

APPENDIX II: PROTO-INDO-EUROPEAN PHONOLOGY

II.1. DORSALS: THE PALATOVELAR QUESTION

1. Direct comparison in early IE studies, informed by the *Centum-Satem* isogloss, yielded the reconstruction of three rows of dorsal consonants in Late Proto-Indo-European by Bezzenger (1890), a theory which became classic after Brugmann (*Grundriss*, 1879) included it in its 2nd Edition. The palatovelars **kʲ*, **gʲ*, and **gʰʲ* were supposedly [k]- or [g]-like sounds which underwent a characteristic phonetic change in the satemized languages – three original “velar rows” had then become two in all Indo-European dialects attested.

NOTE. It is disputed whether Albanian shows remains of two or three series (cf. Ölberg 1976, Kortlandt 1980, Pänzer 1982), although the fact that only the worst known (and neither isolated nor remote) IE dialect could be the only one to show some remains of the oldest phonetic system is indeed very unlikely.

After that original belief, then, The centum group of languages merged the palatovelars **kʲ*, **gʲ*, and **gʰʲ* with the plain velars **k*, **g*, and **gʰ*, while the satem group of languages merged the labiovelars **kʷ*, **gʷ*, and **gʰʷ* with the plain velars **k*, **g*, and **gʰ*.

NOTE. Such hypothesis would then support an evolution [*kʲ*] → [*k*] of *Centum* dialects before *e* and *i*, what is clearly against the general tendency of velars to move forward its articulation and palatalize in these environments.

2. The existence of the palatovelars as phonemes separate from the plain velars and labiovelars has been disputed. In most circumstances they appear to be allophones resulting from the neutralization of the other two series in particular phonetic circumstances. Their dialectal articulation was probably constrained, either to an especial phonetic environment (as Romance evolution of Latin [k] before [e] and [i]), either to the analogy of alternating phonetic forms. However, it is difficult to pinpoint exactly what the circumstances of the allophony are, although it is generally accepted that neutralization occurred after *s* and *u*, and often before *r* or *a*; also apparently before *m* and *n* in some Baltic dialects

NOTE. The original allophonic distinction was disturbed when the labiovelars were merged with the plain velars. This produced a new phonemic distinction between palatal and plain velars, with an unpredictable alternation between palatal and plain in related forms of some roots (those from

original plain velars) but not others (those from original labiovelars). Subsequent analogical processes generalized either the plain or palatal consonant in all forms of a particular root. Those roots where the plain consonant was generalized are those traditionally reconstructed as having “plain velars” in the parent language, in contrast to “palatovelars”.

Many PIE linguists still believe that all three series were distinct in Late Proto-Indo-European, although newest research show that the palatovelar series were a later phonetic development of certain Satem dialects, later extended to others; this belief was originally articulated by Antoine Meillet in 1893, and was followed by linguists like Hirt (1899, 1927), Lehmann (1952), Georgiev (1966), Bernabé (1971), Steensland (1973), Miller (1976), Allen (1978), Kortlandt (1980), Shields (1981), Adrados (1995), etc.

NOTE. There is, however, a minority who consider the labiovelars a secondary development from the pure velars, and reconstruct only velars and palatovelars (Kuryłowicz), already criticized by Bernabé, Steensland, Miller and Allen. Still less acceptance had the proposal to reconstruct only a labiovelar and a palatal series (Magnusson).

There is residual evidence of various sorts in the Satem languages of a former distinction between velar and labiovelar consonants:

- In Sanskrit and Balto-Slavic, in some environments, resonant consonants (denoted by *R*) become *iR* after plain velars but *uR* after labiovelars.
- In Armenian, some linguists assert that *k^w* is distinguishable from *k* before front vowels.
- In Albanian, some linguists assert that *k^w* and *g^w* are distinguishable from *k* and *g* before front vowels.

NOTE. This evidence shows that the labiovelar series was distinct from the plain velar series in Late PIE, and cannot have been a secondary development in the Centum languages. However, it says nothing about the palatovelar vs. plain velar series. When this debate initially arose, the concept of a phoneme and its historical emergence was not clearly understood, however, and as a result it was often claimed (and sometimes still is claimed) that evidence of three-way velar distinction in the history of a particular IE language indicates that this distinction must be reconstructed for the parent language. This is theoretically unsound, as it overlooks the possibility of a secondary origin for a distinction.

3. The original (logical) trend to distinguish between series of “satemizable” dorsals, called ‘palatovelars’, and “non-satemizable” dorsals, the ‘pure velars’, was the easiest

explanation found by neogrammarians, who apparently opened a different case for each irregularity they found. Such an initial answer should be considered erroneous today, at least as a starting-point to obtain a better explanation for this “phonological puzzle” (Bernabé).

