

An analysis of linguistic origins provides relevant archaeological data. For instance, speakers of the proto-Indo-European (PIE) language were believed to be familiar with wheeled vehicles since they used at least six terms to refer to them. By analyzing the origins and evolution of the PIE language, it can be concluded that the PIE language community could not have occupied an area larger than about 500,000-750,000 sq. km. Furthermore, language borrowing among PIE, proto-Caucasian and proto-Uralic speakers was possible. Based on the analysis of the PIE language, the clearest European boundary from 5,000-3,500 BC was the Dnieper River in Ukraine.

The current relationship between archaeology and traditional historical linguistics can be described as a trial separation. In recent publications by archaeologists, historical or comparative linguistics has been criticized as a narrow, self-contained discipline that cannot reliably reconstruct elements of proto-languages or proto-lexicons because unrealistic assumptions guide the comparative method (Renfrew 1987: 78-86, 100-118; 1988; 1992: 448-53; Robb 1991; 1993; Zvelebil 1994). Its worst flaw is said to be its disregard of and inability to account for processes of linguistic borrowing, convergence and creolization as agents of language change; it is said to rely overmuch on linear, 'family-tree' models. The comparative method also has been linked, some would say inextricably (Robb 1993: 748), to outdated theories equating language, ethnicity and material culture, an equation that is demonstrably false in many cases. As a consequence, the lexical reconstructions produced by historical linguistics are considered misleading except at the most general level, and 200 years of comparative research on the Indo-European protollexicon has been thrown into doubt by a wave of criticism from archaeologists. I find myself in the odd position of pleading for the comparative method before a court of archaeologists so that I can use historical linguistics in Indo-European archaeology without seeming naive.

In defence of the comparative method

The comparative method is not at all concerned with ethnicity or its relationship to material culture. Rather, it is a tool for classifying languages and determining the kinds and degree of relationship between them. The results of the comparative method have been used inappropriately in simplistic scenarios of mass ethnic migration by both linguists and archaeologists, encouraged, in Robb's (1993: 748) view, by the 'family tree' diagrams used to illustrate genetic relationships between languages. Linguists are very much aware that diagrams are simplistic summaries of complex relationships. Ann Stewart (1976) has written an entire book on alternative methods for diagramming linguistic relationships. Evolutionary biologists have the same problem, but no one has suggested that evolutionary theory should be discarded because it is difficult to diagram. It is up to archaeologists to use the results of comparative linguistic studies appropriately.

Language is a complex mix of the cultural and the mechanical - culture imposes arbitrary rules that govern vocabulary, grammar and syntax, making every language an entirely cultural invention; and the human vocal apparatus imposes mechanical constraints that guide historical phonological change in predictable directions. Because the rules and lexicon that define any language are cultural and arbitrary, linguists assume that systematic similarities between languages cannot arise by accident, but must reflect cultural contact. A principal goal of the comparative method is to determine if languages are related genetically (that is, if they are differentiated daughters of a common mother language). It is not true that the method assumes that genetic relationships are the only kind of historical linguistic relationship. It is true that genetic relationships are the only kind of relationship that the method tests. The result of a comparative analysis of two or more language lineages is either a verifiable genetic relationship or no verifiable genetic relationship.

A genetic relationship between two or more language lineages is demonstrated by a large cognate vocabulary united through regular rules of sound change to a shared proto-lexicon and to a shared grammar; the cognate terms fit into the grammar in such a way that cognate terms belong to the same arbitrary grammatical classes across the daughter languages. Multi-layered homologies like these can be explained systematically - that is, by reference to a standard set of rules and principles - only by proposing a genetic relationship. No body of theory or method explains systematically how such deeply seated structural and lexical similarities could arise through convergence or borrowing. Scholars who specialize in the study of linguistic convergence (Nichols 1992; Thomason & Kaufman 1988) accept that convergence does not, as far as we know, produce similarities such as these. Even extreme cases of convergence - for example, where a linguistic enclave has been surrounded for centuries by a dominant language group that has exerted strong political, economic and military pressure to force linguistic conformity - do not produce linguistic similarities that simulate those between the Indo-European languages.

The reconstruction of an extinct proto-lexicon is an inseparable part of the comparative method. A phonologically consistent parent term is the residue of a successful comparison of cognates; it is the proof that the words being compared are indeed cognates. For example, *kmtom- (one hundred) is thought to be a good approximation or reconstruction of the Proto-Indo-European root that developed into the cognates simtas (one hundred) in Lithuanian, centum (one hundred) in Latin, and satem (one hundred) in Old Persian. The parent term *kmtom- was reconstructed phoneme by phoneme. It is possible to reconstruct a parental phoneme such as the initial 'k' in *kmtom- only when the initial phoneme in each cognate can be derived from the reconstructed parental phoneme according to the rules of evolutionary sound change that are known to have operated independently in each attested language lineage that has a cognate. The development of initial *k in PIE into initial s in Lithuanian is subsumed under a law (palatalization of initial consonant in specific kinds of phonetic environments) that applies generally in Lithuanian. The comparison can be derailed at any point if a single daughter language contains a single phoneme that cannot be linked to a mutually acceptable parent phoneme by the rules of evolutionary sound change. For this reason many comparisons fail, and it is possible to reconstruct only random pieces of any proto-language. However, when the method succeeds with a large and geographically diverse group of cognates, it is highly likely that the reconstructed proto-term is a relatively close approximation of a term that actually existed in a real proto-language. Reconstructed terms are static idealizations, and their proto-meanings are particularly difficult to interpret, but this is true of all words in all ancient languages for which we have texts, and we still find uses for the records of Egypt and Mesopotamia.

