**Phonological characters.**

The evidential basis for the coding of these characters differs from that for the lexical characters. In order to be entered in the lexical database, a word has to be actually present in the relevant basic meaning in the particular historical stage and dialect of the language that we have chosen; that is necessary in order to make our identifications of "basic" words for particular meanings as consistent as possible. For phonological characters there is no such constraint; the coding reflects whether the sound change or sequence of changes in question has occurred *at any stage of the language* prior to the one reflected in the lexical data.

The characters discussed here were chosen because they seemed unusual enough or complex enough to be probative. It can be seen that they do not validate all the clades that our methodology has found, and that should cause no surprise: purely phonological evidence for some IE subgroups is much better than for others. Most of them define uncontroversial subgroups of the family also recognizable on other grounds; we were able to discover only three (P1 through P3) that might validate higher clades. More phonological characters could have been used, but they would only have confirmed the subgroups already established by the characters we did use.

Because individual sound changes are usually "natural" and repeatable, most of these characters reflect sets or sequences of changes which are reasonably unlikely to have cooccurred by chance. Except as noted below, all are directed characters (i.e., we can state with confidence which states are innovative *independently of the cladistic tree*).

P1 *p … $k^w$ > *$k^w$ … $k^w$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 4 | Av. | 1 | Luv. | 5 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 6 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 2 |
| TB | 1 | OI | 2 | OPru. | 1 | Osc. | 3 |
| Ved. | 1 | Lat. | 2 | Latv. | 1 | Umb. | 3 |

| | |
|---|---|
| 1 absent [ancestral] | 3 evidence destroyed by merger of *p and *k$^{w}$ |
| 2 present | 4 &c. no evidence (relevant words not attested) |

This sound change affected only the three words that exhibited a sequence of phonemes *p … k$^{w}$ at the beginning of successive syllables, namely *pénk$^{w}$e 'five', *pek$^{w}$- 'to cook', and *perk$^{w}$-, the name of a species of tree (not closely identifiable); they thereby became *k$^{w}$énk$^{w}$e, *k$^{w}$ek$^{w}$-, and *k$^{w}$erk$^{w}$- respectively. Since none of those words is attested in Anatolian, we have no evidence that the change did or did not occur in that subgroup. On the other hand, Oscan and Umbrian *cannot* provide any evidence that this change did or did not occur in their prehistory, since they have merged inherited *p and *k$^{w}$; we have therefore coded them with a separate state—a single state for both, since specialists have concluded that the merger was a historically shared change (cf. Meiser 1986:79-92).[1]

In most IE languages it is clear that the change *p … k$^{w}$ > *k$^{w}$ … k$^{w}$ did not occur; in Latin and the Celtic languages it clearly did. (Note that Welsh *p* reflects *k$^{w}$; inherited *p did not survive in Welsh, nor in any Celtic language.) Watkins 1966:33-4 has claimed that this was not a historically shared change, on the following grounds. Caesar, following other ancient authors, mentions a forest *Hercynia,* whose name is probably cognate with Gothic *faírguni* 'mountain', is probably formed to the root *perk$^{w}$-, and ought to be Celtic, since it appears to show *h-* for *p-, plausibly an early stage of the sequence of changes by which Celtic lost *p. The preform was *perkunyo-, with initial *p rather than *k$^{w}$, because the second *k$^{w}$ of the root had been delabialized to *k by the following *u. Watkins argues that since delabialization preceded the sound change coded by this character in Celtic, but not in Latin *quercus* 'oak', then the sound

[1] In Ringe, Warnow, and Taylor 2002:113, fn. 37, we did not say explicitly that this encodes received opinion. Some critics have apparently seized on the wording of that note to infer that our selection and/or coding of characters is biased; one has even asserted, without evidence, that we have selected and coded some characters *in order to* validate particular clades. We have not. Note that coding Oscan and Umbrian with different states for this character would not have changed our results at all, since the Osco-Umbrian clade is forced by character P22 and the narrower coding of lexical character 28 'day (24 hours)' and is also uniquely characterized by lexical 92 'left' and 108 'near'. Moreover, we could easily have used more phonological characters (cf. Meiser 1986:39-107)) and lexical characters (cf. e.g. Buck 1928:11-3)), as well as inflectional markers (e.g. infinitive *-om,* future perfect *-us-,* and the future stem *fus-* 'will be'), if our purpose had been to validate this completely uncontroversial clade. The coding of this character simply reflects what we believe we know about shared changes and states; that is necessarily the case for every character.

change cannot have been historically shared, since the ancestors of Celtic and Latin were no longer *identical* when the sound change occurred.