NOTE. “Palatals” and Velars appear mostly in complementary distributions, what supports their explanation as allophones of the same phonemes. Meillet (1937) establishes the contexts in which there are only velars: before *a*, *r*, and after *s*, *u*, while Georgiev (1966) states that the palatalization of velars should have been produced before *e*, *i*, *j*, and before liquid or nasal or *w + e*, *i*, offering statistical data supporting his conclusions. The presence of palatalized velar before *o* is then produced because of analogy with roots in which (due to the apophonic alternance) the velar phoneme is found before *e* and *o*, so the alternance **kʲe/*ko* would be leveled as **kʲe/*kʲo*.

Arguments in favor of only two series of velars include:

A) The plain velar series is statistically rarer than the other two, is entirely absent from affixes, and appears most often in certain phonological environments (described above).

B) Alternations between plain velars and palatals are common in a number of roots across different “*Satem*” languages, where the same root appears with a palatal in some languages but a plain velar in others. This is consistent with the analogical generalization of one or another consonant in an originally alternating paradigm, but difficult to explain otherwise:

- **ak/ok-*, *sharp*, cf. Lith. *akúotas*, O.C.S. *ostru*, O.Ind. *asrís*, Arm. *aseln*, but Lith. *asrùs*.
- **akmon-*, *stone*, cf. Lith. *akmuõ*, O.C.S. *kamy*, O.Ind. *ásma*, but Lith. *ásmens*.
- **keu-*, *shine*, cf. Lith. *kiáune*, Russ. *kuna*, O.Ind. *Svas*, Arm. *sukh*.
- **bʰleg-*, *shine*, cf. O.Ind. *bhárgas*, Lith. *balgans*, O.C.S. *blagu*, but Ltv. *blâzt*.
- **gʰerdh-*, *enclose*, O.Ind. *grhá*, Av. *gərəda*, Lith. *gardas*, O.C.S. *gradu*, Lith. *zardas*, Ltv. *zârdas*.
- **swekros*, *father-in-law*, cf. O.Sla. *svekry*, O.Ind. *śvaśru*.

B) The existence of different pairs (“*satemized*” and “*not-satemized*”) in the same language, as e.g.:

- *selg-, *throw*, cf. O.Ind. *srjāti, sargas*
- *kau/keu-, *shout*, cf. Lith. *kaukti*, O.C.S. *kujati*, Russ. *sova* (as Gk. *kauax*); O.Ind. *kauti, suka-*.
- *kleu-, *hear*, Lith. *klausyti, slove*, O.C.S. *slovo*; O.Ind. *karnas, sruti, srósati, śrnóti, sravas*.
- *leuk-, O.Ind. *rokás, ruśant-*.

NOTE. The old argument proposed by Brugmann (and later copied by many dictionaries) about “*Centum loans*” is not tenable today. For more on this, see Szemerényi (1978), Mayrhofer (1952), Bernabé (1971).

C) Non-coincidence in periods and number of satemization stages;

- Old Indian shows two stages,
 1. PIE *k → O.Ind. *s*, and
 2. PIE *k^{we}, *k^{wi} → O.Ind. *ke, ki*, & PIE *ske, *ski > O.Ind. *c* (cf. *cim, candra*, etc.).
- In Slavic, however, three stages are found,
 1. PIE *k → *s*,
 2. PIE *k^{we}, *k^{wi} → č (*čto, čelobek*), and
 3. PIE *k^{woi} → *koi* → *ke* gives *ts* (as Sla. *tsenā*).

D) In most attested languages which present aspirated as result of the so-called “palatals”, the palatalization of other phonemes is also attested (e.g. palatalization of labiovelars before *e, i*, etc.), what may indicate that there is an old trend to palatalize all possible sounds, of which the palatalization of velars is the oldest attested result.

E) The existence of ‘Centum dialects’ in so-called Southern dialects, as Greek and some Paleo-Balkan dialects, and the presence of Tocharian, a ‘Centum dialect’, in Central Asia, being probably a northern IE dialect.

NOTE. The traditional explanation of a three-way dorsal split requires that all Centum languages share a common innovation that eliminated the palatovelar series. Unlike for the Satem languages, however, there is no evidence of any areal connection among the Centum languages, and in fact there is evidence against such a connection -- the Centum languages are geographically

noncontiguous. Furthermore, if such an areal innovation happened, we would expect to see some dialect differences in its implementation (cf. the above differences between Balto-Slavic and Indo-Iranian), and residual evidence of a distinct palatalized series (such evidence for a distinct labiovelar series does exist in the Satem languages; see below). In fact, however, neither type of evidence exists, suggesting that there was never a palatovelar series in the Centum languages.

4. It is generally believed that Satemization could have started as a late dialectal ‘wave’ (although not necessarily), which eventually affected almost all PIE dialectal groups. The origin is probably to be found in velars followed by *e*, *i*, even though alternating forms like **gen/gon* caused natural analogical corrections within each dialect, which obscures still more the original situation. Thus, non-satemized forms in so-called Satem languages are actually non-satemized remains of the original situation, just as Spanish has *feliz* and not **heliz*, or *fácil* and not *hácil*, or French uses *facile* and *nature*, and not **fêle* or **nûre* as one should expect from its phonetic evolution. Some irregularities are indeed explained as borrowings from non-satemized dialects.

