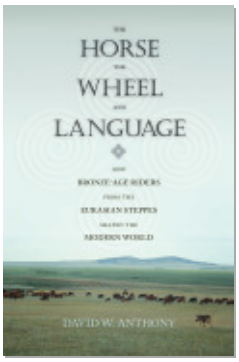
The Horse, the Wheel, and Language

David W. Anthony



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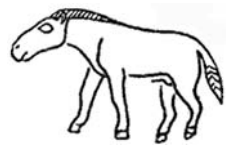
Chapter Four



Language and Time 2
Wool, Wheels, and Proto-Indo-European

If Proto-Indo-European was dead as a spoken language by 2500 BCE, when was it born? Is there a date *after which* Proto-Indo-European must have been spoken? This question can be answered with surprising precision. Two sets of vocabulary terms identify the date after which Proto-Indo-European must have been spoken: words related to woven wool textiles, and to wheels and wagons. Neither woven wool textiles nor wheeled vehicles existed before about 4000 BCE. It is possible that neither existed before about 3500 BCE. Yet Proto-Indo-European speakers spoke regularly about wheeled vehicles and some sort of wool textile. This vocabulary suggests that Proto-Indo-European was spoken after 4000–3500 BCE. As the Proto-Indo-European vocabulary for wheeled vehicles has already been described in chapter 2, let us begin here with the Proto-Indo-European terms for wool.

The Wool Vocabulary

Woven woolen textiles are made from long wool fibers of a type that did not grow on wild sheep. Sheep with long wooly coats are genetic mutants bred just for that trait. If Proto-Indo-European contained words referring unequivocally to woven woolen textiles, then those words had to have entered Proto-Indo-European after the date when wool sheep were developed. But if we are to use the wool vocabulary as a dating tool, we need to know both the exact meaning of the reconstructed roots and the date when wool sheep first appeared. Both issues are problematic.

Proto-Indo-European contained roots that meant "sheep," "ewe," "ram," and "lamb"—a developed vocabulary that undoubtedly indicates familiarity with domesticated sheep. It also had a term that in most daughter cognates meant "wool". The root **HwlHn-* is based on cognates in almost

all branches from Welsh to Indic and including Hittite, so it goes back to the archaic Proto-Indo-European era before the Anatolian branch split away. The stem is unusually long, however, suggesting to Bill Darden of the University of Chicago that it was either borrowed or derived by the addition of the *-n-* suffix from a shorter, older root. He suggested that the shorter root, and the *earliest* form, was **Hwel-* or **Hwol-* (transcribed as **Hw(e/o)l*). Its cognates in Baltic, Slavic, Greek, Germanic, and Armenian meant "felt," "roll," "beat," and "press." "Felt" seems to be the meaning that unites them, since the verbs describe operations in the manufacture of felt. Felt is made by beating or pressing wool fibers until they are pounded into a loose mat. The mat is then rolled up and pressed tightly, unrolled and wetted, then rolled and pressed again, all this repeated until the mat is tight. Wool fibers are curly, and they interlock during this pressing process. The resulting felt textile is quite warm. The winter tents of Eurasian nomads and the winter boots of Russian farmers (made to fit over regular shoes) were traditionally made from felt. If Darden is right, the most ancient Pre-Proto-Indo-European wool root, **Hw(e/o)l-*), was connected with felt. The derivative stem **HwlHn-*, the root retained in both Anatolian and classic Proto-Indo-European, meant "wool" or something made of wool, but we cannot be certain that it referred to a woven wool textile. It could have referred to the short, natural wool that grew on wild sheep or to some kind of felt textile made of short wool.[1]

Sheep (*Ovis orientalis*) were domesticated in the period from about 8000 to 7500 BCE in eastern Anatolia and western Iran as a captive source of meat, which is all they were used for during the first four thousand years of sheepherding. They were covered not with wool but with long, coarse hair called *kemp*. Wool grew on these sheep as an insulating undercoat of very short curly fibers that, in the words of textile specialist Elizabeth Barber, were "structurally unspinnable." This "wild" short wool was molted at the end of the winter. In fact, the annual shedding of short wild wool might have created the first crude (and smelly) felts, when sheep slept on their own damp sheddings. The next step would have been to intentionally pluck the wool when it loosened, just before it was shed. But *woven* wool textiles required wool *thread*.

Wool thread could only be made from unnaturally long wool fibers, as the fibers had to be long enough to cling to each other when pulled apart. A spinner of wool would pull a clump of fibers from a mass of long-fiber wool and twist them into a thread by handfeeding the strand onto a twirling weighted stick, or hand spindle (the spinning wheel was a much later invention). The spindle was suspended in the air and kept twirling with a

motion of the wrist. The spindle weights are called *spindle whorls*, and they are just about the only evidence that survives of ancient thread making, although it is difficult to distinguish spindle whorls used for making woolen thread from those used for making flaxen thread, apparently the oldest kind of thread made by humans. Linen made from flax was the oldest woven textile. Woolen thread was invented only after spinners of flax and other plant fibers began to obtain the longer animal fibers that grew on mutant wool sheep. When did this genetic alteration happen? The conventional wisdom is that wool sheep appeared about 4000–3500 BCE.[2]

In southern Mesopotamia and western Iran, where the first city-based civilizations appeared, woven wool textiles were an important part of the earliest urban economies. Wool absorbed dye much better than linen did, so woolen textiles were much more colorful, and the color could be woven in with differently colored threads rather than stamped on the textile surface (apparently the oldest kind of textile decoration). But almost all the evidence for wool production appears in the Late Uruk period or later, after about 3350 BCE.[3] Because wool itself is rarely preserved, the evidence comes from animal bones. When sheep are raised for their wool, the butchering pattern should show three features: (1) sheep or goats (which differ only in a few bones) or both should make up the majority of the herded animals; (2) sheep, the wool producers, should greatly outnumber goats, the best milk producers; and (3) the sheep should have been butchered at an advanced age, after years of wool production. Susan Pollock's review of the faunal data from eight Uruk-period sites in southern Mesopotamia, northern Mesopotamia, and western Iran showed that the shift to a wool-sheep butchering pattern occurred in this heartland of cities no earlier than the Late Uruk period, after 3350 BCE (figure 4.1). Early and Middle Uruk sheep (4000–3350 BCE) did not show a wool-butchering pattern. This Mesopotamian/western Iranian date for wool sheep was confirmed at Arslantepe on the upper Euphrates in eastern Anatolia. Here, herds were dominated by cattle and goats before 3350 BCE (phase VII), but in the next phase (VIa) Late Uruk pottery appeared, and sheep suddenly rose to first place, with more than half of them living to maturity.[4]

The animal-bone evidence from the Near East suggests that wool sheep appeared after about 3400 BCE. Because sheep were not native to Europe, domesticated Near Eastern sheep were imported to Europe by the first farmers who migrated to Europe from Anatolia about 6500 BCE. But the mutation for longer wool might have appeared as an adaptation to cold winters after domesticated sheep were introduced to northern climates, so

Figure 4.1 Locations of early sites with some evidence for wool sheep. The drawing is from a microscopic image of the oldest known woven wool textile published by N. Shishlina: (1) Uruk; (2) Hacinebi; (3) Arslantepe; (4) Novosvobodnaya; (5) Bronocice; (6) Kétegyháza; (7) Khvalynsk. After Shishlina 1999.