But Watkins is mistaken on at least two quite different grounds. First, the phonological rule delabializing *$k^w$, *$g^w$, and *$g^{wh}$ next to *u, *ū, or *w existed already in PIE (Weiss 1993:153-65); thus it must have been ancestral both to Celtic and to Italic. It follows that it is not *Hercynia* that demands an explanation, but Latin *quercus:* how did initial *p become *$k^w$ in the latter word if the root-final *$k^w$ had already become *k? What we know about PIE nominal inflection provides a ready answer. It is likely that this word, like most u-stems in late PIE, exhibited a proterokinetic ablaut pattern; a partial paradigm will have been: nom. sg. *pérk-u-s, acc. sg. *pérk-u-m, gen. sg. *pr̥$k^w$-éw-s, loc. sg. *pr̥$k^w$-éw(-i), etc. Since *u did not immediately follow *$k^w$ in the oblique forms of the noun, *$k^w$ would not have been delabialized in those forms, and the sound change under discussion would have occurred. The result would have been a more irregular paradigm: nom. sg. *pérk-u-s, acc. sg. *pérk-u-m, gen. sg. *$k^w$r̥$k^w$-éw-s, loc. sg. *$k^w$r̥$k^w$-éw(-i), etc. The root-final alternation between *k (before *u) and * $k^w$ (in all other forms) was still automatic and therefore unlikely to be levelled, but the word-initial alternation was unique and therefore likely to be levelled. Evidently the ancestor of Latin levelled * $k^w$ into the *p-initial forms, giving, e.g., *$k^w$érkus > *quercus*. (Compare the similar solution of Hoenigswald 1973:327-8.) In the case of the derivative *perkunyo-, however, none of these changes could occur, since *-u- followed the root in all forms. So far as we can see, this is the only explanation that will account for all the relevant facts. Note also that *$k^w$erk$^w$- does appear to survive in Celtic in Old Irish *ceirt* 'apple tree' (?; the name of Ogam <Q>), Welsh *perth* 'bush, hedge' < Proto-Celtic *$k^w$er(k)tis < *$k^w$érk$^w$-ti- (cf. Feist 1939:138, McManus 1988:155-6, both with references).[2]

Secondly, even if Watkins had been right about the timing of the delabialization, it would not necessarily follow that the change under discussion was not historically shared by the ancestors of Latin and Celtic. We know from modern sociolinguistic studies that there is variation in every speech community, and that minor differences of

[2] Other solutions can of course be proposed for the unique phenomena adduced by Watkins 1966:34. Cowgill 1970:145-6, fn. 1, effectively demolished the derivation of Old Irish *deac* from *dwei-penk$^w$-; Latin *prope* has no external cognates and can be a purely Latin creation.

dialect do not impede the spread of sound changes through the community. We hardly ever have enough information about languages of the past (even when we have records of them) to detect minor (sub)dialect differences, but we must infer by the uniformitarian principle that they existed. It follows that the nodes and edges of our phylogenetic trees cannot reasonably be taken to reflect completely unitary dialects; they must represent skeins or bundles of closely related dialects which can have differed in minor details. Therefore one cannot effectively impugn a clade by showing that a shared change was preceded in only one of the daughters by another change that affected only a few words, since that could not have caused enough divergence to split the speech community (so Cowgill 1970:113, with reference to this sound change and this clade).

