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In this paper, an attempt is made to date the ancestor of all Indo-European languages on the basis of the Indo-European terminology for the exploitation of animals for products that do not require killing the animal (the "secondary products" revolution). It is argued that this terminology is compatible with a society that made use of animal traction, but that did not necessarily practice dairying or use wool for textile production. This is compatible with a date at the beginning of the fourth millennium BCE and with the hypothesis that this ancestor language was spoken by people of the so-called Khvalynsk culture on the Volga River.

1. The different stages of Proto-Indo-European

The common ancestor of the languages belonging to the Indo-European language family gradually evolved into a number of separate branches (figure 1). The first of these to split off from the rest was the Anatolian branch, the second was probably the Tocharian branch (see, e.g., Oettinger 2013/2014, Kloekhorst & Pronk 2019, Kloekhorst 2021, Peyrot 2021, Melchert in press).

For most purposes "Proto-Indo-European" as a cover term for all three stages of the proto-language is sufficient, but for this paper the distinction between the different stages is crucial. The ancestor of all Indo-European languages will be referred to as "Proto-Indo-Anatolian" (PIA), the ancestor of all branches except Anatolian will be referred to as "Proto-Indo-Tocharian", while the ancestor of all branches except Anatolian and Tocharian is called (Proto-)'core'-Indo-European (CIE). In the literature, the terms "Proto-Indo-Hittite" and "early Proto-Indo-

European" are sometimes used instead of our "Proto-Indo-Anatolian", while scholars also use the terms "Proto-Nuclear-Indo-European" and "late Proto-Indo-European" for our "Proto-Indo-Tocharian" and "Proto-'core'-Indo-European". The exact terminology is of course not particularly important. The main thing is that the relevant stages can easily be referred to without causing confusion.[1]

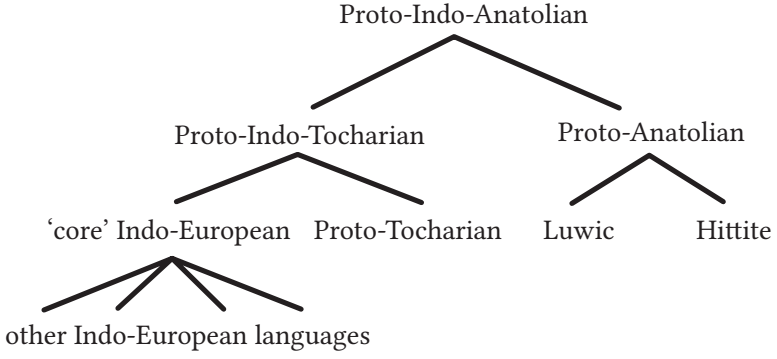

Figure 1: the Indo-European language family (adapted from Kloekhorst & Pronk 2019)

In this paper, an attempt will be made to date Proto-Indo-Anatolian on the basis of the linguistic evidence. Anthony and Ringe (2015: 208) proposed a date of around 4200-4000 BCE for the split between Anatolian and the rest of Indo-European in view of earliest evidence for migrations out of the steppes: the intrusion of people into the lower Danube valley that resulted in the Cernavodă culture (Anthony 2007: 262, 2013: 9, 2019; Parpola 2015: 37).

> the Suvorovo-Cernavoda I movement into the lower Danube valley and the Balkans about 4,300 BCE separated early PIE-speakers (pre-Anatolian) from the steppe population that stayed behind in the steppes and that later developed into late PIE and Yamnaya. (Anthony 2019: 190)

This would be in accordance with the hypothesis that Proto-Indo-Anatolian was at some point spoken in the middle

[1]The terms "late Proto-Indo-European" and "early Proto-Indo-European" are avoided here, because they are also used for other entities, e.g. by Meid (1975).

Volga region by people that were part of the Khvalynsk culture (or the Caspian Steppe Chalcolithic culture as characterized by the Khvalynsk cemetery), as was argued by Carpelan and Parpola (2007: 70), Anthony (2013, 2019) and Kloekhorst (in press). The Khvalynsk culture can be dated to 4300-3800 BCE (Shishlina 2008: 202-203). We will see below that these dates are compatible with the linguistic evidence.

2. Dating prehistoric languages

Linguists have two methods available to date a particular prehistorical linguistic stage. The first method is by assessing the number and nature of the innovations that have taken place between a particular pre-stage of a language and its earliest attestations and comparing those to the rate of change in languages with a long-recorded history like the Romance, Germanic and Slavic languages. Language does not change at a constant rate and the number of innovations can be calculated in several ways. Time-depths estimated in this way are therefore not very precise, but they are reliable enough to be able to tell the difference between, e.g., 500, 1000, 2000 or 4000 years of innovations. The precision of the estimate can be increased if the method is applied to two or more branches of the same proto-language to arrive at a single date for a common ancestor, as is done for Proto-Indo-Anatolian in Kloekhorst (in press).

The second way of dating proto-languages is with the help of linguistic paleontology, i.e. by drawing conclusions about the material culture of a prehistoric population on the basis of their (reconstructed) language (see Olander (2017)) for a good illustration of the method), which is subsequently compared to the archaeological record in order to date that culture. This method should also be applied with care, as inaccuracies and mistakes can easily creep in at any stage of this process. It requires a critical approach to etymology: only words whose etymology is beyond serious doubt can be used. Ideally, it involves sets of words from the same semantic domain rather than individual words. The semantics and word formation of the individual words in these sets need to be taken into account as well in order to rule out parallel innovations.

The fact that neither of the two methods mentioned above is very precise, the potential pitfalls that need to be avoided and the uncertainties that need to be taken into account do not, however, invalidate linguistic dating altogether (*pace* Clackson 2000). It is especially instructive when both methods can be used in combination, as we will try to do below.