it would not be surprising if the earliest long-wool sheep were bred in Europe. At Khvalynsk, a cemetery dated about 4600–4200 BCE on the middle Volga in Russia, sheep were the principal animal sacrificed in the graves, and most of them were mature, as if being kept alive for wool or milk. But animals chosen for sacrifice might have been kept alive for a ritual reason. At Svobodnoe, a farming settlement in the North Caucasus piedmont in what is now southern Russia, dated between about 4300 and 3700 BCE, sheep were the dominant domesticated animal, and sheep outnumbered goats by 5 to 1. This is a classic wool-sheep harvesting pattern. But at other settlements of the same age in the North Caucasus this pattern is not repeated. A new large breed of sheep appeared in eastern Hungary at Kétegyháza in the Cernavoda III–Boleraz period, dated 3600–3200 BCE, which Sandor Bökönyi suggested was introduced from Anatolia and Mesopotamia; at Bronocice in southern Poland, in levels dated to the same period, sheep greatly outnumbered goats by 20 to 1. But beyond these tan-

talizing cases there was no broad or widespread shift to sheep keeping or to a wool-butchering pattern in Europe until after about 3300–3100 BCE, about the same time it occurred in the Near East.[5]

No actual woven woolen textiles are firmly dated before about 3000 BCE, but they were very widespread by 2800 BCE. A woven woolen textile fragment that might predate 3000 BCE was found in a grave in the North Caucasus Mountains, probably a grave of the Novosvobodnaya culture (although there is some uncertainty about the provenience). The wool fibers were dyed dark brown and beige, and then a red dye was painted on the finished fabric. The Novosvobodnaya culture is dated between 3400 and 3100 BCE, but this fabric has not been directly dated. At Shar-i Sokhta, a Bronze Age semi-urban trading center in east-central Iran, woven woolens were the only kinds of textiles recovered in levels dated 2800–2500 BCE. A woven wool fragment was found at Clairvaux-les-lacs Station III in France, dated 2900 BCE, so wool sheep and woven wool textiles were known from France to central Iran by 2900–2500 BCE.[6]

The preponderance of the evidence suggests that woven wool textiles appeared in Europe, as in the Near East, after about 3300 BCE, although wool sheep may have appeared earlier than this, about 4000 BCE, in the North Caucasus Mountains and perhaps even in the steppes. But if the root **HwlHn-* referred to the short undercoat wool of "natural" sheep, it could have existed before 4000 BCE. This uncertainty in meaning weakens the reliability of the wool vocabulary for dating Proto-Indo-European. The wheeled vehicle vocabulary is different. It refers to very definite objects (wheels, axles), and the earliest wheeled vehicles are very well dated. Unlike wool textiles, wagons required an elaborate set of metal tools (chisels, axes) that preserve well, the images of wagons are easier to categorize, and the wagons themselves preserve more easily than textiles.

The Wheel Vocabulary

Proto-Indo-European contained a set of words referring to wheeled vehicles—wagons or carts or both. We can say with great confidence that wheeled vehicles were not invented until after 4000 BCE; the surviving evidence suggests a date closer to 3500 BCE. Before 4000 BCE there were no wheels or wagons to talk about.

Proto-Indo-European contained at least five terms related to wheels and wagons, as noted in chapter 2: two words for *wheel* (perhaps for different kinds of wheels), one for *axle*, one for *thill* (the pole to which the animals

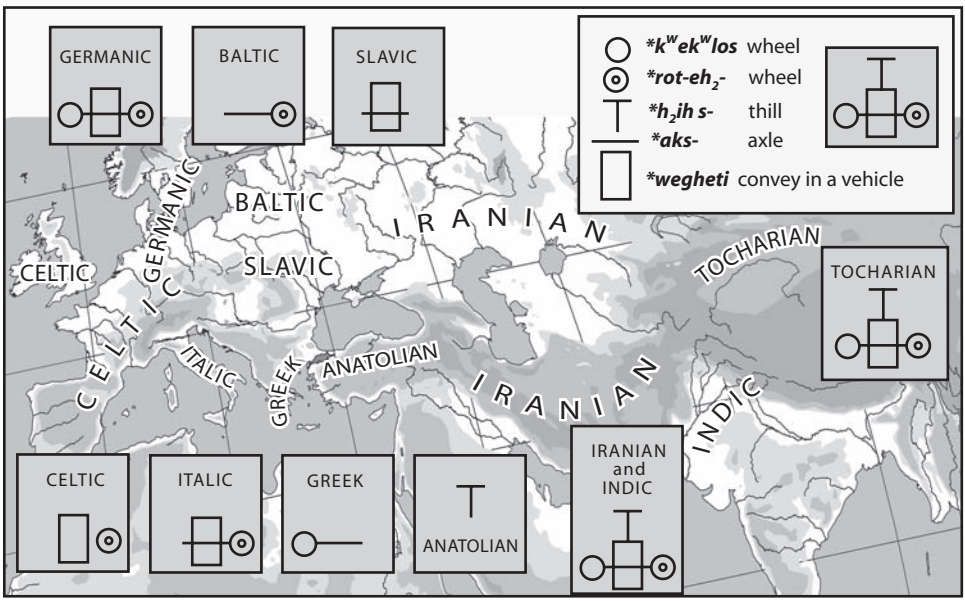


Figure 4.2 The geographic distribution of the Indo-European wheel-wagon vocabulary.

were yoked), and a verb meaning "to go or convey in a vehicle." Cognates for these terms occur in all the major branches of Indo-European, from Celtic in the west to Vedic Sanskrit and Tocharian in the east, and from Baltic in the north to Greek in the south (figure 4.2). Most of the terms have a kind of vowel structure called an o-stem that identifies a late stage in the development of Proto-Indo-European; *axle* was an older n-stem derived from a word that meant "shoulder." The o-stems are important, since they appeared only during the later end of the Proto-Indo-European period. Almost all the terms are derived from Proto-Indo-European roots, so the vocabulary for wagons and wheels was not imported from the outside but was created within the Proto-Indo-European speech community.[7]

The only branch that might *not* contain a convincing wheeled-vehicle vocabulary is Anatolian, as Bill Darden observed. Two possible Proto-Indo-European wheeled-vehicle roots are preserved in Anatolian. One (*hurki-* 'wheel') is thought to be descended from a Proto-Indo-European root, because the same root might have yielded Tocharian A *wärkänt* and Tocharian B *yerkwanto*, both meaning "wheel." Tocharian is an extinct Indo-European branch consisting of two (perhaps three) known languages, called A and B (and perhaps C), recorded in documents written in

about 500–700 CE by Buddhist monks in the desert caravan cities of the Tarim Basin in northwestern China. But Tocharian specialist Don Ringe sees serious difficulties in deriving either Tocharian term from the same root that yielded Anatolian *ḫurki-*, suggesting that the Tocharian and Anatolian terms were unrelated and therefore do not require a Proto-Indo-European root.[8] The other Anatolian vehicle term (*ḫišša-* 'thill' or 'harness-pole') has a good Indo-European source, **ei-/*oi-* or perhaps **h_2ih_3s-*, but its original meaning might have referred to plow shafts rather than wagon shafts. So we cannot be certain that archaic Proto-Indo-European, as partially preserved in Anatolian, had a wheeled-vehicle vocabulary. But the rest of Proto-Indo-European did.

When Was the Wheel Invented?

