

Open-Range Cattle Grazing and the Spread of Farming in Neolithic Central Europe

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Abstract

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This essay advances the proposition that the earliest farmers in central Europe practiced a form of livestock management in which they allowed their cattle to range freely in the forests and to seek good grazing resources with minimal human assistance. Open-range grazing is often used by settlers introducing domestic livestock to new habitats. It provides a plausible alternative to models involving open pastures close to settlements or transhumance between settled areas and distant pastures.

Key words: Neolithic, Europe, Linear Pottery, cattle, open-range grazing, horticulture

Introduction

This essay is a speculative meditation on the animal management practices of the earliest farmers in central Europe. Its fundamental position is that the possibility that communities of the Linear Pottery culture and its congeners allowed their cattle to graze freely in the forests of riverine interior central Europe may help explain many aspects of the archaeological record during the sixth and fifth millennia cal B.C. While it may currently be difficult to substantiate this hypothesis, perhaps clever analytical techniques will be developed over the next several decades to test it. The hypothesis of early Neolithic dairying (e.g. Bogucki 1984) lacked adequate proof until analytical techniques were developed years later to test for lipid residues (e.g. Evershed *et al.* 2008, Salque *et al.* 2013), and perhaps the ideas articulated here will have a similar arc.

My thoughts were inspired by two books: *Creatures of Empire: How Domestic Animals Transformed Early America*, by Virginia DeJohn Anderson (Anderson 2004) and *Where There Are Mountains: an Environmental History of the Southern Appalachians* by Donald Edward Davis (Davis 2000). Both books describe systems of livestock management in eastern North America during the 17th century. While the livestock in question was the property of English and Spanish colonists, their cattle-management techniques had an impact on Native American populations in New England, Virginia, and the southern Appalachian Mountains, and on the native fauna as well.

Open-range grazing¹ is a livestock-management strategy in which animals are allowed to roam freely in search of food rather than being controlled, either by human herders

¹ In this essay, the terms “open range” and “free range” grazing will be used interchangeably. Although there may be some technical distinction in modern animal management terminology, historically they are used as synonyms.

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or by fences. In modern cases, humans intervene regularly in the form of round-ups and cattle drives, whereas in historical examples, human intervention was often limited. Open-range systems are often found in settings where a colonizing population introduces livestock to a novel environment, such as in the Spanish and English colonies of North America, where land is effectively unlimited and where labor is scarce. Such conditions would have prevailed in early Neolithic central Europe as well.

Applying a model of open-range grazing to the economy of early Neolithic central Europe may explain a variety of contradictory aspects of the establishment of farm-

ing communities in central Europe. First, it may help provide motivation for the rapid appearance of Linear Pottery communities from Lake Balaton to the Baltic and from Ukraine to the Paris Basin independent of large-scale, directional movements of population. Second, it could provide a context for interaction between indigenous foragers and immigrant farmers that led to the eventual emergence of creole societies during the fifth millennium B.C. Finally, it provides a complement to the compelling model of intensive garden cultivation with an animal-management strategy uses the larger landscape rather than being similarly limited to small pastures.

Early European Farmers and their Animals

The focus in this essay is on the Linear Pottery culture of central Europe, between 5500 and 4900 B.C. In the 1990s, a polarized debate raged between scholars who considered Linear Pottery to represent the simultaneous uptake of crops, livestock, pottery, and longhouses by indigenous foragers and those who clung to the orthodox view that it reflected selective colonization of specific landscape zones by farming populations from the northern edge of southeastern Europe. The past decade has seen ground given by both sides, with “migrationists” admitting the involvement of local hunter-gatherers and “indigenists” accepting some degree of population movement. Recent syntheses (e.g. Rowley-Conwy 2011; Bogucki 2013) reflect the convergence of these positions, or at least a narrowing of the gap.

Investigations in Transdanubia have established that the roots of the Linear Pottery culture lie in interaction between indigenous foragers on the northern side of Lake Balaton and farming communities of the Late Starčevo culture pushing north from the Balkans (Bánffy and Oross 2010). In this Transdanubian crucible, around 5600 BC., foragers and farmers created a new type of Neolithic that was mutually acceptable. From the resulting mixed communities, the Linear Pottery culture emerged and began its complicated process of diaspora north and west through the Danube valley and beyond.