Before we proceed, a few words need to be dedicated to another method of dating prehistorical linguistic stages that can be found in the more recent literature: Bayesian phylogenetic analysis of groups of related languages. This method calculates the optimal evolutionary tree for a language family with the help of a database containing cognate sets, usually of lexemes. On the basis of an assumed fixed rate of change, the date of splits between these languages is then calculated. This method is unreliable, at least in its current form. The glaring inaccuracies and striking differences in the results of existing attempts to calculate the most likely Proto-Indo-European phylogenetic tree and the approximate time depth of the nodes in that tree with the help of computational cladistics (e.g. Gray & Atkinson 2003; Bouckaert et al. 2012; Chang et al. 2015; Kassian et al. 2021) suggest that the method cannot, or perhaps cannot yet, be applied to the dating of language families in a meaningful way. The data sets used by Kassian et al. (2021) and Heggarty et al. in a forthcoming paper are much improved compared to the older publications cited above, as a result of which we can now safely rule out the possibility that the inaccuracies in the output are (solely) the result of the use of bad input. To be sure, some of the inaccuracies can be explained and the method can probably still be improved, e.g., by reconsidering the role of derivational morphology and that of loanwords in the calculations (Kassian et al. 2021), by relaxing the assumption of a constant rate of change (Chang et al. 2015), by reassessing the assumed time depth for languages with a long oral tradition, and by excluding imperfectly attested languages such as Mycenaean, Lycian, Luwian, Old Prussian, Gaulish etc. As things stand, however, these methods are unable to provide more than a very rough replicate of what can be said about the phylogeny and time-depth of the Indo-European language family on the basis of qualitative methods and, especially when it comes to calculating time-depth, it is

able to do this only when the process is specifically set up to produce this replicate. For example, Chang et al. (2015), whose dates are largely in line with estimates based on qualitative analyses, force ancient languages like Latin and Vedic Sanskrit to come out as direct ancestors of modern Romance and Indic languages. This may produce a more accurate tree, but in their forthcoming paper Heggarty et al. argue that it introduces new artifacts as well. The selection of the prior to be tested also greatly affects the outcome of the analyses (Rama 2018). Summarizing, there is at present no reason to believe that future Bayesian phylogenetic analyses of Indo-European will provide us with reliable guidance in areas where other methods fall short.

3. Dating of Proto-Indo-Anatolian on the basis of linguistic distance

In Kloekhorst and Pronk (2019: 34) potential shared linguistic innovations of the non-Anatolian languages have been listed, 23 of which seem to be particularly forceful. These include substantial structural innovations like the creation of a feminine gender. These innovations must have taken place over many generations. A period of between 800 (Oettinger 2013/2014) and 1000-1200 (Kloekhorst & Pronk 2019) years between Indo-Anatolian and 'core'-Indo-European seems to be a reasonable estimate. There are no indications that 'core'-Indo-European was spoken in a geographic environment that can be expected to have caused extreme linguistic conservatism, nor did it undergo drastic simplification of its phonology or morphology, which would have pointed to a contact situation that could have significantly accelerated linguistic change.

At the beginning of this paper it was observed that Tocharian was probably the second branch to split off from the rest of Indo-European. This event is usually associated with the beginnings of the Afanasievo culture in the Minusinsk Basin of southern Siberia (from around 3300 BCE, Svyatko et al. 2017). The latest shared innovations between Tocharian and 'core'-Indo-European must have taken place some time before the

earliest Afanasievo finds.[2] Also, a few centuries must have passed between the split of Tocharian and the subsequent disintegration of 'core'-Indo-European, which can hardly have been much later than the first century of the third millennium BCE. This date is compatible with the first traces of the Corded Ware culture and associated genetic changes in Europe (Kristiansen et al. 2017). It follows that an Anatolian split from the rest of Indo-European, no later than approximately 3800 BCE and no earlier than approximately 4200 BCE, would account for the linguistic innovations of 'core'-Indo-European as compared to Proto-Indo-Anatolian. Kloekhorst (in press) dates Proto-Anatolian around 3000 BCE and estimates that of the time needed to account for the shared innovations of the Anatolian languages as compared to the rest of Indo-European would have been at least 1000 years. He concludes that Proto-Indo-Anatolian was probably spoken around 4300-4200 BCE, with a margin of error of a few centuries.

The remainder of this paper discusses the evidence for dating Proto-Indo-Anatolian with the help of linguistic paleontology. It will be argued that this evidence is consistent with a period of around 1000 years between the Anatolian split and the dissolution of Proto-'core'-Indo-European.

4. Indo-Anatolian and wagon terminology

Almost all specialists in Indo-European linguistics nowadays accept the idea that Proto-'core'-Indo-European was spoken in the steppe in the fourth millennium BCE as the most likely scenario. Renfrew's alternative (1999) - a homeland in Neolithic Anatolia in the seventh millennium BCE and the earliest splits in CIE around 5000 BCE - is now considered to be highly unlikely. The main reason for this is the fact that the lexicon of reconstructed Proto-'core'-Indo-European is inconsistent with early Neolithic Anatolia, because it lacks terminology that may be expected to have existed (Kortlandt

[2] Intriguingly, the split between Tocharian and the rest of 'core'-Indo-European seems to coincide with a period of aridization of the Caspian Steppes, which appears to have led to the Caspian Steppes being abandoned in the 34th century BCE (Shishlina 2008: 220). On the basis of the evidence that is currently available, however, the hypothesis that there would be a causal relationship between the two events cannot be substantiated.

2009: 40, Garnier, Sagart & Sagot 2017: 292-293), e.g. specific words for crops such as barley, lentil, pea, chickpea and bitter vetch, while it contains terminology for concepts and items that were in all probability unknown in the early Neolithic. Perhaps the most striking argument ruling out any date earlier than the fourth millennium is the fact that Proto-'core'-Indo-European had terminology relating to wheeled vehicles, an invention for which there is no archaeological evidence prior to the middle of the fourth millennium (Mallory 1989: 158, 179; Anthony 2007: 63-81; Lubotsky in press).