The problem of borrowing

A proto-lexicon of reconstructed terms is useless to archaeologists if linguists assign to it terms that in fact did not exist in the parent language, but were introduced and widely borrowed between daughter languages at a later date. The comparative method can be used to identify and exclude borrowed terms. Much of what we know about the extinct pre-Indo-European languages of Europe and the Aegean derives from studies of non-Indo-European loan words that survived in Indo-European languages (Hainsworth 1972; Polome 1986; Huld 1990). These misfits can be identified as borrowed terms even though the borrowing occurred thousands of years ago and the parent language is extinct and unrecorded, because the borrowed terms remain phonologically or morphologically inconsistent with the rest of the language in which they occur. Comparative analysis of widely diffused borrowed terms like 'coffee' would not - contra some critics - yield an anachronistic proto-Indo-European or Latin root for 'coffee'. The multiple inconsistencies that these terms exhibit within languages, in phonology and between languages, in expected phonological relationships, make reconstruction of a parental root term impossible. Many cases of very ancient borrowing remain obvious today.

Borrowing between daughter languages may complicate reconstruction of a parent language if the speakers of the daughter languages re-established contact soon after their languages evolved and remained in contact for a long time. Words that were introduced and diffused among closely related daughter languages early in their evolution might be impossible to distinguish from terms that were inherited from the parent. Some coevolutionary borrowing of this kind probably occurred between some early IE daughters, but it is not likely to cause significant problems for reconstruction of PIE because it was not systematic. PIE appears to have split into numerous fairly distinct branches very early (Nichols 1994: 36-7), and the daughter languages were carried into regions quite distant from each other (Anatolia, Europe, the eastern steppes). Cognates that are attested in the early IE languages of Europe, Anatolia and the east are not likely to have been borrowed into IE after the dispersal.

The recent tension between archaeologists and traditional historical linguists is ironic. Comparative linguists represent perhaps the most cautious and conservative branch of linguistics. They explain language change first and foremost by reference to internal phonetic inconsistencies or tensions; these cause shifts in phonology which lead to changes in morphology and syntax. Comparativists are prejudiced against external causation. When external causes of change are suggested - structural analogical change or borrowing from some other language - traditional comparativists tend to respond that internal causes have not been sufficiently explored (Thomason & Kaufman 1988: 59). Contemporary western archaeologists have precisely the same prejudice. We are deeply suspicious of explanations for culture change that stress external agents - migrations or cultural diffusion - and tend to ask if internal cultural, political or economic causes for an observed change have been adequately explored. Yet when Western archaeologists turn to historical linguistics, many choose diffusionist arguments, preferring to explain linguistic similarities through borrowing rather than internal development from a common ancestor.

I believe that the explanation for this inconsistency is that historical linguists stress the purely mechanical aspects of internal linguistic change. Historical linguistic change is constrained by phonetics; that is what makes it predictable. Sound change is in fact more regular, once it gets started, than the cultural changes that set it in motion. Linguists have been able accurately to predict the existence of undocumented aspects of archaic languages (like certain labiovelars in Mycenaean Greek) prior to their discovery in ancient inscriptions (Bynon 1977: 72). No comparable methodology permits any archaeologist to predict the artefact forms that will be found in

an unexcavated site representing a previously undocumented chronological period. Archaeologists should welcome a tool of such precision, but archaeologists study culture, not phonetics. The cultural aspects of language change - borrowing among them - are of more interest to archaeologists than the phonetic constraints that give direction to change. A similar tension within historical linguistics gave birth to the field of socio-linguistics 50 years ago, but traditional comparative studies were not superseded. The two branches of linguistics deserve equal attention from archaeologists.

Wheels and the date of the Indo-European spread

Reconstructed proto-Indo-European (PIE) represents a real ancient vocabulary that is potentially of inestimable value to archaeologists. Historical linguists have established that the speakers of PIE were familiar with wheeled vehicles, reconstructing at least six PIE terms that refer to them: three terms for wheel (perhaps an indication of the importance of wheels in PIE life), one for axle, one for 'thill' (the draft pole to which the yoke is attached) and a verbal root meaning 'to go or convey in a vehicle' [ILLUSTRATION FOR FIGURE 1 OMITTED]. Cognates for these terms exist in all branches of Indo-European, from Celtic in the west to Sanskrit and Tocharian in the east, and from Baltic in the north to Hittite and Greek in the south (Schrader 1890: 339; Specht 1944: 99-103; Gamkrelidze & Ivanov 1984: 718-38; Anthony & Wailes 1988; Anthony 1991; Meid 1994). The PIE terms probably referred to the earliest form of wheeled vehicle - the solid-wheeled wagon or cart, pulled (slowly) by cattle. There is no single shared root for 'spoke', a later refinement in wheeled-vehicle technology.

Renfrew and others have suggested that none of these terms need derive from PIE; all of them might have spread through the IE languages as wheeled vehicle technology diffused, long after the separation and formation of the IE daughter tongues (Renfrew 1987: 86, 110; 1988: 464-5; Zvelebil & Zvelebil 1988). A post-PIE date for the diffusion of wheeled vehicles is unlikely for four reasons.