5. Those who support the model of the threefold distinction in PIE cite evidence from Albanian (Pedersen) and Armenian (Pisani) that they treated plain velars differently from the labiovelars in at least some circumstances, as well as the fact that Luwian apparently had distinct reflexes of all three series: **k^l > z* (probably [ts]); **k > k*; **k^w > ku* (possibly still [k^w]) (Craig Melchert).

NOTE 1. Also, one of the most difficult problems which subsist in the interpretation of the satemization as a phonetic wave is that, even though in most cases the variation **k^l/k* may be attributed either to a phonetic environment or to the analogy of alternating apophonic forms, there are some cases in which neither one nor the other may be applied. Compare for example **ok^ltō(u)*, eight, which presents *k* before an occlusive in a form which shows no change (to suppose a syncope of an older **ok^litō*, as does Szemerényi, is an explanation *ad hoc*). Other examples in which the palatalization cannot be explained by the next phoneme nor by analogy are **swekru-*, husband’s mother, **akmōn*, stone, **peku*, cattle. Such (still) unexplained exceptions, however, are not sufficient to consider the existence of a third row of ‘later palatalized’ velars (Bernabé, Cheng & Wang), although there are still scholars who come back to the support of the three velar rows’ hypothesis (viz. Tischler 1990).

NOTE 2. Supporters of the palatovelars cite evidence from the Anatolian language Luwian, which supposedly attests a three-way velar distinction **k^l→z* (probably [ts]); **k→k*; **k^w→ku* (probably [k^w]), defended by Melchert (1987). So, the strongest argument in favor of the

traditional three-way system is that the distinction supposedly derived from Luwian findings must be reconstructed for the parent language. However, the underlying evidence “hinges upon especially difficult or vague or otherwise dubious etymologies” (see Sihler 1995); and, even if those findings are supported by other evidence in the future, it is obvious that Luwian might also have been in contact with *satemization* trends of other (Late) PIE dialects, that it might have developed its own satemization trend, and that maybe the whole system was remade within the Anatolian branch.

6. A system of two gutturals, Velars and Labiovelars, is a linguistic anomaly, isolated in the PIE occlusive subsystem – there are no parallel oppositions b^w - b , p^w - p , t^w - t , d^w - d , etc. Only one feature, their pronunciation with an accompanying rounding of the lips, helps distinguish them from each other. Labiovelars turn velars before $-u$, and there are some neutralization positions which help identify labiovelars and velars; also, in some contexts (e.g. before $-i$, $-e$) velars tend to move forward its articulation and eventually palatalize. Both trends led eventually to Centum and Satem dialectalization.

II.2. PHONETIC RECONSTRUCTION

II.2.1. PROTO-INDO-EUROPEAN SOUND LAWS

A few sound-laws can be reconstructed, that may have been effective already in Late PIE dialects, by internal reconstruction.

- Sievers' Law (Edgerton's Law, Lindeman's option)
- Hirt's Law
- Grassman's Law
- Bartholomae's Law

A. SIEVERS' LAW

Sievers' Law in Indo-European linguistics accounts for the pronunciation of a consonant cluster with a glide before a vowel as it was affected by the phonetics of the preceding syllable. Specifically it refers to the alternation between $*ij$ and $*j$, and possibly $*uw$ and $*u$, in Indo-European languages. For instance, Proto-Indo-European $*kor$ - jo - s became Gothic *harjis* “army”, but PIE $*kerd^h$ - jo - s became Proto-Germanic $*herdijas$, Gothic *hairdeis* [hɛrdīs] “shepherd”. It differs from an ablaut in that the alternation is context-sensitive: PIE $*ij$ followed a heavy syllable (a syllable with a diphthong, a long

vowel, or ending in more than one consonant), but **j* would follow a light syllable (i.e. a short vowel followed by a single consonant). This was first noticed by Germanic philologist Eduard Sievers, and his aim was to account for certain phenomena in the Germanic languages. He originally only discussed **j* in medial position. He also noted, almost as an aside, that something similar seemed to be going on in the earliest Sanskrit texts (thus in the Rigveda *dāivya-* “heavenly” actually had three syllables in scansion (*dāivīya-*) but say *satya-* “true” was scanned as written). After him, scholars would find similar alternations in Greek and Latin, and alternation between **uw* and **u*, though the evidence is poor for all of these. Through time, evidence was announced regarding similar alternations of syllabicity in the nasal and liquid semivowels, though the evidence is extremely poor for these, despite the fact that such alternations in the non-glide semivowels would have left permanent, indeed irreversible, traces.

The most ambitious extension of Sievers’ Law was proposed by Franklin Edgerton in a pair of articles in the journal *Language* in 1934 and 1943. He argued that not only was the syllabicity of prevocalic semivowels by context applicable to all six Indo-European semivowels, it was applicable in all positions in the word. Thus a form like **djēus*, “sky” would have been pronounced thus only when it happened to follow a word ending with a short vowel. Everywhere else it would have had two syllables, **dijēus*.

