaviors during this transformation. For Postprocessual Archaeologists what matters is agency. The proposition to reconcile these seemingly conflicting positions is to develop an integrative and comparative perspective within a Hermeneutical approach. In this respect, Johann Gustav Droysen stimulated the following paper with his textbook 'Historik' from 1882.

Keywords: adaptation, agency, evolution, hermeneutics, neolithic, processual archaeology, postprocessual archaeology

Introduction

The development of food producing economy with the domestication of some plants and animals is an important turning point in human history. Impact of the 'Neolithic Revolution' is at least as important as the 'Urban Revolution' with the formation of states and the 'Industrial Revolution'.

However, in the 'Neolithic Revolution', not every domestication process changed similarly the historical trajectory. Cultivation of plants resulted in higher population densities than animal husbandry. Therefore, it is preferred here not to discuss the developmental path from hunting gathering to cattle breeding in the Sahara, for example. For a better understanding of the developments, it is first necessary to discuss the history of the concept of what 'Neolithic' is and then to differentiate (at least at a theoretical level) systems of 'low level food production' and 'subsistence systems based on farming'. With the former term, we construct generally the transition from hunter-gatherers to farming as a continuous process. With the latter term, a discontinuous model of stages might be connected.

History of Research and the Term 'Neolithic'

In 1865 John Lubbock introduced the term Neolithic to distinguish later archaeological material from Paleolithic assemblages (Lubbock 1865). As a criterion, he proposed the existence of ground stone axes. Today we know that e.g. in Europe ground stone artefacts existed already during the Mesolithic. Later on, scholars proposed the existence of ceramics as a criterion for Neolithic assemblages. However today, we know that some forager societies also used ceramic containers and some settled people, like the Polynesians, did not use ceramics at all.

In that time, the 2nd half of 19th century, cultural evolutionists interpreted arriving at later stages of development as progress. It seemed reasonable to expect that underdeveloped countries would later come up to industrial countries. By this perspective, colonialism seemed legitimized. Because man is intelligent, he will recognize sooner or later the true path to progress. In this concept, cultural evolution, in contrast to biological evolution, appears as development *directed* by transmission of information. Teaching natives to be civilized seemed a useful application of Lamarckian evolutionism. Cultural evolution was also seen as the seemingly irreversible development to higher stages of development. These beliefs of 19th century evolutionism have all been heavily criticized and are not elements of today's evolutionary thinking.

In the 1st half of the 20th century, V. Gordon Childe changed the meaning of the term 'Neolithic'. He used it to describe food-producing economies (Childe 1936). Producing more foodstuffs than before guaranteed more people a living. Therefore, in each of the 'Neolithic', 'Urban', and 'Industrial Revolutions' population increased markedly. '...in the economic sphere ... it will be possible to recognize

radical and indeed revolutionary innovations, each followed by such increases in population that, were reliable statistics available, each would be reflected by a conspicuous kink in the population graph. These revolutions can accordingly be used to mark off ... stages in the historical process ...' (Childe 1941/1946: 22; Barker 2006: 10 quotes a similar reference from Childe 1936: 14). With this formulation, Childe overcame the concept that arriving at a new stage is progress (Barker 2006: 10 referring to Childe 1936: 1), and he built a bridge to biological evolution. The complete sequence of steps in the Darwinian understanding of evolution is: 1. *Undirected* variability by e.g. mutation; 2. Selection by competition and 3. Reproductive success.

It is easy to explain the dynamic expansion of food-producing economies as selection by competition. Because farmers also collect and hunt, they removed the nutrition base from foragers in their neighborhood. The reverse (competitive exclusion of farmers) will not happen because only farmers have the additional yields of domestic plants and animals at their disposal. More general formulated – larger populations generally seem to be more competitive than smaller ones. The conceptual model of biological evolution also explains why processes of devolution are the exception and not the rule. Theoretical a reversible development, a decline of population, is possible; the cost, however, is that many people must die early. Childe developed his concept based on data from Europe and the Near East, where the term 'Neolithic' has proven its worth as a chronological term still today. With a global perspective the part 'lithic' of the word is, however, problematic because, e.g. in Africa food producing economy developed and started to expand in an 'Iron Age' context. In this perspective, it would be better to use the term 'food producing economy'.