How do we know that wheeled vehicles did not exist before 4000 BCE? First, a wheeled vehicle required not just wheels but also an axle to hold the vehicle. The wheel, axle, and vehicle together made a complicated combination of load-bearing moving parts. The earliest wagons were planed and chiseled entirely from wood, and the moving parts had to fit precisely. In a wagon with a fixed axle and revolving wheels (apparently the earliest type), the axle arms (the ends of the axle that passed through the center of the wheel) had to fit snugly, but not too snugly, in the hole through the nave, or hub. If the fit was too loose, the wheels would wobble as they turned. If it was too tight, there would be excessive drag on the revolving wheel.

Then there was the problem of the draft—the total weight, with drag, pulled by the animal team. Whereas a sledge could be pulled using traces, or flexible straps and ropes, a wagon or cart had to have a rigid draft pole, or thill, and a rigid yoke. The weight of these elements increased the overall draft. One way to reduce the draft was to reduce the diameter of the axle arms to fit a smaller hole in the wheel. A large-diameter axle was strong but created more friction between the axle arms and the revolving wheel. A smaller-diameter axle arm would cause less drag but would break easily unless the wagon was very narrow. The first wagon-wrights had to calculate the relationship between drag, axle diameter/strength, axle length/rigidity, and the width of the wagon bed. In a work vehicle meant to carry heavy loads, a short axle with small-diameter axle arms and a narrow wagon bed made good engineering sense, and, in fact, this is what the earliest wagons looked like, with a bed only about 1 m wide. Another way to reduce the draft was to reduce the number of wheels from four to two—to make a *wagon* into a *cart*. The draft of a modern two-wheeled

cart is 40% less than a four-wheeled wagon *of the same weight*, and we can assume that an advantage of approximately the same magnitude applied to ancient carts. Carts were lighter and easier to pull, and on rough ground were less likely to get stuck. Large loads probably still needed wagons, but carts would have been useful for smaller loads.[9]

Archaeological and inscriptional evidence for wheeled vehicles is widespread after about 3400 BCE. One uncertain piece of evidence, a track preserved under a barrow grave at Flintbek in northern Germany, might have been made by wheels, and might be as old as 3600 BCE. But the real explosion of evidence begins about 3400 BCE. Wheeled vehicles appeared in four different media dated between about 3400 and 3000 BCE—a written sign for wagons, two-dimensional images of wagons and carts, three-dimensional models of wagons, and preserved wooden wheels and wagon parts themselves. These four independent kinds of evidence appeared across the ancient world between 3400 and 3000 BCE, about the same time as wool sheep, and clearly indicate when wheeled vehicles became widespread. The next four sections discuss the four kinds of evidence.[10]

Mesopotamian Wagons: The Oldest Written Evidence

Clay tablets with "wagon" signs impressed on them were found in the Eanna temple precinct in Uruk, one of the first cities created by humans. About thirty-nine hundred tablets were recovered from level IVa, the end of Late Uruk. In these texts, among the oldest documents in the world, a pictograph (figure 4.3.f) shows a four-wheeled wagon with some kind of canopy or superstructure. The "wagon" sign occurred just three times in thirty-nine hundred texts, whereas the sign for "sledge"—a similar kind of transport, but dragged on runners not rolled on wheels—occurred thirty-eight times. Wagons were not yet common.

The Eanna precinct tablets were inside Temple C when it burned down. Charcoal from the Temple C roof timbers yielded four radiocarbon dates averaging about 3500–3370 BCE. A radiocarbon date tells us when the dated material, in this case wood, died, not when it was burned. The wood in the center of any tree is actually dead (something few people realize); only the outer ring of bark and the sappy wood just beneath it are alive. If the timbers in Temple C were made from the center of a large tree, the wood might have died a century or two before the building was burned down, so the actual age of the Temple C tablets is later than the radiocarbon date, perhaps 3300–3100 BCE. Sledges still were far more common

than wagons in the city of Uruk at that date. Ox-drawn canopied sledges might have preceded canopied wagons as a form of transport (in parades or processions? harvest rituals?) used by city officials.

A circular clay object that *might* be a model wheel, perhaps from a small ceramic model of a wagon, was found at the site of Arslantepe in eastern Turkey, in the ruins of a temple-palace from level VIa at the site, also dated 3400–3100 BCE (figure 4.3.c). Arslantepe was one of a string of native strongholds along the upper Euphrates River in eastern Anatolia that entered into close relations with faraway Uruk during the Late Uruk period. Although the kind of activities that lay behind this "Uruk expansion" northward up the Euphrates valley is not known (see chapter 12), the possible clay wheel model at Arslantepe *could* indicate that wagons were being used in eastern Anatolia during the period of Late Uruk influence.

Wagons and Carts from the Rhine to the Volga: The Oldest Pictorial Evidence

A two-dimensional image that seems to portray a four-wheeled wagon, harness pole, and yoke was incised on the surface of a decorated clay mug of the Trichterbecker (TRB) culture found at the settlement of Bronocice in southern Poland, dated about 3500–3350 BCE (figure 4.3.b). The TRB culture is recognized by its distinctive pottery shapes and tombs, which are found over a broad region in modern Poland, eastern Germany, and southern Denmark. Most TRB people were simple farmers who lived in small agricultural villages, but the Bronocice settlement was unusually large, a TRB town covering fifty-two hectares. The cup or mug with the wagon image incised on its surface was found in a rubbish pit containing animal bones, the broken sherds of five clay vessels, and flint tools. Only this cup had a wagon image. The design is unusual for TRB pottery, not an accidental combination of normal decorative motifs. The cup's date is the subject of some disagreement. A cattle bone found in the same pit yielded an average age of about 3500 BCE, whereas six of the seven other radiocarbon dates for the settlement around the pit average 150 years later, about 3350 BCE. The excavators accept an age range spanning these results, about 3500–3350 BCE. The Bronocice wagon image is the oldest well-dated image of a wheeled vehicle in the world.

Two other images could be about the same age, although they probably are somewhat later. An image of two large-horned cattle pulling what seems to be a two-wheeled cart was scratched on the wall of a Wartberg culture stone tomb at Lohne-Züschen I, Hesse, central Germany (figure 4.3.e). The