There is a potentially more important objection to this character. Since all the examples of the change under discussion are within roots, and since the sequence *$k^w$ … $k^w$ did not occur within PIE roots, the sound change did not really result in a merger (Hoenigswald 1966:7 fn. 16, 1973:326-7); how, then, can we be sure that *$k^w$ … $k^w$ is the derived state, not the ancestral state? A broader consideration of relevant facts gives the answer. The prohibition against *$k^w$ … $k^w$ in roots was part of a larger constraint prohibiting oral stops at the same place of articulation in the onset and coda of root syllables; there are one or two exceptions (notably *tewd- 'knock'), but all the securely reconstructable exceptions involve coronal stops (not surprisingly, since coronals are crosslinguistically the "default" stops). If *$k^w$ … $k^w$ had been the ancestral state, it would have constituted a systematic violation of this constraint; therefore *p … $k^w$ is far more likely to have been the ancestral state. Thus this objection, too, fails to undermine the character.

It seems reasonably likely that this distant assimilation, which apparently affected only the voiceless stops (and not the voiced and breathy-voiced stops), is peculiar enough —and thus unlikely enough to have occurred more than once independently—to be used as a phonological character.

P2 full "satem" development (labiovelars merge with velars; PIE "palatals" become affricates or fricatives)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 2 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 2 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 2 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 2 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 2 | Osc. | 1 |
| Ved. | 2 | Lat. | 1 | Latv. | 2 | Umb. | 1 |

1 absent [ancestral] 2 present

It is clear that Albanian did not undergo the full satem development of dorsals (cf. Demiraj 1997:63-5). There have always been enough exceptions in Armenian to raise doubts (cf. Schmitt 1981:62-5); recently Olsen's clever suggestion of a pre-Armenian sound change *k$^{w}$o > *po (> Arm. *(h)o*), which accounts neatly for the shape of *or* 'who?' and a number of other words (Olsen 1999:805-8 with references), renders it very unlikely that whatever happened in Armenian was part of this historical development. In short, Indo-Iranian and Balto-Slavic clearly underwent this change, while the other subgroups clearly did not.

Nevertheless this character is problematic for cladistic analyses in interesting ways. A fairly small but significant number of Balto-Slavic words have clearly failed to undergo the fronting of the PIE "palatal" stops, so that the reflex of *ḱ is *k* (rather than Lithuanian *š,* OCS *s,* etc.), and so on. Some of the examples, especially in Slavic, can be loans from Germanic at a time before Grimm's Law occurred in the latter; that is especially plausible because a number of other Slavic words must have been borrowed from Germanic in the prehistoric period after Grimm's Law occurred. But there is a residue of cases like Lithuanian *akmuõ* 'stone' < PIE *h$_2$éḱmō, cf. Skt. *áśmā* 'stone', Gk. ἄκμων 'anvil') that are not amenable to such explanations. The most plausible account of these exceptions is perhaps that the sound change in question spread through an already well differentiated dialect continuum, applying inconsistently at the edges of its spread zone, and that Baltic was at such an edge (so Porzig 1954:74-5, Hock 1991:442-4). But in that case we must reckon with the possibility that this was not a shared complex of changes in any sense. Our recent work takes that into account.

This is an only moderately complex phonological character. Both parts of it recur separately (the merger of velars and labiovelars in Irish, for example, and the affrication of palatals in Luvian); it is a matter of judgment whether the two together are peculiar enough to be used as a character. The fact that one component is a phonemic merger guarantees that state 2 is innovative.

P3 "ruki"-retraction of *s

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 2 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 2 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 2 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 2 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 3 | Osc. | 1 |
| Ved. | 2 | Lat. | 1 | Latv. | 4 | Umb. | 1 |

1 absent
2 present
3, 4 situation obscured by subsequent sound change or orthography

We accept the arguments of Andersen 1968 that complete ruki-retraction originally occurred in Baltic and that the alternants were redistributed later. The subsequent merger of *s and *š—including *š which were the reflex of PIE *ḱ—in Latvian has destroyed the evidence in that language. The situation in Old Prussian is much less clear; noninitial sibilants are normally spelled *s(s),* but since all the existing documents were written by native speakers of a quite different language (German), we cannot be sure that they did not miss a contrast that actually existed in the language. Under the circumstances it seems prudent to adopt the most conservative coding, i.e. to code Old Prussian with a unique state. Note that in this case too we are using everything relevant that we know in coding the character; we do not expect that pretending ignorance would lead to more realistic results.