The dramatic transformations in Neolithic economy and society between Mediterranean

and Balkan habitats to the forested valleys of central Europe manifest themselves in several ways. Timber began to be used for major structural elements in houses rather than as reinforcement and roofing for mud-brick or wattle-and daub structures, resulting in the iconic Linear Pottery longhouses, the largest buildings in the world 7500 years ago. Crop use also changed. In the Balkans, the inhabitants of most sites planted a range of cereals and pulses, usually several varieties of each. The crop portfolio of each Linear Pottery community was usually less diversified. College, Conolly, and Shennan (2005) propose that uncertain rainfall patterns in the Mediterranean zone required diversification, whereas more consistent conditions in central Europe permitted concentration on the most productive species in any given locality.

Perhaps the most striking change was seen in the animal economy. The caprines that dominate most Balkan faunal assemblages diminished considerably in Linear Pottery samples, while domestic cattle emerged as the major domestic taxon throughout central Europe. We can be reasonably certain that Linear Pottery cattle were not derived from indigenous European aurochs. Archaeogenetic evidence points toward their derivation from a single domestication event in Anatolia (Edwards *et al.* 2007). While some marginal introgression of DNA from aurochs bulls possibly occurred (Götherstrom *et al.* 2005; Geigl 2008), breeding populations of Linear Pottery cows trace their lineage to

the Near East. Claims for local domestication of aurochs (e.g. Bökönyi 1971) cannot be substantiated.

By the second half of the sixth millennium B.C., the general outline of the Linear Pottery cattle economy had become clearly established. Samples of animal bones across Europe show, with some localized exceptions, a predominance of cattle, relatively few caprines, even fewer pigs, and almost no wild herbivores other than the occasional aurochs. The fact that pigs, wild cattle, and deer appear to have contributed relatively little to the Linear Pottery economy, despite the fact that their sole purpose as meat sources would have resulted in a direct route to the archaeological record, is surprising from a purely functional point of view. Moreover, the interpretation of the faunal assemblages is complicated even further by the fact that cattle were not used only for meat but also for dairy products. The discovery of bovine lipid residues on Linear Pottery ceramics from Kuyavia, including fragments of ceramic sieves (Salque *et al.* 2013), has substantiated conjectures made in the 1980s about the practice of dairying by the first farmers of central Europe as a way to mitigate lactose intolerance (Bogucki 1984).

The shift in the animal economy from caprines to cattle would have required novel adjustments and creativity. The browse and

grazing requirements of the two categories of livestock are sufficiently different to require the accumulation of new landscape knowledge, especially as farmers pushed further and further north and west. Incorporation of indigenous foragers into Linear Pottery communities would have facilitated the acquisition of such knowledge, and trails beaten by the foragers would have promoted the movement of people with cattle.

The question of the character of the central European forests encountered by the Linear Pottery farmers is still open. After the *Steppenheide* theory of the early 20th century (Gradmann 1901; 1933) fell out of favor (Garnett 1945; Firbas 1950), the prevailing orthodoxy has been that the forests of temperate Europe were dense climax tree communities with closed canopies that limited understory vegetation (Iversen 1973). Recently, however, the debate was reopened by Vera (2000), who hypothesized that activities of wild herbivores such as deer and aurochs created a more open park-forest. The Vera hypothesis is controversial and has been subject to criticism (e.g. Mitchell 2005). Kreuz (2008), in her evaluation of the Vera hypothesis, reached a reasonable compromise that although Vera may have overstated his case, it is possible that forests in temperate Europe were more open than hitherto believed.

Models of Neolithic Cattle Management

Linear Pottery cattle management practices have been hypothesized to take one of two forms. The first model involves keeping small herds very close to settlements, grazing on nearby pastures, abandoned fields, or meadows, while the second is generally termed “transhumance” in which cattle are taken some distance from settlements to upland pastures where they stay, under supervision, for a large part of the year. In both cases, the assumption is made, either explicitly or implicitly, that people were continuously aware of where their cattle were grazing and did not let them get too far out of sight.