First, the cognate vocabulary consists of not one term, but at least six. Entire technical vocabularies have rarely been borrowed intact over so large an area in the absence of sophisticated communications and literacy. The core wagon vocabulary is distributed from India to Scotland with no terms confined to just the western or just the eastern IE languages. If it diffused after the IE dispersal it must have spread as a single semantic unit over a very large region that was fragmented linguistically, ethnically and ecologically [ILLUSTRATION FOR FIGURE 1 OMITTED]. The diffusion of other post-PIE technologies (notably the spoke and iron) through the IE-speaking world was not accompanied by the spread of standardized vocabularies in the manner proposed for wheeled vehicles.

Second, the diffusion of the earliest wheeled vehicle technology occurred so rapidly that we cannot now determine if it was invented by a single donor culture and diffused, or if it was independently invented in several regions (Piggott 1983: 63; Hausler 1994). The post-PIE theory assumes a single donor culture whose vehicular vocabulary was adopted across the entire territory between India and western Europe. No archaeological evidence has been offered for this proposition, and much contradicts it.

Third, since five of the six Indo-European wheeled-vehicle terms (all except 'thill' or draft-pole) have good Indo-European etymologies - they are derived from recognizable IE verbal or noun roots - the core vocabulary must have been created by an Indo-European-speaking group, which places additional constraints on an already awkward diffusionary hypothesis.

Finally, there is simply no internal phonetic or morphological evidence for borrowing within the relevant Indo-European vocabulary. None of these terms - and there are at least 35, when the six roots are multiplied by the number of IE languages in which they appear - is a phonological or morphological misfit within its language lineage (Gamkrelidze & Ivanov 1984: 718-38; Meid 1994; Mallory & Adams forthcoming). If the wheeled-vehicle vocabulary originated in an Indo-European daughter language after the separation of the IE languages into numerous distinct phonological and morphological systems, then the phonetic and morphological traits of that language should be detectable in at least some of the borrowed vocabulary, given the phonological distinctiveness of the IE daughter languages. The absence of such evidence indicates that the IE wheeled-vehicle vocabulary was not borrowed, but inherited from PIE.(1)

None of these problems has been explicitly addressed or acknowledged in print, beyond a brief discussion in *Current Anthropology* (Renfrew 1988). While the diffusionary scenario for IE wheeled-vehicle terminology remains an assertion, largely unanalysed and undefended, the genetic-inheritance explanation has been researched and supported in specialized studies by linguists (Specht 1944: 99-103; Gamkrelidze & Ivanov 1984: 718-38; review in Anthony 1991: 198-201; Meid 1994; Mallory & Adams forthcoming). The simplest and most widely accepted explanation of the linguistic evidence is that the speakers of PIE were familiar with and had a vocabulary for wheeled vehicles. Coleman's (1988) brief linguistic dissent stands alone against a body of scholarship to which he did not refer. If we accept the majority interpretation, PIE should have existed as a unified speech community after wheeled vehicles were invented. Archaeological evidence places this event after 3500 BC.

Between about 3300 and 3100 BC wheeled vehicles appeared for the first time in eastern Europe and the Near East in four different media: in Late Uruk written signs in the Near East, in 2-dimensional representations on a TRB pot from southern Poland and in a late TRB tomb at Zuschen, in 3-dimensional models in Baden graves in Hungary and in actual vehicle burials in Yamna graves in the steppes of Russia and Ukraine (Piggott 1983: 38-58; Gei 1991; Izbitser 1993; Hausler 1994). It is unlikely that wheeled vehicles existed earlier, given the diverse range of media in which they suddenly appeared after 3500 BC. PIE existed as a single speech community late enough to experience and create words for wheeled vehicles, or after 3500 BC. Its expansion and differentiation must have occurred later.

When did the dispersal begin? The separation of Hittite, Indic, and Greek by 1800-1500 BC suggests that PIE must have broken up and begun to diversify before around 2000 BC, probably long before. From what place? Where was the PIE homeland? This is not merely an academic question. If we can link one or more archaeological cultures with the reconstructed PIE vocabulary, the effect on European prehistoric archaeology will be analagous to the discovery of a substantial text - the protolexicon - from a remote period beyond the reach of direct textual evidence. The fact that the text is fragmentary, idealized and difficult to decipher does not lessen its significance. It becomes useful, however, only if we can provide a reliable archaeological context for it.

The location of the Indo-European homeland

Any explanation of the location of the PIE homeland must recognize three constraints.

First, the PIE language community could not have covered an area larger than about 500,000-750,000 sq. km (Mallory 1989: 145-6; Anthony 1991: 196-8). There are simply no historic or ethnographic examples of a single-language community larger than this among non-state agriculturalists; most are very much smaller. Reconstructed PIE subsistence terms indicate that the speakers of PIE were herders and farmers: they were familiar with ards or ploughs, domesticated cereals and domesticated sheep, pigs and cattle. We are, then, looking for a discrete linguistic territory not much larger than Spain, as a maximum order-of-magnitude estimate.

Second, numerous specialists have noted strong linguistic parallels and early episodes of borrowing between PIE on the one hand and both the proto-Caucasian (Gamkrelidze 1966) and proto-Uralic (Collinder 1965; Joki 1973) language groups on the other. This suggests that PIE was spoken in a territory between the Caucasus and the Ural Mountains.