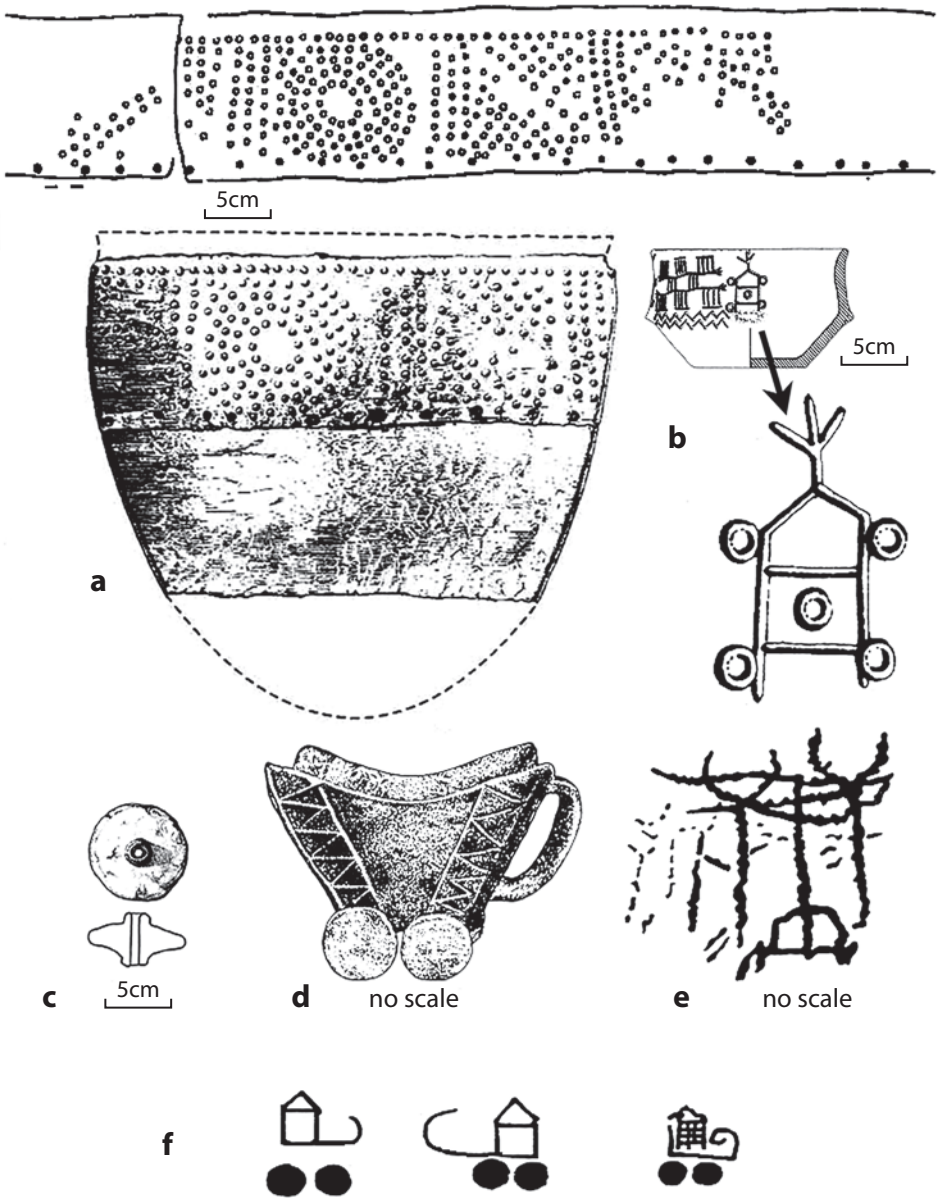


Figure 4.3 The oldest images and models of wagons and wheels: (a) bronze kettle from Evdik kurgan, lower Volga, Russia, with a design that could represent, from the left, a yoke, cart, wheel, X-braced floor, and animal head; (b) image of a four-wheeled wagon on a ceramic vessel from Bronocice, southern Poland; (c) ceramic wheel (from a clay model?) at Arslantepe, eastern Anatolia; (d) ceramic wagon model from Baden grave 177 at Budakalász,

grave was reused over a long period of time between about 3400 and 2800 BCE, so the image could have been carved any time in that span. Far away to the east, a metal cauldron from the Evdik kurgan near the mouth of the Volga River bears a repoussé image that might show a yoke, a wheel, a cart, and a draft animal; it was found in a grave with objects of the Novosvobodnaya culture, dated between 3500 and 3100 BCE (figure 4.3.a). These images of carts and wagons are distributed from central Germany through southern Poland to the Russian steppes.

Hungarian Wagons: The Oldest Clay Models

The Baden culture is recognized by its pottery and to a certain extent by its distinctive copper tools, weapons, and ornaments. It appeared in Hungary about 3500 BCE, and the styles that define it then spread into northern Serbia, western Romania, Slovakia, Moravia, and southern Poland. Baden-style polished and channeled ceramic mugs and small pots were used across southeastern Europe about 3500–3000 BCE. Similarities between Baden ceramics and those of northwestern Anatolia in the centuries before Troy I suggest one route by which wheeled vehicles could have spread between Mesopotamia and Europe. Three-dimensional ceramic models of four-wheeled wagons (figure 4.3.d) were included in sacrificial deposits associated with two graves of the Late Baden (Pécel) culture at Budakalász (Grave 177) and Szigetszentmárton in eastern Hungary, dated about 3300–3100 BCE. Paired oxen, almost certainly a team, were found sacrificed in Grave 3 at Budakalász and in other Late Baden graves in Hungary. Paired oxen also were placed in graves of the partly contemporary Globular Amphorae culture (3200–2700 BCE) in central and southern Poland. The Baden wagon models are the oldest well-dated three-dimensional models of wheeled vehicles.

Steppe and Bog Vehicles: The Oldest Actual Wagons

Remains of about 250 wagons and carts have been discovered under earthen burial mounds, or kurgans, in the steppe grasslands of Russia and Ukraine, dated about 3000–2000 BCE (figures 4.4 and 4.5). The wheels

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Figure 4.3 (*continued*) Hungary; (e) cart image with two cattle incised on stone, from a tomb at Lohne-Züschen I, Hesse, central Germany; (f) earliest written symbols for a wagon, on clay tablets from Uruk IVa, southern Iraq. After (a) Shilov and Bagautdinov 1997; (b, d, e) Milisauskas 2002; (c,f) Bakker et al. 1999.

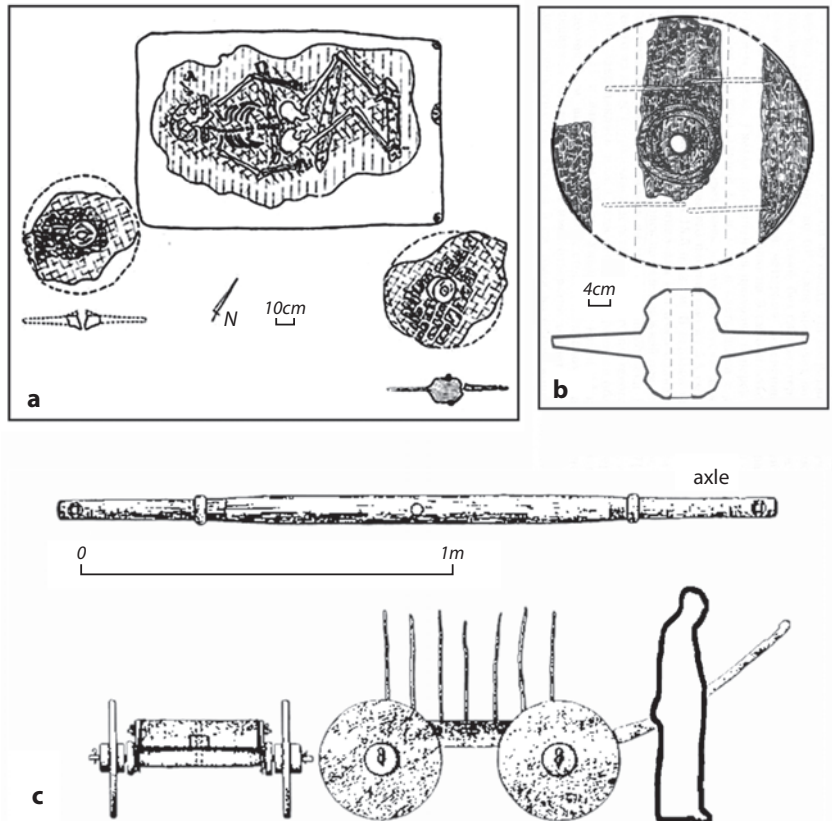

Figure 4.4 Preserved wagon parts and wheels: (a) two solid wooden wheels at the corners of grave 57, Bal'ki kurgan, Ukraine, radiocarbon dated 3330–2900 BCE; (b) Catacomb-culture tripartite wheel with dowels, probably 2600–2200 BCE; (c) preserved axle and reconstructed wagon from various preserved wheel and wagon fragments in bog deposits in northwestern Germany and Denmark dated about 3000–2800 BCE. After (a) Lyashko and Otroshchenko 1988; (b) Korpusova and Lyashko 1990; (c) Hayen 1989.