Bogaard (2004) has proposed that the keeping of cattle close to the Linear Pottery settlements was part of an integrated agricultural system involving intensive garden farming. Cattle grazed on fallow plots and played an important role in maintaining soil fertility

with their manure. By necessity, such herds would have been small and closely-tended. This model is attractive because it does not require the bifurcation of economic activity into an intensive farming sphere and an extensive stock-herding sphere, enabling efficient, compact farming operations around the Linear Pottery settlements

I bear some responsibility for advancing the “transhumance” model when I proposed that Linear Pottery sites in the Polish lowlands were occupied by cattle herders sojourning from permanent settlements in uplands to the south (Bogucki 1982, 120–1). This suggestion was met with a mixture of skepticism and derision. In hindsight, it indeed seems far-fetched. Recently, the suggestion of Linear Pottery transhumance has been revived (Lüning 2000). Isotopic analyses in SW Germany (e.g. Bentley and Knipper 2005) raise

the possibility that Linear Pottery herders took their cattle to upland pastures with different geochemical signatures.

Knipper (2011) has studied the spatial organization of Linear Pottery cattle herding in southwestern Germany using the isotopic analysis of cattle teeth. Her finding was that samples indicating seasonal movement to distant pastures are exceptional, while most data point toward the year-round use of grazing areas closer to settlements. These could be local loess plateaus as at Vaihingen, meadows along nearby streams as at Stuttgart-Mühlhausen, or in different sectors of a heterogeneous geologic substrate as at Hilzingen (Knipper 2011, 364). What seems clear is that Linear Pottery cattle in SW Germany usually remained within areas with consistent geochemical signatures throughout their lives. Knipper believes that her evidence reflects intensive local cattle management, although I would question whether this is the only alternative to seasonal transhumance.

The usual perception of Early Neolithic animal management envisions livestock pastured on cleared fields adjacent to settlements under close supervision. Such an image appears repeatedly in artistic reconstructions of Linear Pottery settlements and is implicit in much of the literature. Occasionally, the notion of Neolithic forest grazing has been raised in the literature (Ellenberg 1954; Bogucki 1982; 1988), and perhaps Neolithic livestock escaped into the forests to be adopted (and eaten) by foragers (Bogucki 1995). As the author of some of these works, I can assure the reader that when I wrote them, I still very much imagined the default Neolithic livestock management system to be one of tight supervision and close control that pre-

vented animals from wandering away from human overseers.

Part of my earlier argument was that there were constraints on how many cattle a Linear Pottery household could manage and how many cattle a settlement catchment could support. I made several estimates (actually, “guesstimates”) of household herd sizes (Bogucki 1982, 107–111; 1988, 87) based on ethnographic analogies (Dyson-Hudson and Dyson-Hudson 1970; Dahl and Hjort 1976) and concerns about how small a herd could sustain loss of animals to disease and predators, ageing, and meat consumption. My conclusion was that Linear Pottery herds needed to be on the order of 30–50 head to be sustainable but that the stocking rate of animals in the forests around the settlements would necessarily have been low. As a result, Linear Pottery farmers were faced with a conflict between having enough cattle to make keeping them a viable economic proposition yet not having so many that they would not be able to keep track of them all in the forests around their settlements. All this made some sense under an overall hypothesis of restricted grazing and tight human control close to settlements.

What if, however, that conception is wrong? What if Linear Pottery livestock, specifically cattle, were allowed to roam freely, with little human supervision? What if Neolithic people did not lie awake nights wondering where their cattle were, knowing that they might be found in predictable locations and that some loss was inevitable and acceptable? What if their cattle multiplied so abundantly in the lush forest undergrowth that they effectively formed feral herds?

A Plausible Alternative: Open-Range Grazing

Let us imagine how open-range grazing would have removed the constraints on herd size and may have made a lot of sense for pioneer farmers interested in rapid expansion of animal populations. It would also account for the disproportionately large number of cattle bones in Linear Pottery faunal assemblages. Somewhere, a large pool of domestic cattle was available for eating.

The notion of open-range grazing is alien to traditional conceptions of prehistor-

ic animal husbandry. Today, it is practiced largely in arid and semi-arid regions such as the American Southwest, where cattle wander among saguaro cactus and chaparral at extremely low stocking rates. Analogy with temperate Europe during the Holocene thermal optimum is utterly improbable. Yet open-range grazing in temperate forests is attested ethnohistorically, and the prime examples come from the British and Spanish colonies of southeastern North America

during the 17th and 18th centuries. In these pioneer animal management systems, cattle roamed freely and were occasionally collected for culling, branding, and other activities before being released again into the wild.