The evidence for alternation presented by Edgerton was of two sorts. He cited several hundred passages from the oldest Indic text, the Rigveda, which he claimed should be rescanned to reveal hitherto unnoticed expressions of the syllable structure called for by his theory. But most forms show no such direct expressions; for them, Edgerton noted sharply skewed distributions that he interpreted as evidence for a lost alternation between syllabic and nonsyllabic semivowels. Thus say *śiras* “head” (from **śrros*) has no monosyllabic partner **śras* (from **śros*), but Edgerton noted that it occurred 100% of the time in the environments where his theory called for the syllabification of the **r*. Appealing to the “formulaic” nature of oral poetry, especially in tricky and demanding literary forms like sacred Vedic versification, he reasoned that this was direct evidence for the previous existence of an alternant **śras*, on the assumption that when (for whatever reason) this **śras* and other forms like it came to be shunned, the typical collocations in which they would have (correctly) occurred inevitably became obsolete

pari passu with the loss of the form itself. And he was able to present a sizeable body of evidence in the form of these skewed distributions in both the 1934 and 1943 articles.

In 1965 Fredrik Otto Lindeman published an article proposing a significant modification of Edgerton's theory. Disregarding Edgerton's evidence (on the grounds that he was not prepared to judge the niceties of Rigvedic scansion) he took instead as the data to be analyzed the scansions in Grassmann's *Wörterbuch zum Rig-Veda*. From these he concluded that Edgerton had been right, but only up to a point: the alternations he postulated did indeed apply to all semivowels; but in word-initial position, the alternation was limited to forms like **djēus/dijēus* "sky", as cited above—that is, words where the "short" form was monosyllabic.

B. HIRT'S LAW

Hirt's law, named after Hermann Hirt who postulated it originally in 1895, is a Balto-Slavic sound law which states in its modern form that the inherited Proto-Indo-European stress would retract to non-ablauting pretonic vowel or a syllabic sonorant if it was followed by a consonantal (non-syllabic) laryngeal that closed the preceding syllable.

Compare:

- PIE: **d^hūmós* "smoke" (compare Sanskrit *dhūmá* and Ancient Greek *thumós*) → Lithuanian *dū' mai*, Latvian *dūmi*, Croatian/Serbian *dīm*.
- PIE **g^wrīwā* "neck; mane" (compare Sanskrit *grīvā*) → Latvian *ģva*, Croatian/Serbian *grīva*.
- PIE **p_lnós* "full" (compare Sanskrit *pūrṇá*) → Lithuanian *pilnas*, Latvian *pīlns*, Serbian *pŭn*.

Hirt's law did not operate if the laryngeal preceded a vowel, or if the laryngeal followed the second component of a diphthong. Therefore, Hirt's law must be older than then the loss of laryngeals in prevocalic position (in glottalic theory formulation: to the merger of glottalic feature of PIE voiced stops who dissolved into laryngeal and buccal part with the reflexes of the original PIE laryngeals), because the stress was not retracted in e.g. PIH **tenh₂wós* (Ancient Greek *tanaós*, Sanskrit *tanú*) "thin" → Latvian *tīēvs*, and also older than the loss of syllabic sonorants in Balto-Slavic, as can be seen from the abovementioned reflexes of PIH **p_lh₁nós*, and also in e.g. PIH **d_lh₁g^hós* "long" (compare

Sanskrit *dīrghá*, Ancient Greek *dolikhós*) → Lithuanian *ilgas*, Latvian *ilgs*, Croatian/Serbian *dùg*.

It follows from the above that Hirt's law must have preceded Winter's law, but was necessarily posterior to Balto-Slavic oxytonesis (shift of stress from inner syllable to the end of the word in accent paradigms with end-stressed forms), because oxytonesis-originating accent was preserved in non-laryngeal declension paradigms; e.g. the retraction occurs in mobile PIH **eh₂*-stems so thus have dative plural of Slovene *goràm* and Chakavian *goràmi* (< PBSl. **-āmús*), locative plural of Slovene and Chakavian *goràh* (< PBSl. **-āsú*), but in thematic (o-stem) paradigm dative plural of Slovene *možêm* (< PBSl. **-mús*), locative plural of Slovene *možéh* and Chakavian *vlāsíh* (< PBSl. **-oysú*). The retraction of accent from the ending to the vowel immediately preceding the stem-ending laryngeal (as in PBSl. reflex of PIH **g^wrH-*) is obvious. There is also a strong evidence that the same was valid for Old Prussian (in East Baltic dative and locative plural accents were generalized in non-laryngeal inflections).

From the Proto-Indo-European perspective, the importance of Hirt's law lies in the strong correspondence it provides between the Balto-Slavic and Vedic/Ancient Greek accentuation (which more or less intactly reflects the original Late PIE state), and somewhat less importantly, provides a reliable criterion to distinguish the original sequence of PIH **eH* from lengthened grade **ē*, as it unambiguously points to the presence of a laryngeal in the stem.