Archaeologists working within the framework of Processual Archaeology emphasize the importance of changing natural environment for the transformation process: climatic development with temperature and precipitation, soils and so on. They understand the development of food producing economy as an *adaptation*, as using opportunities. Form a Postprocessual perspective however, its human *agency* (Barrett 2013: 161–162). Women and perhaps men have chosen to use special kinds of plants or animals more intensive than before. In light of this contradiction, the following statement of Matthew Johnson seems to be still true. 'Papers that end with the depressing banal conclusion that 'there is something to be said for both sides' or that 'we should look for a middle ground' should be banned – not because a middle ground is in itself a bad thing, but because the search for a middle ground all too often becomes an easy replacement ... of serious ... critique of ... theoretical positions.' (Johnson 1999: 187).

Low-Level Food Production

The problem left by the conception of Childe is to delimit foraging and farming. Already hunter-gatherer societies may produce a part of their foodstuffs either by managing the environment or even from domesticated plants as seen for example with the American Hopewell. Therefore, Bruce D. Smith discusses terms as 'resource management' and 'husbandry', 'gardening', 'horticulture', 'incipient agriculture' as well as 'cultivation' (Smith 2001: 17–24). It is even more complicated using terms from different languages because e.g. the German '*Gartenbau*' (Müller 1988) is not equivalent to English 'horticulture' (Johnson 1989) and so on. Another problem is that wild and domesticated species are often not easy to differentiate biologically. It needs a certain time of genetic isolation and selection by humans until a plant or an animal species changes concerning morphological attributes. Of course, we would like to recognize the beginning of the domestication process, but the problem is missing reliable attributes for its earlier phases.

How long was the time from beginning of domestication to the development of recognizable morphological and genetic attributes? Today, regarding annual plants, only a period of a few hundred years seems reasonable. However, by recrossing with the respective wild species this time might have been extended to a few millennia. Bruce D. Smith proposes to integrate already this transitional phase in our considerations and proposes the term 'low-level food production' for economies with less than 30–50% energy supply from food production (Smith 2001: 28–29). In this perspective, the transition from foraging to farming appears as a continuous process of cultural history. People early on understood processes of reproduction and propagation of plants and animals. Transmission of this knowledge builds an uninterrupted tradition at least since tens of millennia. Without doubt, this is an insight of historical relevance.

Childe however emphasized the other perspective with choosing the term 'revolution'. After exceeding a threshold of the amount of food production, a cascade of consequences, intended and not intended, in a complex sequence changed life of the people affected. For example, the actors of this transformation process will not have predicted the results of optional accumulation of wealth and social differentiation. Perhaps they just noticed that they needed more working time for farming than before. Exceeding the threshold may be characterized by two more observations in the archaeological record: a fast increase of population and the beginning of the dispersal process of this new type of economy. In the archaeobotanical record, just a few plants apparently triggered these fundamental changes in historical development.

Development of Food Production

A compilation of Peter Bellwood and Marc Oxenham focuses on seven areas of the world as centers where food-producing economy developed. These centers are the Middle East, central China, West Africa, New Guinea highlands, Mesoamerica, central Andes and Eastern Woodlands of the USA (Bellwood and Oxenham 2008: 16 and Fig. 1). In these case studies, two different patterns become visible. From some centers, domesticated species changed the world within a few thousand years even for people living quite in a distance. These species also help to feed the majority of world population today. In the present rice, wheat, maize and millet satisfy 60% of human energy demand (Gruissem and Bättig-Frey 2009: 9). Other domesticated species as for example the sunflower from Eastern Woodlands of the USA were never as important. While many plants allow high-energy yield per hectare, the critical species seem to be rich in energy due to their content of carbohydrates. Are they better suited to feed the hungry?