It is reasonable to ask what the consequences would be if we had coded Latvian and Old Prussian differently. If we had coded them with state 1, implying that they had never undergone ruki-retraction, this character would split the East Baltic, Baltic, and Balto-Slavic clades, which are well supported by many other characters; thus the overall results would not change, but this character would be incompatible with any likely tree.

If we had coded both with a single state different from 1 or 2, implying that they shared a merger of sibilants, the East Baltic clade would be split, with similar overall results. (In addition, such a coding would be implausible in terms of linguistic history and geography, since the Latvian merger is a relatively recent change and Lithuanian, which does not share the merger, intervenes squarely between Latvian and Old Prussian.)

It is also reasonable to ask what a coding that made no claims about the prehistory of Latvian and Old Prussian would look like. Since coding them with any shared state would imply either that they never underwent ruki-retraction or that they shared a development with some other language(s), the default coding would be to assign each a unique state. But that would be identical with the coding we have adopted. In this case, then, making the specific claims we have made leads to the same coding as making no claims at all.

This is a simple phonological character; whether it is peculiar enough to be used in cladistic analysis is, of course, a matter of judgment, though the highly specific and unusual conditioning of the change suggests to us that it can be. Strictly speaking, it cannot be directed, since it involves only allophony; it is not inconceivable that the ruki-rule existed in PIE but was lost in most daugters, surviving only when a subsequent phonemic split occurred. In addition, the fact that state 2 of this character and state 2 of P2 are more or less coterminous raises the suspicion that even if it was an innovation this sound change spread through an already well differentiated dialect continuum. Our recent work takes account of the fact that the change coded by P3, like that of P2, might not be a historically shared change.

P4 lenition of stops after long vowels and unstressed vowels (only)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 2 | Av. | 1 | Luv. | 2 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 2 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

Lenition is a commonplace phonetic change, but the complex conditioning of this character shows that it encodes two different historical events which are unlikely to have cooccurred in more than one lineage. The combination is characteristic of Anatolian. Since merger (of voiceless and voiced stops) is involved, it is clear that state 2 is derived. Hittite has levelled out most of the effects of lenition after unstressed vowels, but we accept the arguments of Melchert 1994:60-1 that relic forms show that that change did occur in the prehistory of Hittite.

P5 medial *$k^w$ > *$g^w$ unless *s follows immediately

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 2 | Av. | 1 | Luv. | 2 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 2 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

Though this is a single sound change, its conditioning is so strange that it can be used as a character: voicing affects only the voiceless labiovelar and is not blocked by an immediately following voiceless stop. See Melchert 1994:61-2 for the evidence and discussion.

P6 “limited” Cop’s Law (*éC- > *áCC-)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 2 | Av. | 1 | Luv. | 2 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 2 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

We accept the argument of Melchert 1994:62, with references, that only this limited version of Cop’s Law was shared by Hittite. Again the strangeness of the conditioning—gemination occurred only after an accented *e that was word-initial (not merely in an

initial syllable)— makes this change suitable for use as a phonological character.

P7 word-initial *ye- > *e-

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 2 | Av. | 1 | Luv. | 2 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 2 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

Unlike the loss of initial *y (*j) in Irish and Norse, the Anatolian sound change was conditioned by the following vowel (Melchert 1994:75). It seems reasonable, at least, to use it as a character because of its highly specific conditioning.

P8 merger of *i, *e, and *u, and merger of *a and *ō (but *ā and *o remain distinct)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 2 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 1 |
| TB | 2 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

This character encodes several sequences of Tocharian sound changes (see Ringe 1996: 90-8,124-32); all the changes are natural and repeatable, but it seems very unlikely that all would cooccur in more than one lineage.

P9 *mb$^{h}$ > *m

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 2 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 1 |
| TB | 2 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

The fact that only the labial breathy-voiced stop seems to have undergone such a change (see Ringe 1996:42-3) makes this sound change (or, as is more likely, sequence of sound changes) unusual enough to use as a character.

P10 loss of preconsonantal *d, affrication of remaining *d, and merger of palatalized *d with palatalized dorsals

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 2 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 1 |
| TB | 2 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

This unusual sequence of changes is a typical complex phonological character. See Ringe 1996:64-5, 146-50 for discussion.