were 50–80 cm in diameter. Some were made of a single plank cut vertically from the trunk of a tree, with the grain (not like a salami). Most steppe wheels, however, were made of two or three planks cut into circular segments and then doweled together with mortice-and-tenon joints. In the center were long tapered naves (hubs), about 20–30 cm wide at the base and projecting outward about 10–20 cm on either side of the wheel. The naves were secured to the axle arms by a lynchpin that pinned the

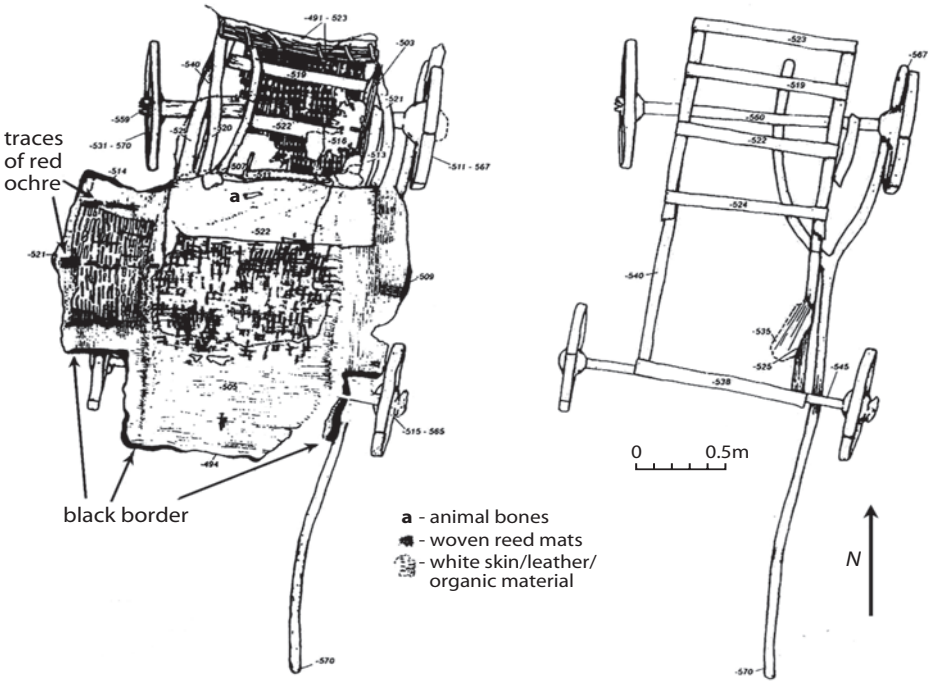

Figure 4.5 The best-preserved wagon graves in the steppes are in the Kuban River region in southern Russia. This wagon was buried under Ostannii kurgan 1. Radiocarbon dated about 3300–2900 BCE, the upper part of the wagon is on the left and the lower part, on the right. After Gei 2000, figure 53.

nave to the axle, and between them they kept the wheel from wobbling. The axles had rounded axle arms for the wheel mounts and were about 2 m long. The wagons themselves were about 1 m wide and about 2 m long. The earliest radiocarbon dates on wood from steppe wagons average around 3300–2800 BCE. A wagon or cart grave at Bal'ki kurgan (grave 57) on the lower Dnieper was dated 4370±120 BP, or 3330–2880 BCE; and wood from a wagon buried in Ostanni kurgan 1 (grave 160) on the Kuban River was dated 4440 ± 40 BP, or 3320–2930 BCE. The probability distributions for both dates lie predominantly before 3000 BCE, so both vehicles probably date before 3000 BCE. But these funeral vehicles can hardly have been the very first wagons used in the steppes.

Other wooden wheels and axles have been discovered preserved in bogs or lakes in central and northern Europe. In the mountains of Switzerland and southwestern Germany wagon-wrights made the axle arms square and

mortised them into a square hole in the wheel. The middle of the axle was circular and revolved under the wagon. This revolving-axle design created more drag and was less efficient than the revolving-wheel design, but it did not require carving large wooden naves and so the Alpine wheels were much easier to make. One found near Zurich in a waterlogged settlement of the Horgen culture (the Pressehaus site) was dated about 3200 BCE by associated tree-ring dates. The Pressehaus wheel tells us that separate regional European design traditions for wheel making already existed before 3200 BCE. Wooden wheels and axles also have been found in bogs in the Netherlands and Denmark, providing important evidence on the construction details of early wagons, but dated after 3000 BCE. They had fixed axles and revolving wheels, like those of the steppes and central Europe.

The Significance of the Wheel

It would be difficult to exaggerate the social and economic importance of the first wheeled transport. Before wheeled vehicles were invented, really heavy things could be moved efficiently only on water, using barges or rafts, or by organizing a large hauling group on land. Some of the heavier items that prehistoric, temperate European farmers had to haul across land all the time included harvested grain crops, hay crops, manure for fertilizer, firewood, building lumber, clay for pottery making, hides and leather, and people. In northern and western Europe, some Neolithic communities celebrated their hauling capacities by moving gigantic stones to make megalithic community tombs and stone henges; other communities hauled earth, making massive earthworks. These constructions demonstrated in a visible, permanent way the solidity and strength of the communities that made them, which depended in many ways on human hauling capacities. The importance and significance of the village community as a group transport device changed profoundly with the introduction of wagons, which passed on the burden of hauling to animals and machines, where it has remained ever since.

Although the earliest wagons were slow and clumsy, and probably required teams of specially trained oxen, they permitted single families to carry manure out to the fields and to bring firewood, supplies, crops, and people back home. This reduced the need for cooperative communal labor and made single-family farms viable. Perhaps wagons contributed to the disappearance of large nucleated villages and the dispersal of many farming populations across the European landscape after about 3500 BCE. Wagons were useful in a different way in the open grasslands of the steppes, where

the economy depended more on herding than on agriculture. Here wagons made portable things that had never been portable in bulk—shelter, water, and food. Herders who had always lived in the forested river valleys and grazed their herds timidly on the edges of the steppes now could take their tents, water, and food supplies to distant pastures far from the river valleys. The wagon was a mobile home that permitted herders to follow their animals deep into the grasslands and live in the open. Again, this permitted the dispersal of communities, in this case across interior steppes that earlier had been almost useless economically. Significant wealth and power could be extracted from larger herds spread over larger pastures.