Third, the clearest and most discontinuous archaeological boundary in all of Europe during the period 5000-3500 BC was at the Dnieper River in modern Ukraine (Anthony 1995). The Tripolye culture, west of the Dnieper, was utterly distinct from the groups east of the Dnieper in ceramic shapes, decoration and technology; in metallurgy; in the use of female figurines; in mortuary rituals; in house forms and construction methods; in settlement size and organization; in several aspects of lithic tool production; in economy; and in the developmental trajectory that led to its appearance. Archaeological cultures do not correlate with prehistoric language groups in a predictable manner, but in many ethnographic situations, material culture does correlate with language (Clarke 1968: 384-5; Hodder 1978: 9-10; Jorgensen 1980: 88; Weissner 1983: 272; Moore & Romney 1994: 387-8). The Dnieper divide is likely to represent a 4th-millennium BC language boundary because: it originated as a boundary between immigrant farmers (west) and indigenous foragers (east); it was remarkably persistent, enduring for 1500 years, even after the societies east of the Dnieper adopted food production; and it separated people who produced fundamentally different material cultures, reflecting basic differences in domestic and economic organization, ritual practice, technological expertise and social display (Anthony 1995: 189-90).

The Dnieper boundary is among the best candidates for a linguistic boundary in 4th-millennium BC Europe. PIE should be placed on one side or the other. The linguistic links to Uralic and Caucasian, just mentioned, and the archaeological background of early Indo-Iranian-speaking groups far to the east combine to suggest a PIE homeland east of the Dnieper. These new arguments lead to an old conclusion: that the PIE homeland was in the Pontic-Caspian steppes, north of the Black and Caspian Seas.

The archaeology of the early Indo-European expansion

How can this conclusion be reconciled with the archaeological evidence from the region? Gimbutas' (1977) scenario of three waves of outward migration caused by shortages of pasture in the steppe is too broad, difficult to support chronologically and fails to address the social dynamics of migration or language shift. Mallory (1989) has offered an alternative interpretation, which I have largely supported (Anthony 1986; 1991), although I have perhaps placed greater stress on the dynamic role of innovations in transportation technology.

Brown and I have proposed that horseback riding began in the Pontic-Caspian steppes by 4000 BC, a conclusion based on the discovery of microscopic bit wear on horse premolars at the Sredni Stog culture site of Dereivka (Anthony & Brown 1990; Anthony et al. 1991; Anthony 1994) [ILLUSTRATION FOR FIGURE 2 OMITTED]. In

1993-94 we performed biting experiments on previously unbitted horses to refine our understanding of bit wear. The results indicate that the Dereivka 'cult stallion' was bitted repeatedly and regularly over a period of at least 350 hours (perhaps 70 5-hour days of riding); he was bitted with a hard bit, minimally bone; and he had been bitted recently before his death (within 0-60 days). The Dereivka stallion was a head-and-hoof deposit, the earliest example of a practice that later was elaborated greatly in the steppes. The antiquity of the Dereivka stallion is not in doubt, as there are four radiocarbon dates from the cultural level (see Telegin 1986: 81), and the stallion skull was covered by a shell/trash midden that contained Sredni Stog ceramic sherds (D. Telegin pers. comm.). Other early examples of bit wear have been observed by Anthony and Brown on about 10% of the horse lower second premolars at the site of Botai in northern Kazakhstan, dated c. 3100-3400 BC (Zaibert 1993). The Botai data reinforce the 4th-millennium evidence for biting in the Eurasian steppes.

Solid-wheeled wagons and carts, probably pulled by oxen, appeared in steppe wagon graves of the related Yamna culture (3500-2500 Bc) by about 3100-3000 BC (4370[+ or -]120 b.p. (KI-606) for a Yamna wagon grave at Bal'ki on the lower Dnieper, 4440[+ or -]40 b.p. (LE-2963) for a late Yamna/Novotitorovskaya wagon grave at Ostannii in the Kuban River region). While earlier steppe cultures, including Sredni Stog, had been centred on the forested river valleys, Yamna cemeteries appeared in deep steppe locations far from major river valleys. The saiga antelope, an animal of the deep steppe, appeared occasionally among the Yamna fauna; it had not appeared in Sredni Stog sites. Yamna metal-workers were the first intensively to exploit steppe copper ores (Chernykh 1992). Yamna settlements seem to have been located at sites previously little used and/or were occupied for significantly shorter periods, particularly in the Volga-Ural region, where intensive field surveys have yielded very little settlement evidence to accompany the rich Yamna cemeteries (Merpert 1974; 1991; Bondar & Telegin 1988). The appearance of the Yamna culture in the deep steppe signified a watershed in the cultural ecology of Eurasia.

I have argued that steppe pastoralism was dependent on the triad of grazing animals (sheep or cattle), horseback riding and ox-wagon transport (Anthony 1986: 310; 1994: 193-4). Horses improved long-distance scouting for pastures, herd management, long-distance trade and warfare. Wagons (probably drawn by oxen) provided the bulk transport for tents, food and supplies that for the first time freed herders from logistical dependence on the river valleys and permitted them to move deep into the steppes with their herds for an entire season. The Yamna culture, the first steppe culture of Eurasia to possess riding horses and wagons, seems to have been the first archaeological culture strongly oriented towards stock-breeding deep in the steppe. The final period of PIE linguistic unity and the initial differentiation of IE languages probably occurred within the context of the Yamna culture.