C. GRASSMANN'S LAW

Grassmann's law, named after its discoverer Hermann Grassmann, is a dissimilatory phonological process in Ancient Greek and Sanskrit which states that if an aspirated consonant is followed by another aspirated consonant in the next syllable, the first one loses the aspiration. The descriptive (synchronic) version was described for Sanskrit by Panini.

Here are some examples in Greek of the effects of Grassmann's Law:

- [t^hu-o:] θύω 'I kill an animal'
- [e-tu-t^he:] ἔτυθη 'it was killed'
- [t^hrik-s] θρίξ 'hair'

- [trik^h-es] τριχῆς ‘*hairs*’
- [t^hap-sai] θάψαι ‘*to bury (aorist)*’
- [t^hapt-ein] θάπτειν ‘*to bury (present)*’
- [tap^h-os] τάφος ‘*a grave*’
- [tap^h-e] ταφή ‘*burial*’

In the reduplication which forms the perfect tense in both Greek and Sanskrit, if the initial consonant is aspirated, the prepended consonant is unaspirated by Grassmann’s Law. For instance [p^hu-o:] φύω ‘*I grow*’: [pe-p^hu:-ka] πεφυκα ‘*I have grown*’.

DIASPIRATE ROOTS

Cases like [t^hrik-s] ~ [trik^h-es] and [t^hap-sai] ~ [tap^h-ein] illustrates the phenomenon of *diaspirate roots*, for which two different analyses have been given.

In one account, the “underlying diaspirate” theory, the underlying roots are taken to be /t^hrik^h/ and /t^hap^h/. When an /s/ (or word edge, or various other sounds) immediately follows, then the second aspiration is lost, and the first aspirate therefore survives ([t^hrik-s], [t^hap-sai]). If a vowel follows the second aspirate, it survives unaltered, and therefore the first aspiration is lost by Grassmann’s Law ([trik^h-es], [tap^h-ein]).

A different analytical approach was taken by the ancient Indian grammarians. In their view, the roots are taken to be underlying /trik^h/ and /tap^h/. These roots persist unaltered in [trik^h-es] and [tap^h-ein]. But if an /s/ follows, it triggers an “*aspiration throwback*” (ATB), in which the aspiration migrates leftward, docking onto the initial consonant ([t^hrik-s], [t^hap-sai]).

Interestingly, in his initial formulation of the law Grassmann briefly referred to ATB to explain these seemingly aberrant forms. However, the consensus among contemporary historical linguists is that the former explanation (underlying representation) is the correct one.

In the later course of Sanskrit, (and under the influence of the grammarians) ATB was applied to original monoaspirates through an analogical process. Thus, from the verb root *gah* ‘*to plunge*’, the desiderative stem *jighak^ha-* is formed. This is by analogy with the forms *bubhutsati* (a desiderative form) and *bhut* (a nominal form, both from the root *budh* ‘*to be awake*’, originally PIE **b^hud^h-*).

D. BARTHOLOMAE'S LAW

Bartholomae's law is an early Indo-European sound law affecting the Indo-Iranian family, though thanks to the falling together of plain voiced and voiced aspirated stops in Iranian, its impact on the phonological history of that subgroup is unclear.

It states that in a cluster of two or more obstruents (*s* or a stop (plosive)), any one of which is a voiced aspirate anywhere in the sequence, the whole cluster becomes voiced and aspirated. Thus to the PIE root **b^heud^h* “learn, become aware of” the participle **b^hud^h-to-* “enlightened” loses the aspiration of the first stop (Grassmann's Law) and with the application of Bartholomae's Law and regular vowel changes gives Sanskrit *buddha-* “enlightened”.

A written form such as *-ddh-* (a literal rendition of the devanāgarī representation) presents problems of interpretation. The choice is between a long voiced stop with a specific release feature symbolized in transliteration by *-h-*, or else a long stop (or stop cluster) with a different phonational state, “murmur”, whereby the breathy release is an artifact of the phonational state. The latter interpretation is rather favored by such phenomena as the Rigvedic form *gdha* “he swallowed” which is morphologically a middle aorist (more exactly ‘injunctive’) to the root *ghas-* “swallow”, as follows: *ghs-t-a > *gzdha* whence *gdha* by the regular loss of a sibilant between stops in Indic. While the idea of voicing affecting the whole cluster with the release feature conventionally called aspiration penetrating all the way to the end of the sequence is not entirely unthinkable, the alternative—the spread of a phonational state (but murmur rather than voice) through the whole sequence—involves one less step and therefore via Occam's Razor counts as the better interpretation.