Some of the earliest open-range grazing systems in the New World are known from islands in the Caribbean (Sluyter 2009). Cattle were introduced to Jamaica in 1509 and roamed untended, moving to high ground in the wet season and low ground in dry season. Herds increased faster than people, who became more hunters of cattle than herders. On the island of Barbuda, stone pens were used as traps to capture feral cattle. Even today, hunting cattle is a popular source of supplemental income on Barbuda. As Sluyter (2009, 336) reports, “Since the feral cattle occur in such abundance relative to demand, with estimates ranging from 1500 to 2500 head of cattle compared to the human population of 1325, they effectively comprise unbranded, communal property that the cattle runners sporadically hunt down.”

The Spanish colonial tradition of open-range cattle grazing appears to have been passed northward from the Caribbean Florida via Native American intermediaries (Davis 2000, 75) and via black slaves from Caribbean islands (Sluyter 2009, 347). From there, it was adopted by English colonists of the 17th century in the southern Appalachian mountains and the Carolina piedmont. In southern Appalachia, the first open-range cattle were considered to be game animals by the Cherokees (Davis 2000, 73), who soon learned to fence in their gardens and cornfields. There is evidence that by the mid-18th century, livestock began to displace deer in the southern Appalachians, and many understory plants that were once abundant had become scarce (Davis 2000, 77).

The transition from the English practice of controlled cowkeeping to open-range grazing appears to have been made expediently by colonists in the Chesapeake Bay region during the 17th century. As Anderson (2004, 114) notes, it was easier to allow livestock to find their own food, and the Maryland and Virginia legislatures enacted laws requiring crops to be fenced in, effectively ceding the rest of the landscape to animals. Calves were often penned temporarily to lure dairy cows back to the farmsteads, and some animals were confined on exhausted fields for their

manure, but for the most part, livestock were able to wander freely in the woods.

Let me make a clear distinction between open-range grazing and transhumance. Transhumance is the seasonal movement of animals, under the care of herders, to new pastures and then back again. It is an annual activity, often between highlands and lowlands, along well-defined routes and between well-defined localities. Animals move as a herd or a flock, under human control. Open-range grazing differs from transhumance in that it lacks close human control and does not involve shifting whole herds between locations at specific times of the year. Animals are free to wander, and people do not chase them to bring them back. The actual distances traveled by each animal can vary. Some might remain in grazing groups a short distance from the settlement, while others might roam more widely. At the same time, roaming cattle from other herds could mingle with local cattle.

Conditions under which open-range grazing is practiced generally fit two general criteria: (1) abundant land with grazing resources, and (2) constraints on the labor pool available to the cattle-raising society. In early Neolithic central Europe during the sixth and fifth millennia B.C., land was effectively unlimited from the perspective of the farming communities. It is true that certain prime agricultural habitats, loess-filled basins along secondary and tertiary streams among the hills of central Europe, were not uniformly distributed, and when they were available, farming communities chose to settle in them to be close to their crops. Yet beyond these specific habitats (which do not themselves appear to have been completely saturated with settlement) was abundant territory with lower agricultural potential but with perfectly adequate grazing resources. Open-range grazing would have permitted the Early Neolithic farmers to have the best of both worlds: settlement in prime agricultural locations and the ability to utilize the less-arable hinterlands without permanent settlement.

In 1988, I addressed the question of labor scarcity in Early Neolithic households primarily with regard to cultivation, noting the tension between maximizing population to supply labor and the cost of unproductive members of the household during child-

hood and pregnancy (Bogucki 1988, 119–20). Adding the need to manage cattle would have been an additional burden, particularly during periods of labor bottlenecks such as land clearance and harvest. Labor scarcity would have been the primary limiting factor on a Linear Pottery household, and if cattle management could be minimized in its time-energy budget (Carlstein 1982), more productive effort could be put to cultivation.