The Yamna culture area extended eastward no farther than the Ural River valley. East of the Urals were very different archaeological cultures (Botai/Surtanda) with no wagon graves, little metal, few domesticated animals except horses and very distinctive ceramics, mortuary rituals and settlement patterns. However, at about 2000 BC a new and remarkable archaeological culture appeared east of the Urals, apparently at least partially derived from a late Yamna variant (the Poltavka culture) on the middle Volga. This new group, the Sintashta-Petrovka culture, established compact, heavily fortified settlements in the northern steppes east of the Urals; engaged in bronze metallurgy on an unprecedented scale; raised herds of cattle, sheep, and horses; and practised complex mortuary rituals that parallel in many specific details the Aryan rituals described in the Rig-Veda (Anthony & Vinogradov in press; Gening et al. 1992; Kuzmina 1994: 226-8; Parpola 1995). Vehicles, buried in the richer Sintashta-Petrovka graves, as they had been earlier in Yamna graves, now included spoke-wheeled chariots, buried with two-horse chariot teams. Recent AMS dates of 2000 BC have established that these are the oldest directly dated chariots (or, some would argue, proto-chariots) in the ancient world.(2) It is likely that Sintashta-Petrovka represents the ancestral Indo-Iranians, whose traditions were later carried into India and Iran. Archaeologically, Sintashta-Petrovka is accepted as the formative phase in the development of the Andronovo horizon, which later (1800 BC) spread across the steppes from the Urals to the Tien Shan (Zdanovich 1984; Mosin 1990; Maliutina 1991).

The Sintashta-Petrovka culture was the first Eurasian steppe culture to display several traits later central to the cultures of the Indo-Iranian-speaking Aryans. These included: compact fortified settlements; chariotry, which was much more than transport, for it provided many of the essential metaphors that colored Vedic mythology and prayer; lavish expenditures of resources on the graves of the elite; and elaborate mortuary animal sacrifices that regularly involved the ritual slaughter of horses and cattle. In the Rig-Veda, the horse sacrifice - the central ritual of early Vedic myth - was preceded by the slaughter of a goat, the goat being the symbol of Pusan, the god of paths and ways. In several instances at the Sintashta cemetery, horses and cattle were sacrificed with a single ram. The ram at Sintashta may have served a role like that of the scapegoat of the Vedas - to guide the sacrifices on the right path to the spirit world. The horses in the Vedic rite were racehorses. The chariot equipment and two-horse teams sacrificed in some Sintashta-Petrovka graves suggest that these also were racehorses. The method of sacrifice also matches the Vedic rite - at Sintashta the horses' legs were carefully segmented and placed in the burial pit with the horses' heads (tibias grouped with metacarpals, metatarsals, and phalanges), but in many cases the remainder of the body was not included - presumably it was consumed by the celebrants. In the Rig-Veda (RV I.162; O'Flaherty 1981: 91) the legs of the ritual horse were carefully cut apart and offered in a specified

sequence, while the flesh was cooked and consumed by the celebrants.

In these and other ways, Sintashta-Petrovka customs anticipated those of the Vedic Aryans. While the Indo-Iranian language might have been emerging from a PIE dialect on the eastern margins of the Yamna territory before 2000 BC, it was with the Sintashta-Petrovka culture that the defining ritual aspects of Indo-Iranian identity seem to have solidified.

The dynamics of Indo-European expansion

The expansion of the Indo-European languages must have involved many episodes of language shift over a long period of time. There is no single explanation for these many episodes; they occurred in different places, at different times, for many different reasons. Even the initial expansion seems to have been facilitated by different processes to the east and to the west of the PIE core area.

Language shift has been modelled by archaeologists in two ways: demographic expansion and elite dominance. In the first, a group with a more intensive economy and a denser population replaces or absorbs a group with a less intensive economy, and language shift occurs as an epiphenomenon of a wave-like demographic expansion (Renfrew 1994; Bellwood 1989). In the second, a powerful elite imposes its language on a client or subject population. While both processes can be important, language shift is more complex than these models imply. Language shift can be understood best as a social strategy through which individuals and groups compete for positions of prestige, power, and domestic security (Anthony in press). What is important, then, is not just dominance, but vertical social mobility and a linkage between language and access to positions of prestige and power (Mallory 1992).

The expansion of the Indo-European languages eastward into the steppes was linked to innovations in transport. The resultant development of deep-steppe pastoralism combined with river-valley agriculture made it possible for a substantial population predictably and productively to exploit the grasslands that occupy the center of the Eurasian landmass. The conquest of the grasslands permanently changed the dynamics of historical development across the Eurasian continent by establishing a bridge, however tenuous, between the previously isolated societies of China, Iran, the Near East and Europe. In a sense, the eastward expansion of the pastoral-agricultural economy might be analogous to the 'demographic wave' that Renfrew and others have applied to the Indo-European expansion in Europe. However, the cultural-archaeological context shows that the steppes were already populated; the process by which this resident population became IE-speakers was cultural, not just demographic.

A relatively small immigrant elite population can encourage widespread language shift among numerically dominant indigenes in a non-state or pre-state context if the elite employs a specific combination of encouragements and punishments. Ethnohistorical cases in Africa (Kopytoff 1987; Atkinson 1989) and the Philippines (Bentley 1981) demonstrate that small elite groups have successfully imposed their languages in non-state situations where they:

- * imported a powerful and attractive new religion or ideology (as the Sintashta-Petrovka culture seems to have done);
- * controlled sufficient wealth to offer gifts and loans on a lavish scale (documented in the metallurgical wealth of Sintashta-Petrovka);
- * controlled sufficient military muscle to punish those who resisted (chariotry might have increased the power of the Sintashta-Petrovka people);
- * occupied strategic positions on critical trade routes (Sintashta controls access to the Orenburg gateway between Europe and the steppes);
- * and actively pursued marriages and alliances with the more powerful members of indigenous groups, offering them enhanced prestige and vertical social mobility in the new order.