The most informative vehicle-related Indo-European words are those for 'wheel' and 'axle' (Anthony & Ringe 2015: 201-202; Olander 2019: 20-24). The word for 'axle' can be reconstructed as *$h_2e\acute{k}s$-, and there is evidence for two words for 'wheel', *k^wek^wlo- and **Hrot(H)o*-, both of which are derived from Indo-European verbal roots, the former from *k^wel- 'to revolve', the latter from **Hret(H)*- 'to run' (only attested in Celtic: Old Irish *-reith*, Old Welsh *retit*). The word *k^wek^wlo- may originally have referred to logs used as rollers. Another possibility is that the original meaning of *k^wek^wlo- was 'constantly roaming, moving' and that this might be connected to the idea that the wagons of the Indo-European speaking nomads were their mobile homes (Lubotsky in press). The term **Hrot(H)o*- may originally have referred to the runners of a sledge or, as Lubotsky proposed, "a lighter wheel, which could be used on a two-wheeled wagon". There is, however, no trace of these presumed original meanings of *k^wek^wlo- and **Hrot(H)o*- in any of the Indo-European languages in which the words are preserved. The words for 'wheel' and 'axle' cannot have been formed independently in several Indo-European languages after the dissolution of the proto-language. The creation of a new word from an existing root requires a clear model. No such model was available to create either *k^wek^wlo- or *$h_2e\acute{k}s$- after the dissolution of Proto-Indo-European. It follows that the speakers of Proto-'core'-Indo-European must have been familiair with wheeled vehicles and, judging by Tocharian A *kukäl*, B *kokale* 'wagon', which is clearly cognate with PIE *k^wek^wlo-, those of Proto-Indo-Tocharian, too. Because the Indo-European words for wheel are not found in Anatolian (no Anatolian word for 'axle' is known), "Anatolian might have

separated before wheels were invented" (Anthony & Ringe 2015: 202; similarly Manco 2015: 126 and Lubotsky in press).

5. Terminology for domesticated livestock in 'core'-Indo-European and Anatolian

A similar discrepancy between the lexicon reconstructed for Proto-'core'-Indo-European and that reconstructed for Proto-Indo-Anatolian exists in terminology relating to domesticated livestock. Proto-'core'-Indo-European had specific verbs for taming a horse, milking (Garnier, Sagart & Sagot 2017) and tending livestock, different nouns for cow, bull (Pronk 2009) and ox (Zimmer 1981), for sheep, ram and lamb, a word for udder, a word for butter, words for pasture, a herdsman and a cowherd, an adjective meaning hornless and a uniform word for wool. All these words suggest a pastoral society in which domesticated cattle, horses and sheep played an important role and were not bred exclusively for their meat. The first to observe this was Uhlenbeck at the end of the nineteenth century (cf. Kortlandt 2009).

For some of these concepts, we can reconstruct a Proto-Indo-Anatolian word. The CIE words for cow, sheep and horse, e.g., are also found in Anatolian. The Hittite words for pasture (*u̯eši-*) and shepherd (*u̯ēštara-*) have cognates in other Indo-European languages as well: Skt. *s₍u₎-vásara-*, Av. *vāstra-* 'pasture, meadow', *vāstar-* 'herdsman', MEn. *wes* pret. 'tended livestock, pastured (?)', ON *vist* 'food', ToA *wäsri* 'grassland', OIr. *fess* 'food, cattle trespass', Lat. *vēscor* 'to take (as) food, use'. The CIE word for 'spring', **ues-r/n-* (Skt. *vasantá-*, Lat. *vēr*, Gr. *éar*), may also belong here if this was the season when the herd returned to the open grasslands from a winter camp in a more forested area. The Indo-Iranian words for 'pasture' and 'herdsman' share the Hittite association with pastoralism. The same may be true for Old Irish *fess*, if it is cognate (see Matasović 2009: 417-418) and for Middle English *wes*, occurring in the alliterating phrase *wes 7 wiste*, which translates Latin *pascō* (Stiles 1985). Tocharian A *wäsri* 'grassland' could originally have meant 'pasture', if this word is indeed cognate and is not related to Latin *vireō* 'to be green' < PIE **uis-* instead. There are no exact morphological matches between formations derived from this root in the different branches of Indo-

European, which makes it difficult to determine what the meaning of the original Proto-Indo-Anatolian word(s) could have been. A verbal root **ues-* 'to pasture', probably preserved in Middle English *wes,* is, however, a likely base for many of the attested forms.

Hitt. *uēštara-* 'shepherd'[3] may be an archaism in view of its similarity to OAv. *vāstar-*, although the long vowel in Avestan, also present in *vāstra-* 'pasture', is rather unusual for an inherited agent noun in **-ter-* and may point to inner-(Indo-)Iranian origin of these words.[4] The length of the Hittite *-ē-* is ambiguous (Kloekhorst 2012: 250).

All other CIE words relating to domesticated livestock are unattested in Anatolian. We can distinguish three distinct categories of these unattested words: 1) Anatolian has a cognate of the CIE word, but it has a different meaning; 2) Anatolian has no cognate of the CIE word and uses a different word to express the meaning of the CIE word; 3) it is unclear whether Anatolian has a cognate of the CIE word because the Anatolian word to express that meaning either does not occur in the texts or is attested as a logogram only. The concrete examples belonging to these categories are the following:

1) The CIE verbal stem **peh₂-* 'to protect; to tend livestock' (Lat. *pascō*, OCS *pasti* 'to tend livestock', Skt. *gopá-* 'cowherd', Gr. *põu* 'flock') does not relate to livestock in Hittite and Tocharian: Hittite *paḫš-* 'to protect, guard, keep (an oath)' and Tocharian A *pās-*, B *pāsk-* 'to protect, beware of, obey (rules)'. The apparent shift in meaning that is documented in the other languages shows that, in their common ancestor, the object of this verb was typically a word for (a type of) livestock. This may, but

[3]This Hittite word is a *hapax*. It occurs in a passage where it is an epithet of the Sun-god (KUB 6.46 iii 52). There are other passages in which we find the same epithet written ideographically with the meaning 'shepherd' (Beckman 1988: 43, Kloekhorst 2008: 1008).