Each of these and other potential domesticates needed specific environmental conditions. Therefore, we have to realize that particular geographical preconditions exist for domestication processes. Another precondition is the timing when it happened. In most cases, climatic changes belong to the group of possible important factors. Most significant is the end of the Ice Age with the consequence that precipitation globally increased. This was the cause why e.g. habitats with concentrations of cereals developed at the hilly flanks of the Fertile Crescent. It might also be possible that rice cultivation became possible in southern China (Werning 2003) as well as Taro in New Guinea (Barker 2006: 218–219). In a next phase of the global development of climate, we observe a limited reduction of precipitation. Precipitation did not decrease to the level of last glacial maximum, but it was sufficient that the large deserts of the world developed. It may be that this increasing aridity promoted intensive use of different kinds of millet as well as the transformation of teosinte to maize in Mesoamerica. In many cases, climatic change seems to force the domestication of plants. Collectors as well as farmers along coasts, large rivers, and lakes might have complemented their basis of subsistence by marine and limnic resources with dense and predictable resources. Summarizing preconditions of nature concerning location and time of domestication seem to be important for development of food production.

Robert L. Kelly, together with other authors, distinguishes two different socio-economic relations within hunter-gatherer societies (Kelly 1995: 189 ff. with Fig. 5–4 and 5–5 referring to Dyson-Hudson and Smith 1978). If predictable and high-density resources are used (aquatic resources are only one example), the groups affected characteristically become dependent on these resources. In this situation, it is necessary to regulate their use. Therefore, people concerned needed effective mechanisms of management. In consequence, these societies become typically non-egalitarian. Hunter-gatherers using low-density resources in the contrary, live typically in egalitarian social relations.

In all cases where the four important plants were domesticated, people already depended on them as dense and predictable resources. Transferring this idea to farming communities, one arrives at the formulation: Farmers produce their own dense and predictable resources. In these situations, therefore, we deal with less egalitarian social systems compared to low resource density situations. In extreme cases, sedentariness develops even in hunter-gatherer societies to allow better defending their predictable resources. The difference to sedentary farmers is that with domesticates is it possible to increase food production as much as working time can be invested.

Kent V. Flannery introduced a competing classification of hunter-gatherer economical systems by the term 'broad spectrum revolution' (1969: 77–79). Emphasizing regional diversity in the Near East, he argued that with increase of temperature at the end of last Ice Age diversity of resources increased markedly. Economy developed away from a preferential use of specific large hoofed mammals in the Upper Paleolithic to small game including terrestrial and marine snails, mussels and so on in Late Paleolithic and Epipaleolithic. Because this development included also an increased importance of plant resources, he understands this 'broad spectrum revolution' as a cultural historical precondition for domestication. Use of a narrow spectrum of resources corresponds well with an economy based on dense and predictable resources. Use of broad spectrum seems to correspond with low-density resources. A discrepancy, however, might exist discussing Natufian and Pre-Pottery Neolithic people of the Near East using many different species of plants and animals on the one hand side but already energetically dependent on highly localized habitats of wheats and barley on the other hand. However, socio-economic relations establish preconditions of culture important for an understanding of domestication processes. As far as I see, no single case of an egalitarian hunter-gatherer society developing a farming economy existed without external introduction of domesticates.

Where plants were domesticated, actors often used several and not only one species. For example, in the Near East it is a combination of ancient wheats, barley and pulses in addition to a range of animals. In China, it is a combination of rice and of two species of millet. In the Americas, domestication of cucurbit took place

much earlier than planting maize. Experts expect that oilseeds were more important than the fruit pulp in this case. In Africa, several other millets are important, and in New Guinea, it is taro and banana. We may understand this limited diversity as a means to minimize risk – if the main crop fails there is still a buffer.

Dispersal of Food Production

Dispersal of food producing economies represent two different processes. Migration, transfer of knowledge or a combination of both. When migration is the reason for change, as in the case of Central European *Linearbandkeramik* (Haak *et al.* 2010) or partly in the case of wet rice cultivators of Japan (Hammer *et al.* 2006), the cultural situation before immigration is less important than in cases of transfer of knowledge. In the latter situation, as for example in the north European plain, the question arises why people changed their way of life 'since early farming represents a decision to work harder ..., I suspect that people did it because they felt they had to, not because they wanted to' (Flannery 1973 cited by Barker 2006: 29).