P11 *tsk > *tk, but *kst > *kəst

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 2 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 1 |
| TB | 2 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

Neither of these changes recurs in the languages of our database. See Ringe 1996:71-2.

P12 merger of all nonhigh vowels and syllabic nasals

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 2 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 2 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 2 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

Though merger of low vowels and syllabic nasals recurs in Greek, and merger of most nonhigh vowels recurs in Luvian, the combination is characteristic of Indo-Iranian.

P13 Bartholomae's Law (rightward assimilation of aspiration)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 2 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 3 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 2 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present 3 no evidence

Though Bartholomae's Law is suspected of having been present in PIE (or in some larger group of daughters), it is unarguably present as a phonological rule only in Indo-Iranian. Since we know that it was present in Gāthā-Avestan but was lost in "younger" Avestan, its absence in Old Persian does *not* lead to the secure inference that it was never present in the prehistory of that language; we have therefore cautiously coded Old Persian with a unique state. However, the fact that the rule can be shown to have been lost in one lineage casts doubt on our assignment of state 1 to at least some other IE languages, and also makes the directionality of the character questionable. This is therefore a somewhat problematic character.

P14 merger of voiceless aspirated stops and preconsonantal voiceless stops as fricatives

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 2 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 2 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

(Many IE languages, of course, have not even developed voiceless aspirated stops and so could not have undergone the merger in any case.)

P15 development of intonation contrast (acute vs. circumflex) in nonfinal heavy syllables

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 2 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 2 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 2 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 2 | Umb. | 1 |

1 absent [ancestral] 2 present

Some similar contrast can be demonstrated for final syllables in Germanic (though the details are obscure) and Greek, but only Balto-Slavic languages can be shown to have developed such a contrast in nonfinal syllables. Note that, although intonations are not written in OCS, they are reconstructable for Proto-Slavic; thus it is clear that this change did occur in the prehistory of OCS.

Like P1, this character codes a phonetic change without merger. We are able to direct it because Balto-Slavic acute syllables correspond to syllables in whose codas a laryngeal is reconstructable, and since laryngeals are also reconstructable in other positions, it is state 1 which is consistent with the structure of PIE and so must be ancestral.

P16 sequence of changes:

(a) Grimm's Law; (b) Verner's Law; (c) shift of stress to initial syllables;
(d) merger of unstressed *e with *i unless *r follows immediately

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 2 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 2 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 2 |
| Alb. | 1 | OE | 2 | OPer. | 1 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

See Ringe 2006:93-105, 122-6, 152.

P17 sequence of changes:

(a) loss of intervocalic *j unless *i precedes and does *not* follow immediately;
(b1) *əi > *ai, and (b2) *ōV > *$\bar{\bar{o}}$

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 2 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 2 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 2 |
| Alb. | 1 | OE | 2 | OPer. | 1 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

We accept the arguments of Cowgill 1959 and Þórhallsdóttir 1993 regarding these changes; see Ringe 2006:128-36.

P18 merger of word-final nonnasalized *ō with short *u; lowering of *ē to *ā in stressed syllables, but merger of *ē with *ai in unstressed syllables

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 2 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 2 |
| Alb. | 1 | OE | 2 | OPer. | 1 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

P19 merger of *ðw and *zw with *ww

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 2 |
| Alb. | 1 | OE | 2 | OPer. | 1 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

This odd sound change, characteristic only of West Germanic languages, is often overlooked; see Stiles 1985:89-94 for full discussion and references. (Many of the languages in our database never developed *ð or *z and so could not have undergone this change.)

P20 merger of *ē with *ī; merger of *ō with *ū in final syllables (including monosyllables), but with *ā elsewhere

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 2 |
| TB | 1 | OI | 2 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

This character encodes several Celtic sound changes; all the changes are natural and repeatable, but it seems very unlikely that all would cooccur in more than one lineage. See Lewis and Pedersen 1974:6-7.

P21 *p > *k before obstruents, *b before liquids, *w before nasals and after *s, Ø elsewhere

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 2 |
| TB | 1 | OI | 2 | OPru. | 1 | Osc. | 1 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 1 |

1 absent [ancestral] 2 present

See Thurneysen 1961:138-40, Lewis and Pedersen 1974:18-9, 26-7.