[4]Rix et al. (2001: 694) suggest that the long vowel might be analogical to verbal forms with the long vowel found in Lat. *vēscor*. De Vaan (2008: 669) explains the long vowels as being from a root noun **uēs*. In both cases, the original PIE form would have been lost and there is no additional evidence that it ever existed. It is therefore very uncertain whether the long vowels of Latin and Avestan are somehow related.

need not, reflect a change in the importance of livestock in 'core'-Indo-European society. Perhaps herding livestock became a specialized task or there was an increased risk of cattle theft. This is speculative, but it would explain the semantic shift in 'core'-Indo-European and be in line with the other evidence for a shift in the subsistence strategies of its speakers.

Hittite *tamāšš-*, which is cognate to verbs meaning, a.o., 'to tame (typically of equids and cattle)' in other branches of Indo-European (Gr. *dámnēmi*, OIr. *damnaid*, Lat. *domāre* etc.), only means 'to (op)press'. The meaning 'to tame' in the non-Anatolian languages may well be a shared innovation. In Hittite, the verb *annanu-*^{zi} is used for training and domesticating animals, including equids (cf. also the derivative $^{(KUŠ)}$*annanuzzi-* 'halter'), and there is an adjective *enant-* 'tame', neither of which is related to PIE **demh₂-*.

2) The Hittite word for udder was probably *pankur* (Güterbock & Hoffner 1994: 93), unrelated to CIE **He/ouHd^{h}-r*. The Hittite word for wool, *ḫulana-*, is somewhat similar to the word for wool in the rest of Indo-European (**ulh₁-no/eh₂-*), but it cannot reflect the same proto-form. Moreover, it can hardly be separated from Hittite *ḫulāli-* 'distaff' and *ḫuliya-* 'wool'. The difficulties have been discussed clearly by Kloekhorst (2008: 357), Pinault (2016: 243-244) and Olsen (in press). One has to resort to several *ad hoc* developments in order to derive the Anatolian word and the CIE word from a single proto-form. This applies to Pinault's (2016) solution, which is discussed by Olsen (in press), but also to that of Olsen herself, who assumes a seemingly irregular loss of the initial laryngeal in Greek and revocalization in Hittite and separates the Hittite words for 'wool' and 'distaff' from each other. Serious consideration should therefore be given to the possibility that the similarities between the Hittite words for 'wool' and CIE **ulh₁-no/eh₂-* are either coincidental or the result of independent borrowing from the same or a similar source. It has in fact been argued that the Indo-European words for wool are borrowed from North East Caucasian (Matasović 2012: 290-291), a possibility to which we will return below.

3) No cognates of the CIE words for milking (**h₂melǵ-*), ox (**uks-n-*), butter (**h₃eng*^{w}*-n-*), herdsman (**poh₂i-men-*), cowherd (**g*^{w}*eh₃ukolo-*) or hornless (**ḱem(H)-*) are attested in Anatolian.

The words for 'milk' and 'to milk' in Hittite are unknown. The neuter noun for 'milk' is always rendered with the sumerogram GA. According to Garnier, Sagart and Sagot (2017), Hittite uses "the Hittite root *lā-* 'to let, make flow' (< PIE **leh₁* - 'to let'), for instance GA *lāttat* 'he let the milk flow = he milked' (Kbo III 8 III 30-31), or the locution GA *ḫamikta* 'he pressed the milk, he milked' (KBo III 8 III 12-13)". This is incorrect: *ḫamikta* and *lāttat* must be read as 'bound' and 'released' respectively. In the "Beschwörung gegen das Verbundensein" in which these phrases are attested, the milk of the *šāša*-animal is just one of a series of animals and objects that are first bound and then released (Kronasser 1961).

There is no attested Hittite word for ox, which was probably rendered by the Sumerogram GU4 in the texts, just like 'cow'. The Hittite noun underlying GU4 was an *u*-stem, in all probability cognate to Luwian *wawa/i-* 'cow' and words for 'cow' in other Indo-European languages. There appears to be a variant *o*-stem or perhaps *n*-stem nom.sg. GU4-*aš*, acc.sg. GU4-*an* in the Hittite laws. This form could either be a different underlying noun or be due to a later inner-Hittite innovation (Tischler 1983: 701; Kloekhorst 2008: 507-508), but it is clear from the context in the Hittite laws that it does not represent a distinct word for 'ox'. It is unclear which Hittite words lie hidden behind the Sumerograms $SILA_4$ 'lamb', UDU.NÌTA, UDU.ŠIR 'ram' and GU_4.NÌTA 'bull'.

The word for 'butter' in CIE appears to have been a neuter **h₃eng*^{w}*-n*, derived from the verbal root **h₃eng*^{w}- 'to smear' (Skt. *añj-*). It is only attested in Italo-Celtic (Lat. *unguen*, OIr. *imb*) and as a masculine in Old High German *ancho*. The Italo-Celtic form looks archaic, because neuter *n*-stems were an unproductive category. The Hittite word for 'butter' is a neuter, but it remains hidden behind the Sumerogram Ì.NUN, so it cannot be determined whether it is cognate to the CIE word.