Simply defeating and dominating the indigenes is insufficient, as the Norman conquest of England and the Celtic conquest of Galatia demonstrate. Language shift occurs when it confers strategic advantages on those who learn the new language. An elite must be not just dominant, but open to assimilation and alliance, and its language must be a key to integration within an attractive socio-political system, as it was for the Roman state at one end of the political spectrum and for Baluchi nomads (Barth 1981) at the other.

The diffusion of the IE languages eastward into the steppes should be understood as a social process, not as an epiphenomenon of a demographic shift. The diffusion westward into Europe was fundamentally different in ecological, cultural and economic terms. It also probably began much earlier. Intrusive kurgan cemeteries in the

lower Danube valley (Panaïotov 1989) and eastern Hungary (Ecsedy 1979; Sherratt 1983) probably testify to a sustained Yamna incursion at about 2900-2700 BC (Anthony 1990). Yet the small-group social dynamics responsible for language shift might have been very similar in Europe and the steppes. In a European context in which wagons and animal traction were becoming increasingly important in the domestic economy (Bogucki 1993), the pastorally-oriented societies of the western steppes might have been seen not as culturally backward 'Huns', but rather as enviably rich and worthy of emulation. Wheeled vehicles may have significantly altered the organization of agricultural labour in eastern Europe, since one person with a wagon and oxen could transport crops from field to farm that would earlier have required the co-operative labour of a group (Bankoff & Greenfield 1984: 17; Bogucki 1993). Wagons made systematic manuring possible, opening areas with less productive soils to agricultural exploitation. Wagons required draft oxen, enhancing the overall importance of cattle-raising, while horseback riding made cattle stealing easier, encouraging inter-community raiding and warfare. Wagons may have encouraged the evolution of increasingly dispersed and individualizing social communities (as automobiles have done in this century). Shifts in values may have been encouraged by changes in eastern European community organization and economy that were themselves caused partially by the adoption of wheeled vehicles and horseback riding. All of these changes might have set the stage for the adoption of new languages just at the time that the Yamna incursion into the grassy plains of the lower Danube valley and eastern Hungary began.

At the root of both expansions lie the speakers of PIE, whose kinship systems, religious concepts, and social organization can be understood through their own reconstructed vocabulary - an unprecedented opportunity for anthropological archaeologists, if we can agree on how it should be exploited.

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1 I have not proposed that wheeled vehicle technology originated in the PIE homeland, a position that has been attributed to me by Hausler (1994: 223). I have proposed only that most of the IE vocabulary for wheeled vehicles originated in PIE.

2 The Krivoie Ozero dates were AMS dates run by the; University of Arizona laboratory on bone from the two horse skulls deposited on the floor of grave 1, kurgan 9, excavated by Nikolai Vinogradov of the State Pedagogical Institute in Chelyabinsk. The horses, the chariot, numerous grave gifts and an adult male were lying on the same floor. The uncalibrated dates were: 3580 [+ or -]50 b.p. (AA-9874a), 3525[+ or -]50 b.p. (AA-9875b), 3700[+ or -]60 b.p. (AA 9875a) and 3740[+ or -]50 b.p. (AA 9874b) (see Anthony & Vinogradov 1995). Littauer (pers. comm.) has recently argued that true chariots of the classic Near Eastern type required a yoke saddle to adapt the vehicle yoke to horse anatomy, and that without such a device the steppe examples should be considered proto-chariots or spoked-wheeled carts. No yokes, yoke-saddles or draft poles are preserved in the steppe chariot graves.

References

ANTHONY, D.W. 1991. The archaeology of Indo-European origins, *Journal of Indo-European Studies* 19(3 & 4): 193-222.

1994. The earliest horseback riders and Indo-European origins: new evidence from the steppes, in Hansel & Zimmer (ed.): 185-97.

1995. Is there a future for the past? An overview of archaeology in western Russia and Ukraine, *Journal of Archaeological Research* 3(3): 177-204.

In press. Migration as social process: material and ideological constraints, in J. Chapman & H. Hamerow (ed.), *Migrations and invasions in archaeological explanation: long-term perspectives*. Washington (DC): Anthropological Quarterly.

ANTHONY, D.W. & D. BROWN. 1991. The origins of horseback riding, *Antiquity* 65: 22-38.