Andrew Sherratt bundled the invention of the wheel together with the invention of the plow, wool sheep, dairying, and the beginning of horse transport to explain a sweeping set of changes that occurred among European societies about 3500–3000 BCE. The Secondary Products Revolution (now often shortened to SPR), as Sherratt described it in 1981, was an economic explanation for widespread changes in settlement patterns, economy, rituals, and crafts, many of which had been ascribed by an older generation of archaeologists to Indo-European migrations. ("Secondary products" are items like wool, milk, and muscular power that can be harvested continuously from an animal without killing it, in contrast to "primary products" such as meat, blood, bone, and hides.) Much of the subject matter discussed in arguments over the SPR—the diffusion of wagons, horseback riding, and wool sheep—was also central in discussions of Indo-European expansions, but, in Sherratt's view, all of them were derived by diffusion from the civilizations of the Near East rather than from Indo-Europeans. Indo-European languages were no longer central or even necessary to the argument, to the great relief of many archaeologists. But Sherrat's proposal that all these innovations came from the Near East and entered Europe at about the same time quickly fell apart. Scratch-plows and dairying appeared in Europe long before 3500 BCE, and horse domestication was a local event in the steppes. An important fragment of the SPR survives in the conjoined diffusion of wool sheep and wagons across much of the ancient Near East and Europe between 3500 and 3000 BCE, but we do not know where either of these innovations started.[11]

The clearest proof of the wheel's impact was the speed with which wagon technology spread (figure 4.6), so rapidly, in fact, that we cannot even say where the wheel-and-axle principle was invented. Most specialists assume that the earliest wagons were produced in Mesopotamia, which was urban and therefore more sophisticated than the tribal societies of Europe; indeed, Mesopotamia had sledges that served as prototypes. But we

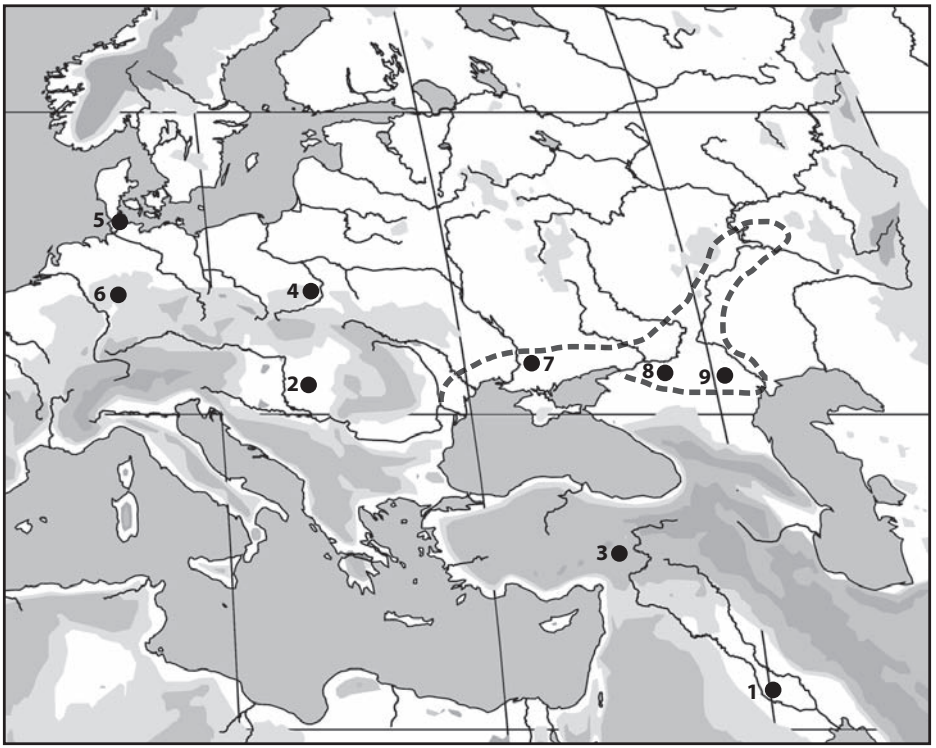

Figure 4.6 Sites with early evidence for wheels or wagons: (1) Uruk; (2) Budakalasz; (3) Arslantepe; (4) Bronicice; (5) Flintbek; (6) Lohne-Zuschen I; (7) Bal'ki kurgan; (8) Ostannii kurgan; (9) Evdik kurgan. Dashed line indicates the distribution of about 250 wagon graves in the Pontic-Caspian steppes.

really don't know. Another prototype existed in Europe in the form of Mesolithic and Neolithic bent-wood sleds, doweled together with fine mortice-and-tenon joints; in much of eastern Europe, in fact, right up to the twentieth century, it made sense to park your wagon or carriage in the barn for the winter and resort to sleds, far more effective than wheels in snow and ice. Bent-wood sleds were at least as useful in prehistoric Europe as in Mesopotamia, and they began to appear in northern Europe as early as the Mesolithic; thus the skills needed to make wheels and axles existed in both Europe and the Near East.[12]

Regardless of where the wheel-and-axle principle was invented, the technology spread rapidly over much of Europe and the Near East between 3400 and 3000 BCE. Proto-Indo-European speakers talked about wagons and wheels using their own words, created from Indo-European

roots. Most of these words were o-stems, a relatively late development in Proto-Indo-European phonology. The wagon vocabulary shows that late Proto-Indo-European was spoken certainly after 4000 BCE, and probably after 3500 BCE. Anatolian is the only major early Indo-European branch that has a doubtful wheeled-vehicle vocabulary. As Bill Darden suggested, perhaps Pre-Anatolian split away from the archaic Proto-Indo-European dialects before wagons appeared in the Proto-Indo-European homeland. Pre-Anatolian could have been spoken before 4000 BCE. Late Proto-Indo-European, including the full wagon vocabulary, probably was spoken after 3500 BCE.

Wagons and the Anatolian Homeland Hypothesis

The wagon vocabulary is a key to resolving the debate about the place and time of the Proto-Indo-European homeland. The principal alternative to a homeland in the steppes dated 4000–3500 BCE is a homeland in Anatolia and the Aegean dated 7000–6500 BCE. Colin Renfrew proposed that Indo-Hittite (Pre-Proto-Indo-European) was spoken by the first farmers in southern and western Anatolia at sites such as Çatal Höyük dated about 7000 BCE. In his scenario, a dialect of Indo-Hittite was carried to Greece with the first farming economy by pioneer farmers from Anatolia about 6700–6500 BCE. In Greece, the language of the pioneer farmers developed into Proto-Indo-European and spread through Europe and the Mediterranean Basin with the expansion of the earliest agricultural economy. By linking the dispersal of the Indo-European languages with the diffusion of the first farming economy, Renfrew achieved an appealingly elegant solution to the problem of Indo-European origins. Since 1987 he and others have shown convincingly that the migrations of pioneer farmers were one of the principal vectors for the spread of many ancient languages around the world. The "first-farming/language-dispersal" hypothesis, therefore, was embraced by many archaeologists. But it required that the first split between parental Indo-Hittite and Proto-Indo-European began about 6700–6500 BCE, when Anatolian farmers first migrated to Greece. By 3500 BCE, the earliest date for wagons in Europe, the Indo-European language family should have been bushy, multi-branched, and three thousand years old, well past the period of sharing a common vocabulary for anything.[13]

The Anatolian—origin hypothesis raises other problems as well. The first Neolithic farmers of Anatolia are thought to have migrated there from northern Syria, which, according to Renfrew's first-farming/