meaning	**'core'-Indo-European**	**Anatolian**	**Indo-Anatolian**
wheel	**k*^{w}*ek*^{w}*lo-*, **Hrot(H)o-*	Hitt. *ḫurki-*	?
axle	**h*$_2$*eḱs-*	unclear	?
yoke	**(H)iug-o-*	Hitt. *iūk-*, *iuka-*	**(H)ieug-*
pole	**h*$_2$*eiH-s-*	Hitt. *ḫišša-*	**h*$_2$*eiH-s-*
harnessing (?)	**d*^{h}*ur-*	Hitt. *tūriie/a-*	**d*^{h}*ur-*
ploughing	**h*$_2$*erh*$_3$*-*	Hitt. *tere(/i)pp-* 'to plough'; cf. *ḫarr(a)-* 'to grind, crush'	**h*$_2$*erh*$_3$*-* 'to crush'
cow	**g*^{w}*eh*$_3$*-u-*	CLuw. *u̯au̯a/i-*, HLuw. *wawa/i-*, Lyc. *wawa-*	**g*^{w}*eh*$_3$*-u-*
bull, ox	**g*^{w}*eh*$_3$*urs-n-*, **uks-n-*	only ideograms	?
sheep	**h*$_3$*eu-i-*	CLuw. *ḫāu̯i-*, HLuw. *hawi-*, Lyc. *χawa-*	**h*$_3$*eu-i-*
ram, lamb	**urh*$_1$*-n-*, **h*$_2$*r-n-*	only ideograms	?
horse	**h*$_1$*eḱ-uo-*	HLuw. *ázu-*, Lyc. *esb-*	**h*$_1$*eḱ-u-*
livestock	**peḱ-u-*	Hitt. *šupp(a)l(a)-*[5]	?
pasture (?)	**ues-*	Hitt. *u̯eši-*	**ues-*
shepherd	**uēs-tr-*?	Hitt. *uēštara-*	**uēs-tr-*?
tending livestock	**peh*$_2$*-*	Hitt. *u̯ešiie/a-* 'to tend cattle'; cf. *paḫš-* 'to protect, guard'	**peh*$_2$*-* 'to protect'
herdsman	**poh*$_2$*i-mn-*	once Hitt. *uēštara-* 'shepherd', otherwise only ideograms	?
taming equids	**demh*$_2$*-*	unclear; cf. Hitt. *tamāšš-* 'to (op)press'	**demh*$_2$*-* 'to (op)press'
hornless	**ḱem(H)-*	unclear	?
wool	**ulh*$_1$*-n-*	Hitt. *ḫulana-*, *ḫuliia-*	?
butter	**h*$_3$*ng*^{w}*-n-*	unclear	?
milking	**h*$_2$*melǵ-*	unclear	?
udder	**HeuHd*^{h}*-r/n-*	Hitt. *pankur*	?

Table 1: Indo-European and Hittite words related to animal domestication.

[5]It has been suggested that the Sumerogram UDU-*uš* contains the Hittite equivalent of **peḱ-u-* (Olsen 2018: 72 with references). I consider this to be too speculative to take the word into consideration here, if only because the Hittite word is a common gender noun, whereas CIE **peḱ-u-* was neuter. The original neuter gender is preserved in Italic, Germanic, Baltic and Vedic. Secondary non-neuter forms were created independently in Indo-Iranian and Latin.

6. Terminology for domesticated livestock in Indo-Anatolian

The only positive linguistic indication that the speakers of Anatolian lost contact with the other Indo-European speakers *after* the domestication of livestock is the fact that they preserve Indo-European **ues-* 'to pasture' and words for the yoke, Hittite ^{GIŠ}*iuk(a)-*, the word for the pole connecting the draught animals to the yoke, ^{GIŠ}*ḫišša-*, and a verbal root *tūriie/a-*^{zi} meaning 'to harness' that has cognates in other Indo-European languages (see table 1).

The word for yoke in Anatolian has a different morphological make up than in the other Indo-European languages, but because the non-Anatolian form can be derived directly from the Anatolian form (cf. Kloekhorst 2008: 423), there is no doubt that they continue a single PIA proto-form **(H)ieug-*. This root noun was derived from a verbal root meaning 'to join, connect', found in, e.g., Latin *iungō* and Lithuanian *jùngti*.

The Indo-European word for pole was an *s*-stem **h$_2$eiH-s-*, preserved as such in Slovenian *ojȇ*, gen.sg. *ojȇsa*. Other cognates include Sanskrit *īṣá-*, Avestan *aēšā-* 'pole' and Greek *oiḗion* 'rudder'. The word was borrowed into Finnic languages, probably from a lost Baltic source, where it turns up as, e.g., Finnish *aisa*. The word for yoke, or perhaps even that for pole, may originally have referred to the leather straps or rope used to fasten a load to a draught animal, but because we can clearly distinguish the two terms in Anatolian and the rest of Indo-European, they must have referred to the yoke and pole during the last phase of Proto-Indo-Anatolian.

The Hittite verb *tūriie/a-* 'to harness' is probably cognate with Sanskrit *dhúr-* 'joint of the chariot pole and the yoke, the pole and the yoke together', perhaps also with the CIE word for 'door' (Lubotsky in press). It is unclear which meaning is the oldest, but it would seem probable that it pertained to the process of connecting a draught animal to its load in Proto-Indo-Anatolian.

The word for pole is the only word denoting a part of the vehicle that Hittite shares with non-Anatolian Indo-European languages. It has been suggested that it originally referred to the pole of a plough or a sledge (Anthony 2007: 65; Anthony & Ringe 2015: 202). The latter option is the most likely of the two.

The speakers of Proto-Indo-Anatolian probably did not practise agriculture, because not a single agricultural term is shared between Anatolian and the other branches of Indo-European. There is a shared word for plough (ard), **h₂erh₃tro-*, in the western branches of Indo-European including Armenian, but the word is absent in Anatolian, Tocharian and Indo-Iranian and it has a different (perhaps renewed) suffix in Balto-Slavic. It may have existed in Proto-'core'-Indo-European, but is unlikely to have been present in Proto-Indo-Anatolian. The word for plough derives from a verb that means 'to plough' in 'core'-Indo-European but has a different and probably older meaning in Anatolian, viz. 'to crush' (Kloekhorst 2008: 9-10). It therefore seems most likely that the yoked draught animals of the Proto-Indo-Anatolians were used to pull a load, perhaps with the help of a sledge or a travois (cf. Pétrequin et al. 2006: 12). The word for sledge or travois is not preserved anywhere,[6] but this is not surprising since sledges had been replaced by wheeled vehicles as the main means of transport by the time of our first attestations of Indo-European languages.