One rationale for investing time and energy in maintaining tight control of herds is to prevent losses of animals to predators and thieves. Predators on livestock in the central European environment would have included wild carnivores such as wolves and other humans, including foragers and other farmers. Wolves were present in the European forests, probably in small numbers. Their bones are rarely found on Early Neolithic sites. More consequential would have been hunting by foragers, who were accustomed to encountering the more fearsome aurochs and the more elusive red deer. Docile domestic cattle would have been a gift from heaven. Two factors may be in play, however, to mitigate the effects of such predation. First, the population density of indigenous foragers in the

regions settled by the Linear Pottery farmers during the sixth millennium B.C. is an open question. All indications are that it was low, and thus the encounter rate between hunters and free-ranging livestock may have been correspondingly low. Second, the attractiveness of cattle as a resource may have drawn some of the more daring foragers into closer contact with the farmers, enabling them eventually to “become Neolithic”. In any event, it seems likely that the pool of free-ranging cattle could have been replenished faster than it was depleted by predation.

In colonial examples of open-range grazing, losses to predation and theft do not seem to have been excessive. Rather, it appears that the reproductive rate of cattle was more than adequate to compensate for losses and the mitigation of labor bottlenecks in the human populations was more important than worrying about every last beast. In the end, however, open-range grazing implies a certain relinquishment of control. In the forests of central Europe, once the cattle got loose, there would have been no hope of bringing every last one back to a settlement. Feral cattle may have been the norm rather than the exception.

Is Open-Range Grazing Feasible in Central European Forests?

If the understory vegetation of the forests of temperate Europe was not as dense as hitherto believed, as Vera hypothesized, conditions for grazing may have been good. Such openness would have important ramifications for an open-range system. Visibility would have been better than if the underbrush had remained a thicket of shrubs. The herbivore stocking rate per square kilometer would have been higher, thus enabling more cattle to be grazed within any forest tract. Animals would have been drawn to predictable locations with richer and tastier vegetation growth. These may have been forest glades created through tree falls or Mesolithic burning, or they may have been low-lying meadows and alder carrs along watercourses. Deeper rivers would have restricted overland movement, while smaller streams and ponds would have provided access to water. Interior surface water may actually have been more accessible to cattle than larger streams with

steep banks and denser riparian vegetation. Animals could be tracked through their droppings, grazed areas, and damage to stream banks. Trails along natural corridors would have linked settlements and other frequently-visited areas in the forest, thus facilitating cattle movement.

What about snow? Unlike sub-tropical and arid zone grasslands, it snows heavily in central Europe, thus potentially preventing cattle from finding food in the winter. Clearly this would be a problem, although like predation it may be exaggerated. During the sixth millennium B.C., central Europe was experiencing particularly warm conditions of the post-glacial thermal maximum, perhaps up to 3°C warmer than recent preindustrial levels in some places (Renssen *et al.* 2012). Conditions during the winter may not have been snow-free, but in many areas, they would have been milder. While high mountain ranges and foothills of the Alps and

Carpathians may have had heavy snow cover, many of the loess basins in which Linear Pottery settlements were found might have had relatively light snow that melted quickly. Cattle can graze through up to 50 cm of snow if there is ample ungrazed forage beneath (Decker 1988 cited by Hedtcke *et al.* 2002), and around trees and shrubs the snow cover may have been lighter than in open terrain. Cutting and bringing fodder to stabled cattle would have been another labor bottleneck for the Neolithic household, so leaving animals to fend for themselves in the forests during the winter is compatible with the argument that open-range grazing eases a household's time-energy budget.

How fast would Neolithic cattle have reproduced? We cannot quantify many key metrics, including mean age at first calving, calving interval, average number of calves

per cow, and length of reproductive careers. Dahl and Hjort (1976) present several models for pastoral herd growth in Africa, and it is only with extreme caution can these be applied to agro-pastoral economies in Neolithic central Europe. From these models, we learn that population increases among cattle can proceed at wildly varying rates, depending on calf mortality and how many calves a cow can produce over her career. In a "normal" model, which balances positive and negative factors, the female herd doubles its size after 21.5 years and the number of fertile cows doubles after 24 years (Dahl and Hjort 1976, 64). Even conservatively assuming a potential doubling of their numbers every two human generations, it is likely that free-ranging herds of cattle could stock large forested tracts in central Europe sustainably.

Open-Range Grazing as an Engine of Agricultural Dispersal

The hypothesized practice of open-range grazing does *not* mean that the Linear Pottery farming communities themselves were nomadic. Far from it. While task groups for catching and hunting free-ranging cattle may have traveled far from permanent habitations, Linear Pottery settlements with their longhouses and other evidence of long-term occupation were fixed points in the Neolithic landscape. Linear Pottery communities were sedentary, not mobile, on both annual or decadal time scales, perhaps longer, despite the fact that *individual* households fissioned and relocated with enough frequency to cause the dispersal of Neolithic economic and cultural practices throughout interior central Europe.