- ANTHONY, D.W., D.Y. TELEGIN & D. BROWN. 1991. The origin of horseback riding, *Scientific American* 265(6): 94-100.
- ANTHONY, D.W. & N.B. VINOGRADOV. In press. The birth of the chariot, *Archaeology*. 48(2).
- ANTHONY, D.W. & B. WAILES. 1988. CA review of *Archaeology and language* by Colin Renfrew, *Current Anthropology* 29(3): 441-5.
- ATKINSON, R.R. 1989. The evolution of ethnicity among the Acholi of Uganda: the precolonial phase, *Ethnohistory* 36(1): 19-43.
- BARTH, F. 1981. Ethnic processes on the Pathan-Baluch boundary, in F. Barth (ed.), *Features of person and society in Swat. Collected essays on Pathans. Selected essays of Fredrick Barth II*: 93-102. London: Routledge & Kegan Paul. (Originally published 1963, in G. Redard (ed.), *Indo-Iranica*, Wiesbaden.)
- BELLWOOD, P. 1989. The colonization of the Pacific: some current hypotheses, in A.V. Hill & S.W. Serjeantson (ed.), *The colonization of the Pacific: a genetic trail*: 1-59. Oxford: Clarendon Press.
- BENTLEY, G.C. 1981. Migration, ethnic identity, and state building in the Philippines: the Sulu case, in C.F. Keyes (ed.), *Ethnic change*: 118-53. Seattle (WA): University of Washington Press.
- BOGUCKI, P. 1993. Animal traction and household economies in neolithic Europe, *Antiquity* 67: 492-503.
- BONDAR, N.N. & D.Y. TELEGIN (ed.). 1988. *Novye Pamiatniki Yamnoi Kul'tury Stepnoi Zany Ukrainy*. Kiev: Naukova Dumka.
- BYNON, T. 1977. *Historical linguistics*. Cambridge: Cambridge University Press.
- CHERNYKH, E.N. 1992. *Ancient metallurgy in the USSR*. Cambridge: Cambridge University Press.
- CLARKE, D. 1968. *Analytical archaeology*. London: Methuen.
- COLLINDER, B. 1965. *An introduction to the Uralic languages*. Los Angeles (CA): University of California Press.
- ECSEDY, I. 1979. *The people of the pit-grave kurgans in eastern Hungary*. Budapest: Akademiai Kiado.
- GAMKRELIDZE, T.V. 1966. A typology of common Kartvelian, *Language* 42: 69-83.
- GAMKRELIDZE, T.V. & V.V. IVANOV. 1984. *Indoevropskii Yazyk i Indoevropeitsy*. Tbilisi: Tbiliskogo Universiteta.
- GEI, A.N. 1991. Novotitorovksaya kul'tura, *Sovietskaya Arkheologiya*(1): 54-71.
- GENING, V.F. & G.B. ZDANOVICH & V.V. GENING. 1992. *Sintashta*. Chelyabinsk: Iuzhno-Ural'skoe Knizhnoe Izdatel'stvo.
- GIMBUTAS, M. 1977. The first wave of Eurasian steppe pastoralists into copper age Europe, *Journal of Indo-European Studies* 5: 277-338.
- HAINSWORTH, J.B. 1972. Some observations on the Indo-European placenames of Greece, in *Acta, second international colloquium on Aegean prehistory: the first arrival of Indo-European elements in Greece*: 39-42. Athens: Ministry of Culture and Sciences.
- HANSEL, B. & S. ZIMMER (ed.). 1994. *Die Indogermanen und das Pferd*. Budapest: Archaeolingua.
- HAUSLER, A. 1994. *Archaeologische Zeugnisse für Pferd und Wagen in Ost- und Mitteleuropa*, in Hansel & Zimmer (ed.): 217-58.
- HODDER, I. 1978. Simple correlations between material culture and society: a review, in I. Hodder (ed.), *The spatial organisation of culture*: 3-24. Pittsburgh (PA): University of Pittsburgh Press.
- HULD, M. 1990. The linguistic typology of the Old European substrate in north central Europe, *Journal of Indo-European Studies* 18(3 & 4): 389-423.
- IZBITZER, Y. 1993. *Wheeled vehicle burials of the steppe zone of Eastern Europe and the Northern Caucasus, 3rd to 2nd millennium BC*. Doctoral thesis, Institute of the History of Material Culture, St Petersburg, Russia. (English)

abstract.)

JOKI, A.J. 1973. Uralier und Indogermanen; Die alteren Berührungen zwischen den Uralischen und Indogermanischen Sprachen. Helsinki: Suomalais-Ugrilainen Seura.

JORGENSEN, J.G. 1980. Western Indians: comparative environments, languages, and cultures of 172 western Indian tribes. San Francisco (CA): W. H. Freeman.

KOPYTOFF, I. 1987. The internal African frontier: the making of African political culture, in I. Kopytoff (ed.), *The African frontier. The reproduction of traditional African societies*: 3-84. Bloomington (IN): Indiana University Press.

KUZMINA, E.E. 1994. Otkuda Prishli Indoarii? Moskva: M.G.P. 'Kalina' VINITI R.A.N.

MALIUTINA, T.S. 1991. Stratigraficheskaya positsiya materialov Fedorovskoi kul'tury na mnogoslounnykh poseleniyakh Kazakhstanskikh stepei, in *Drevnosti Vostochno-Evropeiskoi Lesostepi* : 141-61. Samara: Samarskii Gosudarstvennyi Pedagogicheskii Institut.

MALLORY, J.P. 1989. *In search of the Indo-Europeans*. London: Thames & Hudson.

1992. Migration and language change, *Universitetets oldsaksamlings skrifter ny rekke* (Oslo) 14: 145-53.

MALLORY, J.P. & D.Q. ADAMS. Forthcoming. *Encyclopedia of Indo-European culture*. New York (NY): Garland Press.

MARTIN, J. 1994. Modeling language contact in the prehistory of the southeastern United States, in P.B. Kwachka (ed.), *Perspectives on the southeast. Linguistics, archaeology, and ethnohistory*: 14-24. Athens (GA): University of Georgia Press.

MEID, W. 1994. Die Terminologie van Pferd und Wagen im Indogermanischen, in Hansel & Zimmer (ed.): 53-65.

MERPERT, N.Y. 1974. *Drevneishie skotovody Volzhsko-Uralkogo mezhdurechiya*. Moskva: Akademiia Nauk.

1991. Die neolithisch-aneolithischen Denkmaler der Pontisch-Kaspischen Steppen und der Formierungsprozess der fruhen Grubengrabkultur, in J. Lichardus (ed.), *Die Kupferzeit als Historische Epoche*: 35-46. Bonn.

MOORE, C.C. & A.K. ROMNEY. 1994. Material culture, geographic propinquity, and linguistic affiliation on the north coast of New Guinea: a reanalysis of Welsch, Terrell & Nadolski (1992). *American Anthropologist* 96(2): 370-91.