Absence of evidence is not evidence of absence, but it is striking that, apart from the words for yoke and pole, the 'core'-Indo-European terminology associated with the more extensive use of secondary products that characterizes the Chalcolithic and later periods does not exist in the known lexicon of the Anatolian languages. There are three possible explanations for this fact. First, the speakers of (pre-)Proto-Anatolian may have given up practices like dairying and wool production. This seems unlikely, especially in view of the fact that the language moved into an area where these practices were adopted relatively early. Second, we may be dealing with accidental replacement of all these words by other terms in Anatolian. This explanation is not particularly satisfactory, because it remains unclear why this should have happened to (almost) the whole semantic domain. This leaves us with the third, in my view most likely option: the speakers of Indo-European did not make extensive use of domesticated animals for purposes other than their meat, skin and horns as well as

[6]Unless this is the original meaning of PIE **ueǵʰno-*, reflected in OIr. *fén* 'wagon', ToB *yakne* 'way, manner'.

traction, until after they had been separated from speakers of pre-Proto-Anatolian.

In order to assess the likelihood of this scenario, we will take a look at the archaeological evidence for animal domestication and exploitation before we proceed to discuss the implications for the dating of Proto-Indo-Anatolian.

7. The Secondary Products Revolution

Animal domestication in the steppes east of the Dnieper River began with the Dnieper-Donets II culture from about 5200-5000 BCE (Anthony 2007: 175). Domesticated cattle, sheep/goats and probably horses were also known to the Khvalynsk culture (4700-3800) (Anthony 2007: 184-185), which has been associated with the speakers of early Proto-Indo-Anatolian as we have seen at the beginning of this paper. Animal domestication was followed by the exploitation of animals for products that do not require killing the animal, like milk, wool and traction. These innovations form a package that Sherratt (1981, 1983) referred to as the Secondary Product Revolution and that took place during the fourth millennium BCE. It was a gradual process with local differences that probably reflects the beginnings of intensive use of techniques like animal traction and milking rather than their initial sporadic use (Greenfield 2010, 2014; Marciniak 2011).

7.1. Animal traction

The oldest archaeological evidence for animal traction comes in the form of direct archaeological remains of ploughs, wheeled vehicles, cheek pieces and nose rings, images and models of sledges, wheeled vehicles, ploughs and yoked animals, impressions of wheels, ploughs and threshing sledges on fossil soil, zoopathological traces on cattle skeletons, interpretation of cattle mortality patterns and burials of paired cattle (cf. Bogucki 1993; Bartosiewicz, van Neer & Lentacker 1997: 9; Boroffka 2004; Sherratt 2004; Johannsen 2005). It is traditionally thought that the use of draught animals started in the fourth millennium BCE, since this is the period when first evidence for animal traction in the form of images of sledges from Uruk appears. The positive evidence for the use of cattle for traction is abundant in the fourth millennium BCE, but

much less so before that. Gaastra, Greenfield and Vander Linden (2018: 1464) have identified zoopathological evidence for an "early 'light' phase of cattle exploitation" in the Central and Western Balkans from the beginning of the sixth millennium onwards. It is possible that locally and on a sporadic basis cattle have been used for traction as early as the eighth millennium BCE, but it was the development of the yoke and the pole connecting the animal to the object being drawn in the fourth millennium that enabled daily use of animal traction (Sherratt 2004: 410). The earliest way of connecting a draught animal to a sledge or other load to be pulled was with the help of one or more ropes or straps of leather that were probably connected to the horns of the animal. Later, two draught animals under a single wooden yoke, that either rested before their withers or was fastened to their horns, were connected to the load by a pole that runs between the two animals (Gandert 1964). This innovation preceded the invention of the wheel and the cattle-drawn plough, for which the first evidence also stems from the fourth millennium BCE. Proto-'core'-Indo-European was spoken by people familiar with probably all these innovations, while speakers of Proto-Indo-Anatolian seem to have been unfamiliar with the last phase (see figure 2).

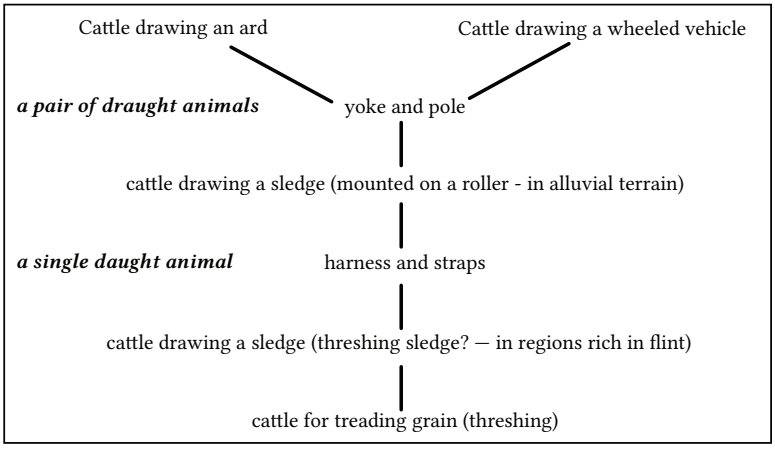

Figure 2: the evolution of animal traction (after Sherratt 2006: 343).