Why expand food-producing economy? As already said, Childe overcame the answer that it was progress; instead, he proposed that it was different levels of population density. Why are population densities of farmers larger than of hunter-gatherers? The reason is the different energy efficiency of organisms at different trophic levels. Man living as vegetarian needs in average 4 Gigajoule/Person/Year. Consuming a maximal amount of animal foodstuff consumption may increase to 32 Gigajoule/Person/Year of primary energy. Primary energy considers not only the energy contents of animals' meat and fat but also the plants needed to bring up the respective animals (Sieferle *et al.* 2006: 27). Herbivores consuming plants only transform a small amount of energy consumed in flesh and fat consumable for predators. Therefore, the more meat farmers or hunter-gatherer consume the larger is the area they needed to procure their subsistence. The result is higher population density within farming societies. Principally, in mutual interaction a large population will affect a small group more than vice versa. We expect that not only for the genetic composition but in many cases also for the resulting cultural habitus. Specifically, as already said, farmers outcompete hunter-gatherers because they remove their nutrition base.

Integrative and comparative Interpretation

As a methodological starting point for interpretation, the Hermeneutic method of Johann Gustav Droysen is used (Droysen 1882: 13–24). Beside Leopold von Ranke, Droysen is one of the important exponents of the Historicism of the 19th century in Germany. He distinguished six steps to arrive at a sufficient interpretation:

1. *Heuristics* ('research questions'): For this paper, as central research-question the subtitle of a recent book may be used (Barker 2006): Why foragers became farmers?
2. *Critics*: Is it possible to answer this question by available data due to their representativeness?
3. *Pragmatic Interpretation*: Data concerning the past is always incomplete; it is necessary to complement available data.
4. *Interpretation of conditions*: It is important to recognize that also in the past preconditions existed which actors were not able to influence. For example, people had to react to changes in temperature and precipitation at the end of Ice Age; they were not able to change the climate.
5. *Psychological Interpretation*: In the internal perspective, motivations of actors are of interest.
6. *Interpretation of ideas*: Droysen believed that it is necessary to look for structures, which are more general than just preconditions of specific historical situations and the respective motivations of individual agents. In this paper, I propose to apply an *integrative interpretation* as well as a special *comparative interpretation* to approximate such generalized ideas of development.

Critics and *pragmatic interpretation* are important steps for understanding specific historical cases. Let us assume for the moment that our knowledge is sufficient concerning the best-known histories of development and dispersal of farming. In the comparative perspective of this paper therefore, we discuss only steps 4 to 6 in more detail.

In the perspective of the *interpretation of conditions*, J. G. Droysen emphasizes boundary conditions independent of human action but influencing what actors did (Droysen 1882: 21 §40). He differentiated geographical and chronological conditions as well as conditions of means for example technology. In this way, one accepts natural and cultural environment as important factors for human behavior. By this position, even in Droysen's time of colonialism people overseas evidently were not responsible for every aspect of the conditions that they were living in. Climate change and properties of plants are important preconditions of nature in this respect for development of food producing economy. This point of view resembles the concept of adaptation as accentuated by the Processual Archaeology of the 1960ies and 70ies. Of equal rank are preconditions of culture. We addressed already social relations in section 'Development of Food Production' and population

Table 1 Suggestions from different disciplines to understand motivations of behavior.

Discipline	Motivations of behavior	Author
Anthropology /Ethnology	Basic needs	Malinowski 1939 and 1944/1966
Philosophy	Needs, wants, duties, abilities and opportunities	Stegmüller 1987: 130
Sociology	Situation, need and evaluation of situation	Parsons according to Korte 2000: 174

Table 2. Selected authors with regard of motivations leading to food producing economy.

Author	Needs	Cause
V. Gordon Childe 1936	Bodily needs	Nutrition
Brian Hayden 1990	Social needs	Prestige
Jacques Cauvin 2000	Cognitive needs	Religious or spiritual understanding of the world order

density in section 'Dispersal of Food Production'. In the perspective of the interpretation of conditions, these circumstances seem to determine human behavior. What humans do are consequences of these reasons.

In the perspective of the *psychological interpretation*, J. G. Droysen is searching for acts of volition ('*Willensakt*'). Motivations of the actors matter. This point of view resembles the concept of agency as accentuated by the Postprocessual Archaeology since the 1980s. Motivations are the cause, and specific behavior is the effect. Behavior becomes meaningful by motivations.