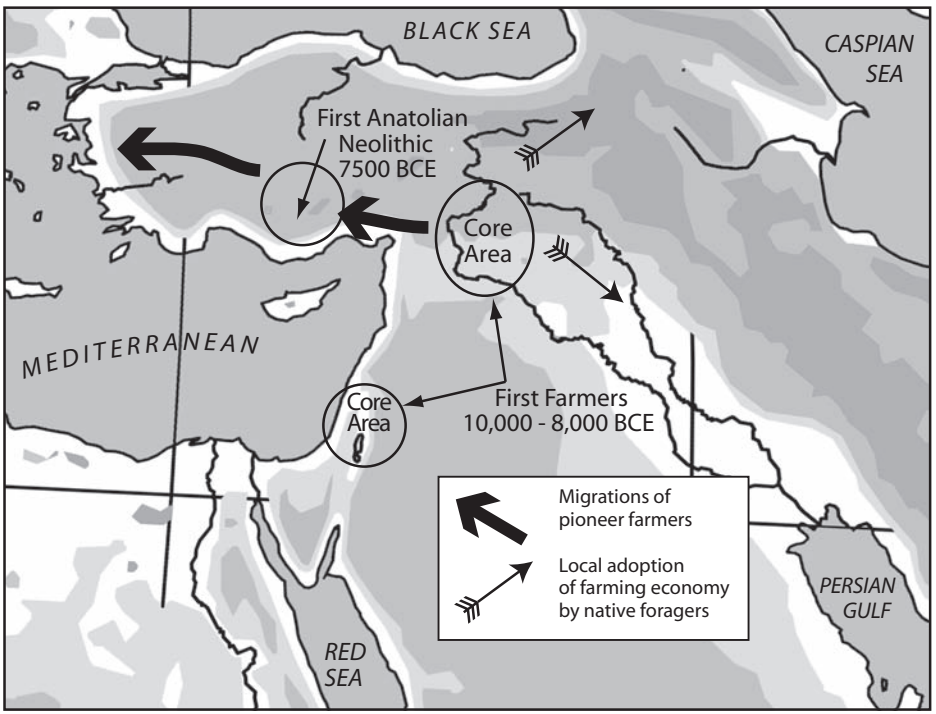

Figure 4.7 The spread of the first farming economy into Anatolia, probably by migration from the Core Area in northern Syria, about 7500 BCE. The first pioneer farmers probably spoke an Afro-Asiatic language. After Bar-Yosef 2002.

language-dispersal hypothesis, should have resulted in the spread of a north Syrian Neolithic language to Anatolia (figure 4.7). The indigenous languages of northern Syria probably belonged to the Afro-Asiatic language phylum, like Semitic and most languages of the lowland Near East. If the first Anatolian farmers spoke an Afro-Asiatic language, it was that language, not Proto-Indo-European, that should have been carried to Greece.[14] The earliest Indo-European languages documented in Anatolia—Hittite, Palaic, and Luwian—showed little diversity, and only Luwian had a significant number of speakers by 1500 BCE. All three borrowed extensively from non–Indo-European languages (Hattic, Hurrian, and perhaps others) that seem to have been older, more prestigious, and more widely spoken. The Indo-European languages of Anatolia did not have the established population base of speakers, and also lacked the kind of diversity that would be expected had they been evolving there since the Neolithic.

Phylogenetic Approaches to Dating Proto-Indo-European

Still, the Anatolian-origin hypothesis has support from new methods in phylogenetic linguistics. Cladistic methods borrowed from biology have been used for two purposes: to arrange the Indo-European languages in a chronological *order* of branching events (discussed in the previous chapter); and to estimate *dates* for the separation between any two branches, or for the root of all branches which is a much riskier proposition. Attaching time estimates to language branches using evolutionary models based on biological change is, at best, an uncertain procedure. People intentionally reshape their speech all the time but cannot intentionally reshape their genes. The way a linguistic innovation is reproduced in a speech community is quite different from the way a mutation is reproduced in a breeding population. The topography of language splits and rejoinings is much more complex and the speed of language branching far more variable. Whereas genes spread as whole units, the spread of language is always a *modular process*, and some modules (grammar and phonology) are more resistant to borrowing and spread than others (words).

Russell Gray and Quentin Atkinson attempted to work around these problems by processing a cocktail of cladistic and linguistic methods through computer programs. They suggested that pre-Anatolian detached from the rest of the Indo-European community about 6700 BCE (plus or minus twelve hundred years). Pre-Tocharian separated next (about 5900 BCE), then pre-Greek/Armenian (about 5300 BCE), and then pre–Indo-Iranian/Albanian (about 4900 BCE). Finally, a super-clade that included the ancestors of pre–Balto-Slavic and pre–Italo-Celto-Germanic separated about 4500 BCE. Archaeology shows that 6700–6500 BCE was about when the first pioneer farmers left Anatolia to colonize Greece. One could hardly ask for a closer match between archaeological and phylogentic dates.[15] But how can the presence of the wagon vocabulary in Proto-Indo-European be synchronized with a first-dispersal date of 6500 BCE?

The Slow Evolution Hypothesis

The wagon vocabulary cannot have been created *after* Proto-Indo-European was dead and the daughter languages differentiated. The wagon/wheel terms do not contain the sounds that would be expected had they been created in a later daughter language and then borrowed into the others, whereas they do contain the sounds predicted if they were inherited into the daughter

branches from Proto-Indo-European. The Proto-Indo-European origin of the wagon vocabulary cannot be rejected, as it consists of at least five classic reconstructions. If they are in fact false, then the core methods of comparative linguistics—those that determine "genetic" relatedness—would be so unreliable as to be useless, and the question of Indo-European origins would be moot.

But could the wagon/wheel vocabularies have been created *independently* by the speakers of each branch from the same Proto-Indo-European roots? In the example of **k^{w}ek^{w}los* 'wheel', Gray suggested (in a comment on his homepage) that the semantic development from the verb **kwel-* 'turn' to the noun *wheel* 'the turner' was so natural that it could have been repeated independently in each branch. One difficulty here is that at least four different verbs meaning "turn" or "roll" or "revolve" are reconstructed for Proto-Indo-European, which makes the repeated independent choice of **kwel-* problematic.[16] More critical, the Proto-Indo-European pronunciations of **kwel-* and the other wagon terms would not have survived unchanged through time. They could not have been available frozen in their Proto-Indo-European phonetic forms to speakers of nine or ten branches that originated at different times across thousands of years. We cannot assume stasis in phonetic development for the wheel vocabulary when all the rest of the vocabulary changed normally with time. But what if all the other vocabulary also changed very slowly?

This is the solution Renfrew offered (figure 4.8). For the wagon/wheel vocabulary to be brought into synchronization with the first-farming/language-dispersal hypothesis, Proto-Indo-European must have been spoken for thirty-five hundred years, requiring a very long period when Proto-Indo-European changed very little. Pre-Proto-Indo-European or Indo-Hittite was spoken in Anatolia before 6500 BCE. Archaic Proto-Indo-European evolved as the language of the pioneer farmers in Greece about 6500–6000 BCE. As their descendants migrated northward and westward, and established widely scattered Neolithic communities from Bulgaria to Hungary and Ukraine, the language they carried remained a single language, Archaic Proto-Indo-European. Their descendants paused for several centuries, and then a second wave of pioneer migration pushed across the Carpathians into the North European plain between about 5500 and 5000 BCE with the Linear Pottery farmers. These farming migrations created Renfrew's Stage 1 of Proto-Indo-European, which was spoken across most of Europe between 6500 and 5000 BCE, from the Rhine to the Dnieper and from Germany to Greece. During Renfrew's Proto-Indo-European Stage 2, between 5000 and 3000 BCE, archaic Proto-Indo-European spread into the steppes