Bartholomae's Law intersects with another Indic development, namely what looks like the deaspiration of aspirated stops in clusters with *s*: descriptively, Proto-Indo-European **leig^h-si* “you lick” becomes **leiksi*, whence Sanskrit *lekṣi*. However, Grassmann's Law, whereby an aspirated stop becomes non-aspirated before another aspirated stop (as in the example of *buddha-*, above), suggests something else. In late Vedic and later forms of Sanskrit, all forms behave as though aspiration was simply lost in clusters with *s*, so such forms to the root *dugh-* “give milk” (etymologically **dhugh-*) show the expected devoicing and deaspiration in, say, the desiderative formation *du-dhuḥṣ-ati* (with the

root-initial *dh-* intact, that is, undissimilated). But the earliest passages of the Rigveda show something different: desiderative *dudukṣati*, aor. *dukṣata* (for later *dhukṣata*) and so on. Thus it is apparent that what went into Grassmann's Law were forms like **dhugzhata*, *dhudhugzha-* and so on, with aspiration in the sibilant clusters intact. The deaspiration and devoicing of the sibilant clusters were later and entirely separate phenomena – and connected with yet another suite of specifically Indic sound laws, namely a 'rule conspiracy' to eliminate all voiced (and murmured) sibilants. Indeed, even the example 'swallowed' given above contradicts the usual interpretation of devoicing and deaspiration: by such a sequence, **ghs-to* would have given, first, **ksto* (if the process was already Indo-European) or **ksta* (if Indo-Iranian in date), whence Sanskrit **kta*, not *gdha*.

E. BRUGMANN'S LAW

Brugmann's law, named for Karl Brugmann, states that Proto-Indo-European **o* (the ablaut alternant of **e*) in non-final syllables became **ā* in open syllables (syllables ending in a single consonant followed by a vowel) in Indo-Iranian. Everywhere else the outcome was **a*, the same as the reflexes of PIE **e* and **a*. The rule seems not to apply to "non-apophonic **o*", that is, **o* that has no alternant, as in **poti-*, "master, lord" (thus Sanskrit *pati-*, not **pāti*, there being no such root as **pet-* "rule, dominate"). Similarly the form traditionally reconstructed as **owis*, "sheep" (Sanskrit *avi-*), which is a good candidate for re-reconstructing as PIH **h₃ewi-* with an o-coloring laryngeal rather than an ablauting o-grade.

The theory accounts for a number of otherwise very puzzling facts. Sanskrit has *pitaras*, *mātaras*, *bhrātaras* for "fathers, mothers, brothers" but *svasāras* for "sisters", a fact neatly explained by the traditional reconstruction of the stems as **-ter-* for "father, mother, brother" but **swesor-* for "sister" (cf. Latin *pater*, *māter*, *frāter* but *soror*; note, though, that in all four cases the Latin vowel in the final syllable was originally long). Similarly, the great majority of n-stem nouns in Indic have a long stem-vowel, such as *brāhmaṇas* "Brahmins", *śvānas* "dogs" from **kwones*, correlating with information from other Indo-European languages that these were actually on-stems. But there is one noun, *ukṣan-* "ox", which in the Rigveda shows forms like *ukṣāṇas*, "oxen". These were

later replaced by “regular” formations (*ukṣāṇas* and so on, some as early as the Rigveda itself), but the notion that this might be an **en*-stem is supported by the unique morphology of the Germanic forms, e.g. Old English *oxa* nom.singular “ox”, *exen* plural—the Old English plural stem (e.g., the nominative) continuing Proto-Germanic **uχsiniz* < **uχseniz*, with two layers of umlaut. As in Indic, this is the only certain Old English n-stem that points to **en*-vocalism rather than **on*-vocalism.

Perhaps the most startling confirmation comes from the inflection of the perfect tense, wherein a Sanskrit root like *sad-* “sit” has *sasada* for “I sat” and *sasāda* for “he, she, it sat”. It was tempting to see this as some kind of ‘therapeutic’ reaction to the falling-together of the endings *-*a* “I” and *-*e* “he/she/it” as *-a*, but it was troubling that the distinction was found exclusively in roots that ended with a single consonant. That is, *dadarśa* “saw” is both first and third person singular, even though a form like **dadārśa* is perfectly acceptable in terms of Sanskrit syllable structure. This mystery was solved when the ending of the perfect in the first person singular was reanalyzed as PIH *-*h₂e*, that is, beginning with an a-coloring laryngeal: that is, at the time Brugmann’s Law was operative, a form of the type **se-sod-h₂e* in the first person did not have an open root syllable. A problem (minor) for this interpretation is that roots that pretty plainly must have ended in a consonant cluster including a laryngeal, such as *jan-* < **genh₁-* “beget”, and which therefore should have had a short vowel throughout (like *darś-* “see” < **dork-*), nevertheless show the same patterning as *sad-*: *jajana* 1sg., *jajāna* 3sg. Whether this is a catastrophic failure of the theory is a matter of taste, but after all, those who think the pattern seen in roots like *sad-* have a morphological, not a phonological, origin, have their own headaches, such as the total failure of this “morphological” development to include roots ending in two consonants. And such an argument would in any case cut the ground out from under the neat distributions seen in the kinship terms, the special behavior of “ox”, and so on.

Perhaps the most worrisome data are adverbs like Sankrit *prati*, Greek *pros* (< **proti*) (meaning “motion from or to a place or location at a place”, depending on the case of the noun it governs) and some other forms, all of which appear to have ablauting vowels. They also all have a voiceless stop after the vowel, which may or may not be significant.