Nomadism as an alternative to sedentism is a subject of anthropological fascination. It is practiced in parts of the world where resources are structured such that population movement with livestock is an optimal strategy. Nomadism is correlated with the emergence of the concept of wealth-in-animals in which herds of livestock with clear ownership substitute for the accumulation of durable goods in fixed settlements. It would have been a highly unlikely strategy in the forests, however open, of Neolithic central Europe and is contradicted by abundant archaeological evidence.

In contrast, open-range grazing involves animals moving autonomously in pursuit of attractive grazing, within constraints posed by geography and their individual instincts for aggregation or solitude. Larger rivers would have posed barriers, but thick winter ice and low summer levels would have enabled crossings, perhaps helped by humans or by swimming themselves. Free movement of cattle in forests would have had a random, Brownian quality, with some animals venturing far afield and most remaining within smaller catchments. As herds multiplied in the wildscape, Neolithic farmers may have become aware of new territories where they had not yet settled but to which cattle were gravitating. Thus, wandering cattle may have had an ability to "pull" Neolithic settlers further along to the north and west.

Any human population movement in response to the distribution of feral cattle in Early Neolithic central Europe was not nomadism by any sense of the word but rather the opportunistic pursuit of a naturalized resource. Such human movement may not have routinely involved the relocation of permanent settlements, yet it would have promoted exploration and increasing familiarity with new terrain. Households would have made decisions would to relocate closer to emerging concentrations of feral cattle in

the wildscape to facilitate periodic collection and culling.

In this way, following the feral cattle may have introduced Linear Pottery farmers to new lands beyond those which they had already settled in the Danube basin. Word of mouth information about these regions may have pulled Neolithic farmers through the Moravian Gate and down the valleys of the Oder and the Vistula, for example. Thus, in addition to social factors which may have

pushed along the dispersal of Linear Pottery communities along (discussed in Bogucki 1988), open-range grazing may have added another motivating factor for the spread of farming in central Europe. The Linear Pottery exclaves on the North European Plain in Kuyavia, Ziemia Chełminska, and Ziemia Pyrzycka, as well as the eastward expansion of Linear Pottery into Ukraine and Moldova, are tempting to attribute to open-range cattle movement.

Displacement of Deer and Other Herbivores

Another interesting question is the relationship between intrusive populations of free-ranging domestic cattle and indigenous populations of wild herbivores such as deer and aurochs. Could the cattle have displaced the wild herbivores or pushed them into refugia? Since the demise of the last aurochs in 1627 it has been impossible to study the interaction between wild and domestic cattle, but the literature of wildlife management contains abundant information on how cattle interact with deer.

A large body of literature exists on interaction between domestic cattle and *Cervus elaphus*, known as red deer in Europe and elk in North America (e.g. Stewart *et al.* 2002; Mattiello *et al.* 2002, Wallace and Kraussman 1987; Skovlin *et al.* 1968, Chaikina and Ruckstuhl 2006). Many variables need to be taken into account. Studying deer-cattle interactions in Alpine pastures, Mattiello *et al.* (2002, 304) note that red deer are more alert in the presence of cattle and that proximity to cattle is a source of disturbance to the deer due to the dominance of the larger cattle, but the disturbance is limited and can be tolerated by the deer. In central Arizona ponderosa pine forests, Wallace and Krausman (1987) noted that cattle appear to displace elk at moderate stocking rates. Skovlin *et al.* (1968) observed that red deer tolerate light

stocking levels of cattle but are inhibited by moderate and heavy stocking.

A particularly illuminating study is that of Stewart *et al.* (2002) in forests of NE Oregon and SE Washington states. They note that cattle and elk compete for grazing because both consume mostly graminoidae, but this competition leads to spatial displacement. In other words, cattle and elk (as well as mule deer, *Odocoileus hemionus*, included in the study) try to avoid each other. When cattle were introduced into the range, elk moved to areas of higher elevation and steeper slopes, and cattle did not follow.