P22 syncope of short vowels in final syllables next to *s and after semivowels

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Hitt. | 1 | Av. | 1 | Luv. | 1 | Goth. | 1 |
| Arm. | 1 | OCS | 1 | Lyc. | 1 | ON | 1 |
| Gk. | 1 | Lith. | 1 | TA | 1 | OHG | 1 |
| Alb. | 1 | OE | 1 | OPer. | 1 | Welsh | 1 |
| TB | 1 | OI | 1 | OPru. | 1 | Osc. | 2 |
| Ved. | 1 | Lat. | 1 | Latv. | 1 | Umb. | 2 |

1 absent [ancestral] 2 present

See Meiser 1986:59-66 with references. The highly specific and rather odd conditioning of this character suggests that several sound changes were involved and makes this a reliable phonological character. Final-syllable syncope under other conditions is more widespread (next to *r in Latin and perhaps in Anatolian (see Melchert 1994:87-8); under much broader conditions in Latvian, Gothic, Old Norse, etc.).

Bibliography.

Andersen, Henning. 1968. IE **s* after *i, u, r, k* in Baltic and Slavic. Acta linguistica Hafniensia 11.171-90.

Buck, Carl D. 1928. A grammar of Oscan and Umbrian. 2nd ed. Boston: Ginn & Co.

Cowgill, Warren. 1959. The inflection of the Germanic *ō*-presents. Language 35.1-15.

—. 1970. Italic and Celtic superlatives and the dialects of Indo-European. Cardona, George, et al. (edd.), Indo-European and Indo-Europeans (Philadelphia: U. of Pennsylvania Press) 113-53.

Demiraj, Bardhyl. 1997. Albanische Etymologien. Amsterdam: Rodopi.

Feist, Sigmund. 1939. Vergleichendes Wörterbuch der gotischen Sprache. Leiden: Brill.

Hock, Hans Henrich. 1991. Principles of historical linguistics. Berlin: Mouton de Gruyter.

Hoenigswald, Henry. 1966. Criteria for the subgrouping of languages. Birnbaum, Henrik, and Jaan Puhvel (edd.), Ancient Indo-European dialects (Berkeley: U. of California Press) 1-12.

—. 1973. Indo-European **p* in Celtic and the claim for relative chronologies. JIES 1.324-9.

Lewis, Henry, and Holger Pedersen. 1974. A concise comparative Celtic grammar. 3rd ed. Göttingen: Vandenhoeck & Ruprecht.

McManus, Damian. 1988. Irish letter-names and their kennings. Ériu 39.127-68.

Meiser, Gerhard. 1986. Lautgeschichte der umbrischen Sprache. Innsbruck: IBS.

Melchert, H. Craig. 1994. Anatolian historical phonology. Amsterdam: Rodopi.

Olsen, Birgit Anette. 1999. The noun in Biblical Armenian. Berlin: Mouton de Gruyter.

Porzig, Walter. 1954. Die Gliederung des indogermanischen Sprachgebiets. Heidelberg: Winter.

Ringe, Don. 1996. On the chronology of sound changes in Tocharian. Vol. 1. New Haven: American Oriental Society.

—. 2006. From Proto-Indo-European to Proto-Germanic. A linguistic history of English, Vol. 1. Oxford: Oxford U. Press.

Schmitt, Rüdiger. 1981. Grammatik des Klassisch-Armenischen. Innsbruck: IBS.

Stiles, Patrick V. 1985. The fate of the numeral '4' in Germanic. NOWELE 6.81-104.

Thurneysen, Rudolf. 1961. A grammar of Old Irish. Revised ed. Dublin: Institute for Advanced Studies.

Watkins, Calvert. 1966. Italo-Celtic revisited. Birnbaum, Henrik, and Jaan Puhvel (edd.), Ancient Indo-European dialects (Berkeley: U. of California Press) 29-50.

Weiss, Michael. 1993. Studies in Italic nominal morphology. Ph.D. dissertation, Cornell U.

Þórhallsdóttir, Guðrún. 1993. The development of intervocalic **j* in Proto-Germanic. Ph.D. dissertation, Cornell U.