And for all its charms, Brugmann's Law has few supporters nowadays – even Brugmann himself eventually gave up on it, and Jerzy Kuryłowicz, the author of the brilliant insight into the *sasada/sasāda* matter, eventually abandoned his analysis in favor of an untenable appeal to the agency of marked vs unmarked morphological categories. Untenable because, for example, it's a commonplace of structural analysis that 3rd person singular forms are about as “unmarked” as a verb form can be, but in Indic it is the one that “gets” the long vowel, which by the rules of the game is the marked member of the long/short opposition.

F. WINTER'S LAW

Winter's law, named after Werner Winter who postulated it in 1978, is a sound law operating on Balto-Slavic short vowels **e*, **o*, **a*, **i* and **u*, according to which they lengthen in front of unaspirated voiced stops in closed syllable, and that syllable gains rising, acute accent. Compare:

- PIE **sed-* “to sit” (that also gave Latin *sedeō*, Sanskrit *sīdati*, Ancient Greek *hézomai* and English *sit*) → Proto-Balto-Slavic **sēd-tey* → Lith. *sėsti*, O.C.S. *sešti* (with regular Balto-Slavic **dt→st* change; O.C.S. and Common Slavic yat (ǐ) is a regular reflex of PIE/PBSl. long **ē*).
- PIE **ābl-* “apple” (that also gave English *apple*) → Proto-Balto-Slavic **ābl-* → standard Lithuanian *obuol̥s* (accusative *óbuol̥i*) and also dialectal forms of *óbuolas* and Samogitian *óbulas*, O.C.S. *abl̥ko*, modern Croatian *jābuka*, Slovene *jābolko* etc.

Winter's law is important for several reasons. Most importantly, it indirectly shows the difference between the reflexes of PIE **b*, **d*, **g*, **g^w* in Balto-Slavic (in front of which Winter's law operates in closed syllable), and PIE **b^h*, **d^h*, **g^h*, **g^{wh}* (before which there is no effect of Winter's law). This shows that in relative chronology Winter's law operated before PIE aspirated stops **b^h*, **d^h*, **g^h*, merged with PIE plain voiced stops **b*, **d*, **g* in Balto-Slavic.

Secondary, Winter's law also indirectly shows the difference between the reflexes of PIE **a* and PIE **o* which otherwise merged to **a* in Balto-Slavic. When these vowels lengthen

in accordance with Winter's law, one can see that old *a has lengthened into Balto-Slavic *ā (which later gave Lithuanian o, Latvian ā, O.C.S. a), and old *o has lengthened into Balto-Slavic *ō (which later gave Lithuanian and Latvian uo, but still O.C.S. a). In later development that represented Common Slavic innovation, the reflexes of Balto-Slavic *ā and *ō were merged, as one can see that they both result in O.C.S. a. This also shows that Winter's law operated prior to the common Balto-Slavic change *o→*a.

The original formulation of Winter's law stated that the vowels regularly lengthened in front of PIE voiced stops in all environments. As much as there were numerous examples that supported this formulation, there were also many counterexamples, such as OCS *stogъ* "stack" < PIE *stógos, O.C.S. *voda* "water" < PIE *wodór (collective noun formed from PIE *wódy). Adjustment of Winter's law, with the conclusion that it operates only on closed syllables, was proposed by Matasović in 1994 and which, unlike most of the other prior proposals, successfully explains away most counterexamples, although it's still not generally accepted. Matasović's revision of Winter's law has been used in the *Lexikon der indogermanischen Verben*. Other variations of blocking mechanism for Winter's law have been proposed by Kortlandt, Shintani, Rasmussen, Dybo and Holst but have not gained wide acceptance. Today Winter's law is taken for granted by all specialists in Balto-Slavic historical linguistics, though the exact details of the restrictions of law remain in dispute.

II.2.2. CONSONANTS

NOTES: ¹ After vowels. ² Before a plosive (p, t, k). ³ Before an unstressed vowel (Verner's Law). ⁴ After a (Proto-Germanic) fricative (s, f). ⁵ Before a (PIE) front vowel (i, e). ⁶ Before or after a (PIE) u. ⁷ Before or after a (PIE) o, u. ⁸ Between vowels. ⁹ Before a resonant. ¹⁰ Before secondary (post-PIE) front-vowels. ¹¹ After r, u, k, i (RUKI). ¹² Before a stressed vowel. ¹³ At the end of a word. ¹⁴ After u, r or before r, l. ¹⁵ After n.