A general pattern emerges that as cattle pass a critical threshold of population density on the range, the deer move away into habitats that the cattle avoid, such as higher areas with steeper slopes. The possible implications of this for Neolithic Europe are significant. Very few deer bones are found in Linear Pottery faunal assemblages. One possibility is that the deer had already been displaced by free-ranging cattle in advance of the farming settlement, thus decreasing the opportunities for farmers to hunt them. Deer would have continued to be displaced so long as cattle ranged freely in the forests, possibly resulting in widespread depauperization of cervids throughout large areas of central Europe.

Feral Livestock as an Instrument of Mesolithic Conversion

The establishment of farming communities throughout central Europe would also have included the recruitment of indigenous foragers to the agricultural lifestyle. Elsewhere, I have referred to this process as “entrain-

ment” (Bogucki 2013) as hunter-gatherers, either as individually or collectively, were incorporated over the course of several generations into the Linear Pottery communities. We can imagine the impact that the ap-

pearance of Neolithic cattle in their hunting grounds had on their interest in joining the agricultural revolution.

At the level of the individual animal, the distinction between feral cattle and those ranging freely is academic. We can imagine that indigenous foragers would have regarded Neolithic cattle as another species of large herbivore to be hunted, although behaviorally somewhat more tractable than the aurochs with which they were familiar. The association between the new cattle and the new neighbors would have been quite clear, and conflicts between the Neolithic wish to conserve their cattle for future use and the Mesolithic desire to hunt them as a free resource would have been inevitable. Such conflicts may have been more common than disputes over territory, which mobile foragers would have resolved by moving away from the sedentary farmers. Instead, conflicts would have been negotiated and resolved, either violently or peacefully, with the result being that foragers and farmers could not avoid interaction.

The possibility that free-ranging cattle outran the advance of farming households

across central Europe, and that they also expanded into areas that were not settled outright by farmers, may put the enigmatic La Hoguette and Limburg pottery styles into a new perspective. Contemporaneous with the earliest Linear Pottery in western central Europe, La Hoguette ware is often attributed to terminal Mesolithic populations on the fringes of the Linear Pottery domain (Gronenborn 1999). The suggestion has been advanced that the makers of La Hoguette pottery actually served nearby Linear Pottery communities by taking their cattle up to summer pastures in a transhumant system (Lüning 2002, 114). Perhaps, however, the La Hoguette makers were simply drawn to the Linear Pottery world by the presence of free-ranging livestock. Limburg ware is a later phenomenon that occupies an interstitial niche in Belgium, Holland, and north-eastern France, also possibly an indigenous development. Might free-ranging cattle have been the connection between the people who made these wares and the farmers who made traditional Linear Pottery ceramics?

The Linear Pottery Economy: Garden Farming and Open-Range Grazing

A key question is how the concept of open-range grazing articulates with models of Early Neolithic cultivation. Bogaard (2004), based on the meta-analysis of botanical assemblages, proposed that Linear Pottery cultivation involved intensive garden cultivation of small fixed plots sown in the autumn. Kreuz and Schäfer (2011), however, suggest that .5 ha/person/year would have been needed to meet individual nutritional minima, probably sown in the spring for summer harvest. In their view, a small Linear Pottery settlement would have needed a cultivated area the size of several football fields, more of a park than a garden. Within these dimensions, however, the model of small-scale intensive fixed-plot horticulture with a relatively small impact on the primeval forest is currently the popular working model of the Linear Pottery agricultural landscape.

Bogaard's compelling case for intensive garden cultivation presumes that animal management was similarly concentrated, in order to provide manure to sustain fertility on the

small plots. I do not believe that open-range grazing is necessarily incompatible with intensive fixed-plot horticulture. There is no reason why all the livestock should have ranged freely, and keeping a small household herd on fallow fields would be an excellent way of managing valued animals. If Döhle (1997) is correct that animal traction was used from the beginning of the Neolithic, draft animals would not have been part of the open-range system but rather would have remained close to settlements and fields. Moreover, sheep and goat bones are present in small quantities in Linear Pottery faunal samples and increase in proportion during the following millennium (Bogucki 2008; Bedault and Hachem 2008), and these animals certainly would have contributed ample manure for the small garden plots.

Dairy cows might also have been part of an intensive system. As cows gave birth, their calves could be captured and brought to the settlement, thus luring the lactating mothers. After the calves were weaned, the cows

would be penned for milking. Dry cows could then be released back to the open range to be impregnated again, while retired cows would also be turned loose to put on a few kilograms before their eventual slaughter. If provisioning surplus male cattle were not a major concern, they could also roam freely until being caught and killed.