Zooarchaeological data from Knossos on Crete in the form of traction-related pathologies and sexable pelves suggest that

at least on Crete mostly female cattle was used for traction during the Neolithic (Isaakidou 2006). The use of male animals for this purpose seems to have intensified in the Bronze Age. It seems reasonable to assume that this shift is related to the practise of castration, which makes the male animal, which is stronger than the female, less difficult to handle. As was mentioned above, CIE had a specific word for 'ox'.[7]

7.2. Dairying

Economic factors may have played a role in the use of oxen for traction (thus Halstead 2014: 59-60), as well as a change of the role of female cattle to that of a supplier of milk. While goat milking appears to have been practised throughout Neolithic Europe, sheep and cow milking have been argued to be post-Neolithic phenomena (Greenfield & Arnold 2015). In this light, it is interesting to observe that it is rather difficult to reconstruct a Proto-Indo-European word for 'goat' (Kroonen 2012: 245-247), especially 'she-goat'. The following reconstructions have been proposed for Proto-Indo-European: **h₁er-i-* (Gr. *ériphos* 'kid', Lat. *ariēs* 'ram', OIr. (glosses) *eirp*, *erp*, *erb* 'she-goat; doe', Arm. *erinj* 'heifer'), **h₂eiǵ-* (Gr. *aíks*, Arm. *ayc* '(she-)goat', Alb. *edh* 'kid'), **h₂eǵ-* (Skt. *ajá-*, Lith. *ožỹs* 'billy-goat') and **bʰuǵ-* (Av. *būza-*, OHG *bock* 'billy-goat'). The only noun that appears to refer to the she-goat is **h₂eiǵ-*, which is limited to the "Balkan-Indo-European" languages. Absence of initial *h-* as a reflex of the laryngeal in Armenian may in fact point to a proto-form **aiǵ-*, in which case the *a-* can be viewed as evidence that we are dealing with a non-Indo-European loanword (cf. Pronk 2019: 154). Its phonetic similarity to **h₂eǵ-* 'billy goat' is perhaps also best explained by the assumption that these words were borrowed from one or more non-Indo-European languages not long after the dissolution of Proto-Indo-European (Matasović 2012: 290). The lack of evidence for a Proto-Indo-European word for 'she-goat' suggests that there

[7]No specific verb meaning 'to castrate' can be reconstructed, presumably because a verb with a more general meaning 'to cut' was used instead. Attested verbs with the meaning castrate in the Indo-European languages (e.g. Latin *castrāre*, Sanskrit *akṣṇoti*, Greek *témnō*) tend to be specializations of a more general 'to cut'.

either was no such word or that the word could easily be lost because (she-)goats were of less economic importance than cattle, horses and sheep. It is thus a distinct possibility that the 'core'-Indo-European verb meaning 'to milk' referred specifically to milking cows, perhaps also sheep or horses, which was a fourth millennium innovation if Greenfield and Arnold (2015) are right. The Anatolian branch could have split off before the introduction of dairying in view of the absence of dairying terminology shared with the other branches.

This timeline suggests itself: the Anatolian split occurred at some point no later than the early fourth millennium, followed by the introduction of dairying during the first half of the fourth millennium, after which came the Tocharian split around 3400 BCE. This scenario is not contradicted by the evidence for dairying in the Eurasian Steppes that is currently available. The earliest evidence in the form of lipid residues comes from the Botai culture of northern Kazakhstan (horse milk, middle of the fourth millennium BCE, Outram et al. 2009) and the Afanasievo culture of the Minusinsk Basin in southern Siberia (sheep or cow milk, late fourth millennium BCE, Wilkin et al. 2020). The latter is usually associated with the speakers of an early form of Proto-Tocharian.

7.3. **Wool**

The beginnings of wool production can probably be dated to the late fifth millennium in South-West Asia, from where it spread to other parts of Eurasia. The evidence comes from sheep bones, specifically changes in herd structure and culling practices (Anthony 2007: 61). From around 4500 BCE the sheep found at sites in South-West Asia become larger and more robust, and the variation in size between sheep decreases, while around 4000 BCE the proportion of male sheep increases significantly (Benecke et al. 2020). The evidence for the (common) use of wool in textile production dates to the fourth millennium (Shishlina, Orfinskaya & Golikov 2003: 339, Becker et al. 2016: 109). The archaeological evidence for woollen textiles in and near the Eurasian Steppes in the fourth millennium BCE is limited to a single piece of cloth from a kurgan in Novosvobodnaya that may have been imported from elsewhere (Shishlina, Orfinskaya & Golikov 2003).

Proto-'core'-Indo-European is thought to have been spoken around the time of the first evidence for woollen textiles in western Eurasia, no later than 3000 BCE. A shared word for 'wool' is widely attested in 'core'-Indo-European languages, reconstructable as CIE **ulh₁-no/eh₂-*. The speakers of this language must therefore have been familiar with wool. This has been used as an argument to define a *terminus post quem* for the dating of Proto-Indo-European, with the important reservation that if the word "referred to the short undercoat wool of 'natural' sheep, it could have existed before 4000 BCE" (Anthony 2007: 63).

We have seen above that there are serious difficulties with the idea that the Hittite word for wool is a direct cognate of the 'core'-Indo-European word. That word is not attested in Tocharian either. Tocharian B *yok* 'wool' is of unknown origin.[8] It is therefore possible that the word for wool was a recent, post-Indo-Tocharian innovation. It has been suggested that Proto-'core'-Indo-European **ulh₁-no/eh₂-* was borrowed from North East Caucasian (Matasović 2012: 290-291). Indo-European and North East Caucasian could also have borrowed the word from a third source. Either scenario would be in line with the archaeological evidence for the spread of wool production from South-West Asia. Hittite *ḫulana-* might be an independent borrowing from the same or a similar source as well.

Barber (1975: 319) argued that the "most important garments [of the Indo-Europeans] must have been the colored woolen blanket-wrap and the belt". There is, however, very little linguistic evidence for woollen textiles in Proto-'core'-Indo-European. Indo-European words for felt, felting, and fulling (listed in Mallory & Adams 1997: 569-570, 573 and 2006: 233, 236) have a limited distribution and none of them can be securely traced back to the proto-language, while Proto-Indo-European terms for spinning (**sneh₁-*) and weaving (**h₁ueb^{h}-*)[9] may originally have been used for textiles made of plant fibers

[8]Note that at the Afanasievo site of Balyktyul, 61% of the bones found were of domesticated sheep/goats (Anthony 2007: 310). This suggests that sheep (or perhaps goats) were of great importance, but this may have been because of their meat and milk rather than their wool.