Therefore, we have to discuss if the contradiction between Processual Archaeology with the adaptation argument and Postprocessual Archaeology with the agency argument may be overcome by an *integrative and comparative interpretation*. Already J. G. Droysen included both interpretations in the same Hermeneutical approach, because both look at the same relation between motivations and preconditions but from the two different points of view. In practice, humans must consider preconditions. Therefore, to arrive at a good interpretation we have to discuss dialectically these two perspectives together. The respective context comprises conditions of nature and culture as frame of reference as well as fossilized remains of human agency. Diversity of farming systems in non-state societies describes the bandwidth of decision-making that I consider. The range of solutions observed represents the freedom of choice. In the case of Central Europe during the Neolithic for example cases with and without plough seem to have existed; fields were prepared with and without burning. This is the variability needed in the first step of the biological model of evolution.

To operationalize this integrative approach it is necessary to understand causes of behavior. There are several suggestions from different disciplines (Tab. 1).

This paper is interested in group-motivations for adopting food producing economy. Therefore, individual abilities are not of central interest. Duties and opportunities are a result of situations. As situations are a matter beyond archaeological chronological resolution, common denominator seems to be needs. For our research question *Why foragers became farmers?* (Barker 2009), we do not need to care for an exhaustive list of human needs. Concerning food producing economy, until now most authors have proposed one of three types of interpretation (Tab. 2).

Therefore, as a general answer to the question '*Why foragers became farmers?*' nutritional security, strive for prestige and spiritual convictions as well as different combinations offer good reasons for development and dispersal of a food producing economy. For an answer concerning a specific case in the competition of the three types of interpretation, the central argument of the evaluation we have to discuss if one specific need or a group of graded needs is more important than the others are. To evaluate the importance of a specific need, two approaches are possible. On the one hand, one could derive this importance by their own ideological position. In this case, empirical archaeological fieldwork is not needed. The other possibility is to derive the importance of the respective needs by archaeological observations concerning specific contexts – only then its possible to develop specific arguments in a comparative approach. The question is why in a specific context one need would have been more important than others.

Table 3. Two case studies of different use of domesticates. Choices connect needs and preconditions by use of opportunities.

Example of maize domestication in the Americas			
Precondition of nature		**Choices**	
	Slow domestication process from teosinte to maize → low yields		Social need to find an appropriate position within in-group → feasting with alcoholic beverages
Precondition of culture			
	Comparatively high population density?		
Example of wheat use in Bandkeramik Europe			
Precondition of nature		**Choices**	
	Domestication process already advanced → high yields		Choice of best soils for settlement location
Precondition of culture		Small diversity of staple foods chosen	
	No alternative foodstuff		Use of wheat as staple food for bodily need nutrition
	Comparatively low population density		No need for marked social inequality

As an example, I present a short draft of a comparative interpretation. One case study is domestication and dispersal of maize in Mesoamerica. The other is the use of ancient wheat in early Neolithic *Linearbandkeramik* in Central Europe (Tab. 3). Of course, both interpretations are valid only if step 2 and 3 of J. G. Droysens interpretation sequence are convincingly elaborated.

Both cases have in common, that in the long-term cultivation of maize as well as of wheat changed the way of living of large populations at a continental scale. Of many differences in preconditions of nature, here dissimilarities in the speed of cultivation is emphasized. Teosinte developed slowly to maize (Galinat 1985: Fig. 8.1 according to Barker 2006: Fig. 10), and so yields of ancient maize would initially have been quite low. Thus at the beginning, maize probably was not cultivated primarily as a staple food. It is possible that production of alcoholic beverages was the initial intention (Smalley and Blake 2003 according to Barker 2006: 264). Feasting is a well-established impetus for gaining prestige by ambitious individuals (Hayden 1990). While pursuit of prestige could be a human universal its importance is 'phenotypical' very different in human societies. Therefore, to validate this function of maize in early Mesoamerican societies specific preconditions of culture should be observable. As prestige is of more importance in large-scale societies, quite high population densities and group size should be expected in the Mesoamerican cases.

In contrast, in the European case, yields of ancient wheats probably have not differed too much from pre-industrial farming (Wendt *et al.* in print). Therefore, due to missing alternatives in the spectrum of positively documented foodstuffs wheats seem to be an important part of nutrition. Therefore, it is not surprising that these first farmers have chosen loess soils best suitable for wheats to arrive at high yields (Zimmermann *et al.* 2009a: Fig. 8). They used a condition offered by their environment. On the other side, population density seems to have been quite low during this time (Zimmermann *et al.* 2009b: 370 and Fig. 6) so that competition for prestige does not seem a strong argument (for a different interpretation of the *Linearbandkeramik* case see e. g. Kreuz 2010). Therefore, an interpretation of *Linearbandkeramik* farming as mainly caused by desire for alcoholic beverages seems not probable.