We can thus hypothesize a complementary relationship between intensive fixed-plot horticulture with manure provided by dairy and draft cattle and small ruminants

on one hand and open-range cattle grazing on the other. Such an arrangement would have made maximum use of the available landscape without necessitating more forest clearance than necessary. It also would have provided some physical separation between the cultivated gardens or fields and the large number of cattle in the forest. Large numbers of cattle grazing closer to settlements would have compounded the difficulty of keeping them away from ripening grain.

Conclusion: Open-Range Grazing and Early Farming

This paper has advanced the proposition that Linear Pottery farmers allowed many cattle to range freely in the forests away from settlements, unconcerned about controlling their movements and confident that most would be found within a predictable area when they needed them. Under these conditions, cattle would have multiplied at such a rate that losses to predators, hunters, disease, and hunger would not have depleted the standing herd. Such a model of open-range grazing would eliminate the worries that I had in the 1980s about the limitations on herd sizes kept by Linear Pottery households. If the human role in stock-herding was dramatically reduced and the amount of territory used for forest grazing increased substantially, then the number of cattle per Linear Pottery household and per person would be relatively unconstrained. Property rights may have been expressed in terms of territory and access to prime grazing rather than by animal headcount, although the emergence of true wealth-in-cattle appears to have been a later development (Bogucki 2011).

Let us imagine the working landscape of the first farmers in central Europe incorporating an open-range grazing system: A Linear Pottery hamlet, a collection of farmsteads, is situated in its typical location along a small stream. Around the settlement is an anthropogenic landscape of gardens and fields, along with pastures and gardens lying fallow on which livestock could be grazed. Paths connect the hamlet with similar settlements up and down the stream as well as outlying garden plots and pastures. Behind this highly modified landscape is the relatively unmodified forest into which trails

lead. Within the forest we find areas that for one reason or another are currently optimal spots for cattle to graze. These may be open glades or simply areas of lush undergrowth. Free-ranging cattle would be drawn, or even directed by people, to these areas, which functioned as reservoirs of livestock. Since the animals are not confined, however, many wander off, simply because that is what cattle do if left to their own devices. Some do not go far, or simply move around within a small area within the forests. Others, however, roam outside the local area, perhaps chancing upon similar prime grazing areas, either not yet in use or otherwise populated by cattle from other settlements. Similarly, cattle from other areas wander in the opposite direction.

The result would be a hinterland of forest in which cattle graze freely. When needed, they can be caught and led back to the settlement, or simply hunted and butchered in the forest. The point is, enough cattle would be in the system that some would always be nearby, particularly in well-known optimal grazing areas. This does not exclude the possibility, even likelihood, of small household herds kept in a higher level of confinement close to the settlement. The confined animals may have been dairy cows and (possibly) draft oxen, whose manure would have been useful in maintaining fertility on fallow garden plots.

This speculative essay does not demand immediate agreement. Future investigations may show it to be inconsistent with emerging data. At the moment, all I ask is for it to be considered when models of Early Neolithic economy in central Europe are developed and refined.

My Intellectual Debt to Janusz Kruk

During the summer of 1975, on my first visit to the PAN bookstore in Pałac Kultury i Nauki in Warsaw, I bought a copy of *Studia osadnicze nad neolitem wyżyn lessowych* because it looked interesting and had “Neolithic” in the title. I sent it home, and a few weeks later, it arrived at Harvard, where I had just begun graduate studies. The following spring, planning to take part in excavations at Brześć Kujawski with Ryszard Grygiel and taking a course in settlement pattern analysis, I started reading it, deliberately trying to master the Polish text rather than relying on the English summary. I could not yet read Polish well, but with the help of a dictionary, I made slow but steady progress. One April

morning I sat in the dining room of Lehman Hall in Harvard Yard and worked through several pages laboriously. It dawned on me that *Studia osadnicze* demonstrated how to address important questions of cultural change and process with the archaeological record of central Europe. I was inspired to study the Polish Neolithic and to find my own set of archaeological challenges with data from Brześć Kujawski, knowing that I was not alone in my interest. Although our paths did not cross in person until 20 years later, Janusz Kruk’s work was continually in my mind as an innovative example of problem-oriented processual archaeology.

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