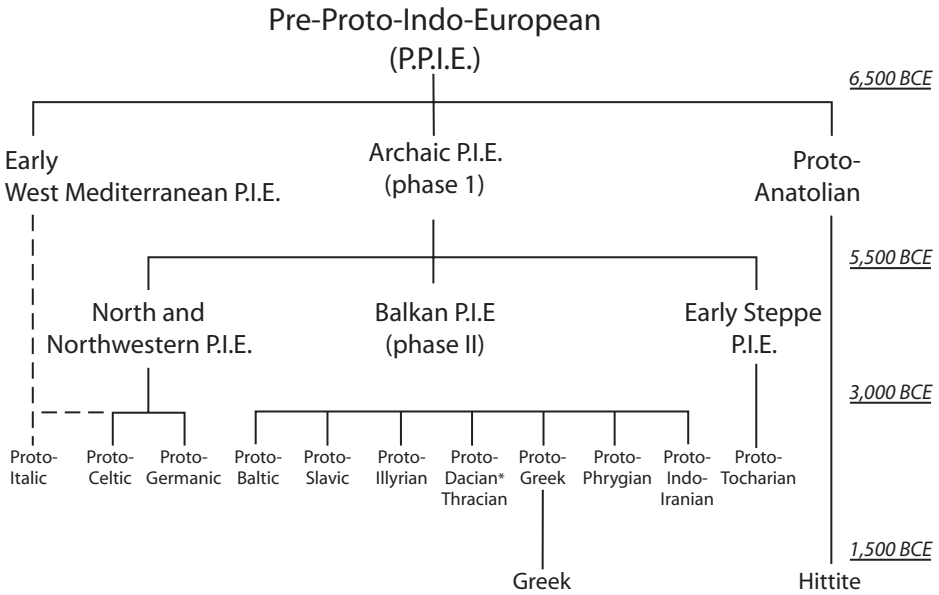

Figure 4.8 If Proto-Indo-European spread across Europe with the first farmers about 6500–5500 BCE, it must have remained almost unchanged until about 3500 BCE, when the wheeled vehicle vocabulary appeared. This diagram illustrates a division into just three dialects in three thousand years. After Renfrew 2001.

and was carried to the Volga with the adoption of herding economies. Late Proto-Indo-European dialectical features developed, including the appearance of "thematic" inflections such as o-stems, which occur in all the wagon/wheel terms. These late features were shared across the Proto-Indo-European–speaking region, which comprised two-thirds of prehistoric Europe. The wagon vocabulary appeared late in Stage 2 and was adopted from the Rhine to the Volga.[17]

It seems to me that this conception of Proto-Indo-European contains three fatal flaws. First, for Proto-Indo-European to have remained a unified dialect chain for more than thirty-five hundred years, from 6500 to 3000 BCE, would require that all its dialects changed at about the same rate and that the rate was extraordinarily slow. A *homogeneous rate of change* across most of Neolithic Europe is very unlikely, as the rate of language change is affected by a host of local factors, as Sheila Embleton showed, and these would have varied from one region to the next. And for Proto-Indo-European only to have evolved from its earlier form to its later form

in thirty-five hundred years would require a pan-European condition of near stasis in the speed of language change during the Neolithic/Eneolithic, a truly unrealistic demand. In addition, Neolithic Europe evinces an almost incredible *diversity in material culture*. "This bewildering diversity," as V. Gordon Childe observed, "though embarrassing to the student and confusing on a map, is yet a significant feature in the pattern of European prehistory."[18] Long-established, undisturbed tribal languages tend to be *more* varied than tribal material cultures (see chapter 6). One would therefore expect that the linguistic diversity of Neolithic/Eneolithic Europe should have been even more bewildering than its material-culture diversity, not less so, and certainly not markedly less.

Finally, this enormous area was just too big for the survival of a single language under the conditions of tribal economics and politics, with foot travel the only means of land transport. Mallory and I discussed the likely scale of tribal language territories in Neolithic/Eneolithic Europe, and Nettles described tribal language geographies in West Africa.[19] Most tribal cultivators in West Africa spoke languages distributed over less than 10,000 km^2. Foragers around the world generally had much larger language territories than farmers had, and shifting farmers in poor environments had larger language territories than intensive farmers had in rich environments. Among most tribal farmers the documented size of language *families*—not languages but language families like Indo-European or Uralic—has usually been significantly less than 200,000 km^2. Mallory used an average of 250,000–500,000 km^2 for Neolithic European language families just to make room on the large end for the many uncertainties involved. Still, that resulted in twenty to forty language families for Neolithic Europe.

The actual number of language families in Europe at 3500 BCE probably was less than this, as the farming economy had been introduced into Neolithic Europe through a series of migrations that began about 6500 BCE. The dynamics of long-distance migration, particularly among pioneer farmers, *can* lead to the rapid spread of an unusually homogeneous language over an unusually large area for a few centuries (see chapter 6), but then local differentiation should have set in. In Neolithic Europe several distinct migrations flowed from different demographic recruiting pools and went to different places, where they interacted with different Mesolithic forager language groups. This should have produced incipient language differentiation among the immigrant farmers within five hundred to a thousand years, by 6000–5500 BCE. In comparison, the migrations of Bantu-speaking cattle herders across central and southern Africa

occurred about two thousand years ago, and Proto-Bantu has diversified since then into more than five hundred modern Bantu languages assigned to nineteen branches, still interspersed today with enclaves belonging to non-Bantu language families. Europe in 3500 BCE, two thousand to three thousand years after the initial farming migrations, probably had at least the linguistic diversity of modern central and southern Africa—hundreds of languages that were descended from the original Neolithic farmers' speech, interspersed with pre-Neolithic language families of different types. The language of the original migrants to Greece cannot have remained a single language for three thousand years after its speakers were dispersed over many millions of square kilometers and several climate zones. Ethnographic or historic examples of such a large, stable language territory among tribal farmers simply do not exist.

That the speakers of Proto-Indo-European had wagons and a wagon vocabulary cannot be brought into agreement with a dispersal date as early as 6500 BCE. The wagon vocabulary is incompatible with the first-farming/language-dispersal hypothesis. Proto-Indo-European cannot have been spoken in Neolithic Greece and still have existed three thousand years later when wagons were invented. Proto-Indo-European therefore did not spread with the farming economy. Its first dispersal occurred much later, after 4000 BCE, in a European landscape that was already densely occupied by people who probably spoke hundreds of languages.

The Birth and Death of Proto-Indo-European

The historically known early Indo-European languages set one chronological limit on Proto-Indo-European, a *terminus ante quem*, and the reconstructed vocabulary related to wool and wheels sets another limit, a *terminus post quem*. The latest possible date for Proto-Indo-European can be set at about 2500 BCE (chapter 3). The evidence of the wool and wagon/wheel vocabularies establishes that late Proto-Indo-European was spoken after about 4000–3500 BCE, probably after 3500 BCE. If we include in our definition of Proto-Indo-European the end of the archaic Anatolian-like stage, without a securely documented wheeled-vehicle vocabulary, and the dialects spoken at the beginning of the final dispersal about 2500 BCE, the maximum window extends from about 4500 to about 2500 BCE. This two thousand-year target guides us to a well-defined archaeological era.

Within this time frame the archaeology of the Indo-European homeland is probably consistent with the following sequence, which makes

sense also in terms of both traditional branching studies and cladistics. Archaic Proto-Indo-European (partly preserved only in Anatolian) probably was spoken before 4000 BCE; early Proto-Indo-European (partly preserved in Tocharian) was spoken between 4000 and 3500 BCE; and late Proto-Indo-European (the source of Italic and Celtic with the wagon/wheel vocabulary) was spoken about 3500–3000 BCE. Pre-Germanic split away from the western edge of late Proto-Indo-European dialects about 3300 BCE, and Pre-Greek split away about 2500 BCE, probably from a different set of dialects. Pre-Baltic split away from Pre-Slavic and other northwestern dialects about 2500 BCE. Pre-Indo-Iranian developed from a northeastern set of dialects between 2500 and 2200 BCE.

Now that the target is fixed in time, we can solve the old and bitter debate about *where* Proto-Indo-European was spoken.