Conclusion

This paper understands *food-producing economy* in the sense of Childe. It changed the life of the affected people in a revolutionary way. Looking back from today, only a few plant species had the potential to change nutrition in such an elementary way. In this respect, in farming economy cereals, rice, maize or perhaps some kinds of millet are grown. *Low-level food production* as defined by Bruce D. Smith on the other hand is a useful term for many techniques in hunter-gatherer societies to improve their subsistence base. These techniques include burning forest as well as even domestication of other species such as sunflower and cucurbit. In culture historic perspective, these practices prove that man always knew how to reproduce plants and animals – in this respect food-producing economy is an evolution with a long tradition.

Although development and dispersal of food-producing economy would not have happened without cultural transmission of knowledge, the three steps of Charles

Darwin's concept of evolution are recognizable: 1. Variability by experimentation; 2. Selection by competition and 3. Reproductive success.

At the level of *specific answers* to the question 'Why foragers became farmers?' responses are possible by an approach of cultural comparison. Specific archaeological observations may help to identify a specific need or a group of needs that in a particular case was probably more important than in others. In this paper, it is tried to illustrate a possible way to argue by two examples. One is cultivation of wheat in *Linearbandkeramik* early Neolithic in Europe. The other is domestication of maize in Mesoamerica.

Different *general answers* exist to the question '*Why foragers became farmers?*' In an uncompromising Processual Archaeology perspective, people just used options. Because it would have been stupid not to use these chances, it seems questionable if people really had a choice. By a Postprocessual perspective, agency becomes visible in the way actors used their options. The enormous diversity of farming systems in only one arbitrarily selected region already during non-state societies illustrates freedom of choice. In an integrative perspective, we recognize choices as considering both, preconditions as well as needs of actors. Actually human needs seem to be an appropriate basis to understand beginning of farming. Insofar, both theoretical positions within Archaeology help to understand better behavior of humans during the food producing revolution. However, the competitive relation between both Processual and Postprocessual approaches does not contribute to an improved knowledge.

Acknowledgments

Timothy Earle tried to improve my English and to clarify my ideas.

References

Barker, G. 2006. *The Agricultural Revolution in Prehistory. Why did Foragers become Farmers*? Oxford, Oxford University Press.

Barrett, J. C. 2013. *Agency: A Revisionist Account.* In I. Hodder (ed.), *Archaeological Theory Today*: 146–166. Cambridge, Polity.

Bellwood, P. and Oxenham, M. 2008. *The Expansion of Farming Societies and the Role of the Neolithic Demographic Transition*. In J.-P. Bocquet-Appel and O. Bar-Yosef (eds), *The Neolithic Demographic Transition and its Consequences*: 13–33 Dordrecht, Springer.

Brown, D. E. 1991. *Human Universals*. New York, Temple Univ Pr.

Childe, V. G. 1936. *Man Makes Himself.* London, Coronet Books.

Childe, V. G. 1941/1946. *What happend in History*. New York 1946, 1. Edition Harmondsworth.

Cauvin, J. 2000. *The Birth of the Gods and the Origins of Agriculture.* Cambridge, Cambridge University Press.

Droysen, J. G. 1882. *Grundriss der Historik*. Leipzig, 3. changed edition [First Edition 1858].

Dyson-Hudson, R. and Smith, E. A. 1978. Human Territoriality: An Ecological Reassessment. *American Anthropologist* 80: 21–41.

Flannery, K. V. 1969. *Origins and ecological effects of early domestication in Iran and the Near East*. In P. J. Ucko and G. W. Dimbleby (eds), *The domestication and exploitation of plants and animals. Conference London*: 73–100. London, Aldine Pub. Co.

Flannery, K. V. 1973. The Origins of Agriculture. *Annual Review of Anthropology* 2: 271–310.

Galinat, W. C. 1985. *Domestication and diffusion of maize.* In R. J. Ford (ed.), *Prehistoric Food Production in North America*: 245–278. Ann Arbor, University of Michigan Museum.