MOSIN, V.S. 1990. K voprosu o preemstvennosti eneolitabronzy v iuzhnom Zaural'e, in *Arkheologiya Volgo-Ural'skikh stepei*: 15-25. Chelyabinsk: Chelyabinskii Gosudarstvennyi Universitet.

NICHOLS, J. 1992. *Linguistic diversity in space and time*. Chicago (IL): University of Chicago Press.

1994. The origin and dispersal of Indo-European. Unpublished paper presented at the 93rd annual meeting of the American Anthropological Association, Atlanta, Georgia.

O'FLAHERTY, W.D. 1981. *The Rig Veda. An anthology*. Harmondsworth: Penguin.

PARPOLA, A. 1995. Formation of the Aryan branch of Indo-European. Unpublished paper presented at the World Archaeological Congress 3, New Delhi.

PANAIOTOV, I. 1989. Yamnata Kultura v B'lgarskite Zemi. Sofia: B'lgarskata Akademiya Naukite. Razkopki i Prouchvaniya 21.

PIGGOTT, S. 1983. *The earliest wheeled transport: from the Atlantic coast to the Caspian Sea*. Ithaca (NY)?? OK??: Cornell University Press.

POLOME, E.C. 1986. The non-Indo-European component of the Germanic lexicon, in A. Etter (ed.) *O-o-pe-ro-si: Festschrift fur Ernst Risch* : 661-72. Berlin: Walter de Gruyter.

RENFREW, C. 1987. *Archaeology and language: the puzzle of Indo-European origins*. London: Jonathan Cape.

1988. Author's precis and reply: CA book review of *Archaeology and language: the puzzle of Indo-European origins*, *Current Anthropology* 29: 437-41, 463-6.

1992. Archaeology, genetics and linguistic diversity, *Man* 27(3): 445-78.

ROBB, J. 1991. Random causes with directed effects: the Indo-European language spread and the stochastic loss of lineages, *Antiquity* 65: 287-91.

1993. A social prehistory of European languages, *Antiquity* 67: 747-60.

SHERRATT, A.G. 1983. The development of neolithic and copper age settlement in the great Hungarian plain, Part II: site survey and settlement dynamics, *Oxford Journal of Archaeology* 2(1): 13-41.

SPECHT, F. 1944. *Der Ursprung der Indogermanischen Deklination*. Gottingen: Vandenhoeck & Ruprecht.

STEWART, A.H. 1976. *Graphic representation of models in linguistic theory*. Bloomington (IN): Indiana University Press.

TELEGIN, D.Y. 1986. Dereivka. A settlement and cemetery of Copper Age horse keepers on the Middle Dnieper. Oxford: British Archaeological Reports. International series 287.

THOMASON, S.G. & T. KAUFMAN. 1988. *Language contact, creolization, and genetic linguistics*. Berkeley (CA): University of California Press.

WIESSNER, P. 1983. Style and social information in Kalahari San projectile points, *American Antiquity* 48(2): 253-75.

WOBST, M. 1977. Stylistic behavior and information exchange, in C.E. Cleland (ed.), *Papers for the Director: research essays in honor of James B. Griffin*: 317-42. Ann Arbor (MI): University of Michigan. Anthropological papers of the Museum of Anthropology 61.

ZAIBERT, V.F. 1993. *Eneolit Uralo-Irtyshskogo mezhdurech'ia*. Petropavlovsk: Nauka, Kazakhstan.

ZDANOVICH, G.B. 1984. Otnositel'naya khronologiya pamiatnikov bronzovogo veka Uralo-Kazakhstanskikh stepei, in *Bronzovyi vek Uralo-Irtyshskogo mezhdurech'ya*: 3-17. Chelyabinsk: Chelyabinskii Gosudarstvennyi Universitet.

ZVELEBIL, M. 1994. Indo-European origins and the agricultural transition in Europe. Unpublished ms.

ZVELEBIL, M. & K. ZVELEBIL. 1988. Agricultural transition and Indo-European dispersals, *Antiquity* 62: 574-83.

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Anthony, David W. "Horse, wagon & chariot: Indo-European languages and archaeology." *Antiquity*, vol. 69, no. 264, 1995, p. 554+. *Academic OneFile*, go.galegroup.com/ps/i.do?

p=AONE&sw=w&u=capes&v=2.1&id=GALE%7CA17422776&it=r&asid=9fd3edbcf7bd3efebaf54abe997e18a9. Accessed 31 May 2017.

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Cobb, P. (1995). Cultural tools and mathematical learning: A case study. *Journal for Research in Mathematics Education*, 26, 362-385.

Cobb, P., & Steffe, L. P. (1983). The constructivist researcher as teacher and model builder. *Journal for Research in Mathematics Education*, 14, 83-94.

Confrey, J. (1994). A theory of intellectual development: Part 1. *For the Learning of Mathematics*, 14 (3), 2-8.

Confrey, J. (1995a). A theory of intellectual development: Part 2. *For the Learning of Mathematics*, 15 (1), 38-48.

Confrey, J. (1995b). A theory of intellectual development: Part 3. *For the Learning ...* Cambridge: Cambridge University Press.

Dubinsky, E. (1991). *Reflective abstraction in advanced mathematical thinking*. University Press with validated assessment from the experts at Cambridge English Language Assessment.

Introduction to bioinformatics. Oxford University Press Inc. 255 Pages 2002 6.49 MB 10,301 Downloads.

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