[9]The meaning 'to weave' is clearly distinguished from 'to plait', for which the root **pleḱ-* can be reconstructed.

only. Textile fragments found in Yamnaya graves were made of the fibers of "cattail (*Typha*), rush (*Juncus*), reed, feather grass and gramineous plants. Supposedly, leather, sinew and horse hair were used as well" (Shishlina 2008: 234). It is probably no coincidence that the root of the Indo-European word for sinew, **sneh₁-*, was homophonous with that of the word for spinning. It is doubtful that flax or hemp fibers would have been used for textile production as well, because the word for flax and linen that is shared by Latin *līnum*, Greek *línon*, Lithuanian *lìnai* and Russian *lën* is most probably a later loanword from a non-Indo-European source (de Vaan 2008: 344-345; Olsen 2018: 73)[10] and the same is true for the similar words for hemp in Greek *kánnabis*, Old High German *hanap*, Russian *konopljá* and Persian *kanaf* (Kroonen 2013: 209; Olsen 2018: 73).[11]

Words for combing and plucking (**uel-*, **kes-*, **peḱ-*, **Hreu-*) do not prove the existence of woollen textiles and for at least part of these terms the object that was plucked or combed may originally have been hair or plant fibers, cf. Latin *vellō* 'to pluck (a bird, hair)', Old Norse *hǫrr* 'flax' and Sanskrit *pákṣman-* 'eyelashes' and *róman-* 'hair' from these roots.[12] In conclusion,

[10]The earliest archaeological evidence for woven linen textile north of the Caucasus is from Novosvobodnaya and can be dated to the fourth millennium (Majkop culture). The cloth may have been imported from elsewhere (Shishlina, Orfinskaya & Golikov 2003).

[11]The fact that Indo-European languages in Europe and western Asia independently borrowed words for 'hemp' suggests that in the early third millennium hemp played a more important role in the economic and/or cultural life of those regions than in the steppes. This poses a problem for the idea that the Early Bronze Age spread of the practice of cannabis smoking in Europe and simultaneous increase of cannabis in the archaeological record in East Asia is linked to the same migrations that are thought to have caused the spread of the Indo-European languages, as was suggested by Long et al. (2017: 252-253).

[12]The Proto-Indo-European word **peḱu* 'livestock' (Latin *pecū*, Sanskrit *páśu* etc.) may originally have referred to small cattle only, in which case it might derive from **peḱ-* 'to pluck' (Olsen 2018: 72-73). In the absence of a Proto-Indo-European word for 'goat', the difference in meaning between **peḱu* and the word for 'sheep' might then be that **peḱu* had a collective meaning only, whereas the word **h₃eui-* would be used to talk about individual, countable sheep. If this is correct, the derivation from **peḱ-* 'to pluck' makes most sense if the main value of sheep was their wool, as Olsen rightly observes. However, the evidence for an original meaning 'small cattle' is slim and there are no other neuter deverbal *u*-stems with a collective meaning parallel to **peḱu*. It

the possibility that wool was not yet used for producing textile by the speakers of Proto-'core'-Indo-European deserves serious consideration.

8. Dating Proto-Indo-Anatolian

The picture that emerges from the evidence discussed above is clear. Speakers of Proto-Indo-Anatolian made use of yoked draught animals to pull a load, perhaps with the help of a sledge or a travois, but they cannot be demonstrated to have had knowledge of the wheel, the plough, dairying or wool production. From the point of view of Indo-European, these innovations associated with the Secondary Products Revolution seem to have taken place between the Proto-Indo-Anatolian and Proto-'core'-Indo-European stages.

The contact between the speakers of an early ancestor of the Anatolian languages and the common ancestor of all other Indo-European languages was lost after the introduction of animal traction, which can hardly have happened much before 4000 BCE. This provides us with a *terminus post quem* for the latest common ancestor of all Indo-European languages (Proto-Indo-Anatolian), which is consistent with the lower end of the estimate based on the linguistic distance between the Anatolian languages and the rest of Indo-European discussed in section 3.

The introduction of the wheel and the plough and the systematic exploitation of cattle and sheep for their milk by speakers of Proto-Indo-European can all have taken place after Anatolian had split off, but before Tocharian split off around 3400 BCE. If this was indeed the case, the introduction and spread of these techniques can be assumed to have taken some time. Proto-Indo-Anatolian would then have been spoken at least a few generations before the Tocharian split, no later than approximately 3600 BCE. The systematic exploitation of sheep for their wool may have started after the Tocharian split and, in view of the lack of terminology associated with woollen textiles, perhaps even after the dissolution of 'core'-Proto-Indo-European around the year 3000 BCE.

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therefore seems prudent not to use **peḱu* as evidence in the present discussion.

The number of linguistic innovations that must have taken place between the Anatolian and Tocharian splits is considerable (see Kloekhorst & Pronk 2019: 8), which suggests a date for Proto-Indo-Anatolian closer to 4000 BCE than to 3600 BCE. Combining all evidence discussed here, 4000-3800 seems to be a reasonable estimate for the Anatolian split. This is only slightly later than Kloekhorst's (in press) estimate of 4300-4200 BCE based on the linguistic distance between Anatolian and 'core'-Indo-European and is very close to Anthony and Ringe's (2015: 208) estimate of 4200-4000 BCE based on the earliest evidence for migrations out of the steppes. A date of 4000-3800 for Proto-Indo-Anatolian is perfectly compatible with the hypothesis that Proto-Indo-Anatolian may have been spoken by people of the archaeological Khvalynsk culture.[13]

[13]This article was first presented as a paper at a workshop in honor of David Anthony at the *25th Annual Meeting of the European Association of Archaeologists* in Bern, 2019. I want to express my gratitude to Alwin Kloekhorst for the fruitful discussions that we had about many of the issues touched upon in this article.

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