Gruissem, W. and Bättig–Frey, P. 2009. Magere Zeiten – Die Herausforderungen der modernen Landwirtschaft. *BioFokus* 80: 1–16.

Haak, W., Balanovsky, O., Sanchez, J.J., Koshel, S., Zaporozhchenko, V., Adler, J., Der Sarkissian, C.S.I., Brandt, G., Schwarz, C., Nicklisch, N., Dresely, V., Fritsch, B., Balanovska, E., Villems, R., Meller, H., Alt, K.W. and Cooper, A. 2010. Ancient DNA from European Neolithic Farmers Reveals their Near eastern Affinities. *PLoS Biology* 8, Issue 11.

Hammer, M.F., Karafet, T.M., Perk, H., Omoto, K., Harihara, S., Stoneking, M. and Horai, S. 2006. Dual origins of the Japanese: common ground for hunter-gatherer and farmer Y chromosomes. *Journal of Human Genetics* 51: 47–58.

Hayden, B. 1990. Nimrods, Piscators, Pluckers, and Planters: The Emergence of Food Production. *Journal of Anthropological Archaeology* 9: 31–69.

Johnson, A. 1989. *Horticulturalists: Economic Behavior in Tribes.* In S. Plattner (ed.), *Economic Anthropology*: 49–77. Stanford, Stanford University Press.

Johnson, M. 1999. *Archaeological Theory. An Introduction*. Oxford and Malden Ma, Blackwell Publishers.

Kelly, R. L. 1995. *The foraging spectrum. Diversity in hunter-gatherer lifeways.* Washington and London, Eliot Werner Publications.

Korte, H. 2000. *Einführung in die Geschichte der Soziologie 6*. Edition Opladen, VS Verlag für Sozialwissenschaften.

Kreuz, A. 2010. Die Vertreibung aus dem Paradies? Archäobotanische Ergebnisse zum Frühneolithikum im westlichen Mitteleuropa. *Bericht der Römisch-Germanischen Kommission* 91: 23–196.

Lubbock, J. 1865/1874. *Prehistoric times, as illustrated by ancient remains and the manners and customs of modern savages.* London, Williams and Norgate [German edition Jena 1874].

Malinowski, B. 1939. The Group and the Individual in Functional Analysis. *American Journal of Sociology* 44: 938–964.

Malinowski, B. 1944/1966. A Scientific Theory of Culture and Other Essays. New York/Oxford 1966, Oxford University Press.

Müller, W. 1999. *Gartenbau*. In W. Hirschberg (ed.), *Wörterbuch der Völkerkunde*: 141. Berlin, Reimer.

Sieferle, R. P., Krausmann, F., Schandl, H. and Winiwater, V. 2006. *Das Ende der Fläche: Zum gesellschaftlichen Stoffwechsel der Industrialisierung. Köln–Weimar–Wien*, Böhlau Köln Umwelthistorische Forschungen 2.

Smalley, J. and Blake, M. 2003. Sweet beginnings: stalk sugar and the domestication of maize. *Current Anthropology* 44: 675–703.

Smith, B. D. 2001. Low Level Food Production Economies. *Journal of Archaeological Research* 9: 1–43.

Stegmüller, W. 1987. *Hauptströmungen der Gegenwartsphilosophie II*. 8. Edition Stuttgart, Kröner.

Werning, J. 2003. *Früheste Scherben, frühester Reis, früheste Hirse: Zur Neolithisierung in China. Eine kritische Betrachtung.* In: J. Eckert, U. Eisenhauer and A. Zimmermann (eds), *Archäologische Perspektiven. Analysen und Interpretationen im Wandel. Festschrift Jens Lüning*. Rahden/Westfalen, Vlg Marie Leidorf. Internationale Archäologie 20.

Zimmermann, A., Wendt, K.P, Frank, T. and Hilpert, J. 2009a. Landscape Archaeology in Central Europe. *Proceedings of the Prehistoric Society* 75: 1–53.

Zimmermann, A., Hilpert, J. and Wendt, K.P. 2009b. *Estimations of Population Density for Selected Periods Between the Neolithic and AD 1800.* In J. Steel and St. Shennan (eds), *Special Issue on Demography and Cultural Macroevolution*: 357–380. Human Biology 81.