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PIE	Skr.	Av.	OCS	Lith.	Arm.	Toch.	Hitt.	Gk.	Lat.	O.Ir	Gmc.
*p	p [p]	p [p]	p [p]	p [p]	h [h]; w [w] ¹	p [p]	p [p]	p [p]	p [p]	Ø; ch [x] ²	*f; *β ³ ; *p ⁴
*t	t [t]	t [t]	t [t]	t [t]	t' [tʰ]	t [t]; c [c] ⁵	t; z ⁵	t [t]	t [t]	t [t]; th [θ] ₈	*θ; *ð ³ ; *t ⁴
*R	ś [ç]	s [s]	s [s]	š [ʃ]	s [s]	k; ś [ç] ⁹	k [k]	k [k]	k [k]	c [k]; ch [x] ₈	*x; *γ ³ ; k ⁴
*k	k [k]; c [c]	k [k]; c [tʃ] ⁵	k [k]; č [tʃ] ⁵ ; c [ts] ¹⁰	k [k]	k' [kʰ]						
*k ^w	⁵						ku [k ^w]	p; t ⁵ ; k ⁶	qu [k ^w]; c [k] ⁷	c [k]; ch [x] ₈	*x ^w ; *γ ^w ; *w ³ ; k ^w ₄
*b	b [b]	b [b]	b [b]	b [b]	p [p]	p [p]	p [p]	b [b]	b [b]	b [b]	*p
*d	d [d]	d [d]	d [d]	d [d]	t [t]	ts [ts]; ś [ç] ⁵	t [t]	d [d]	d [d]	d [d]; dh [ð] ₈	*t
*ǵ	j [j]	z [z]	z [z]	ž [ʒ]	c [ts]	k [k]; ś [ç] ⁹	k [k]	g [g]	g [g]	g [g]; gh [ɣ] ₈	*k
*g	g [g]; j [j] ⁵	g [g]; j [dʒ] ₅	g [g]; ž [ʒ] ⁵ ; dz [dz] ¹⁰	g [g]	k [k]						
*g ^w							ku [k ^w]	b [b]; d [d] ⁵ ; g [g] ⁶	u [w]; gu [g ^w] ₁₅	b [b]; m, bh [w] ⁸	*k ^w
*bʰ	bh [bʰ]	b [b]	b [b]	b [b]	b [b]; w [w] ⁸	p [p]	p [p]	ph [pʰ]	f [f]; b ⁸	b [b]; m, bh [m, w] ⁸	*β
*dʰ	dh [dʰ]	d [d]	d [d]	d [d]	d [d]	t [t]; c [c] ⁵	t [t]	th [tʰ]	f [f]; d ⁸ ; b [b] ¹⁴	d [d]; dh [ð] ₈	*ð

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*g^h	h [h]	z [z]	z [z]	ž [ʒ]	j [dʒ]; z [z] 8	k [k]; ś [ç] ⁵	k [k]	ch [kʰ]	h [h]; h [h]/ g [g] ⁹	g [g]; gh [χ] 5	*γ
*g^h	gh [gʰ];	g [g]; ǵ [dʒ] 5	g [g]; ž [ʒ] ⁵ ; dz [dʒ] ¹⁰	g [g]	g [g]; ǵ [dʒ] 5						
*g^{wh}	h [h] 5						ku [kʷ]	ph [pʰ]; th [tʰ] ⁵ ; ch [kʰ] ⁶	f [f]; g [g] / u [w] ⁸ ; gu [gʷ] 15	g [g]	*γ ^w
*s	s [s]; ś [ʃ] 11	h [h, x]; s [s] ² ; š [ʃ] 11	s [s]; x [x] ¹¹	s [s]; š [ʃ] 11	h [h]; s [s] 2; [-] 8	s [s]; ś [ʃ]	š [s]	h [h]; s [s] ² ; [-] 8	s [s]; r [r] ⁸	s [s]	*s; *z ³
*m	m [m]	m [m]	m [m]; ǵ [ɰ] ¹³	m [m]; n [n] 13	m [m]; n [n] 13	m [m]; ∅ ¹³	m [m]; n [n] 13	m [m]; n [n] ¹³	m [m]	b [b]; m, bh [m, w] 8; n [n] ¹³	*m; ∅ ¹³
*n	n [n]	n [n]	n [n]	n [n]	n [n]	n [n]; ñ [ɲ]	n [n]	n [n]	n [n]	n [n]	*n
*l	r [r] (dial. l [l])	r [r]	l [l]	l [l]	l [l], ł [ł] > ɣ]	l [l]	l [l]	l [l]	l [l]	l [l]	*l
*r	r [r]	r [r]	r [r]	r [r]	r [r]	r [r]	r [r]	r [r]	r [r]	r [r]	*r
*j	y [j]	y [j]	j [j]	j [j]	∅	y [j]	y [j]	z [ʔzd/dz > z] / h [h]; ∅ ⁸	i [j]; ∅ ⁸	∅	*j
*u	v [v]	v [w]	v [v]	v [v]	g [g] / w [w]	w [w]	w [w]	w > h / ∅ [w > h / -]	u [w > v]	f [f]; ∅ / w [w] ⁸	*w

II.1.3. VOWELS AND SYLLABIC CONSONANTS

PIE	PIH	Skr.	Av.	OCS	Lith.	Arm.	Toch.	Hitt.	Gk.	Lat.	O.Ir	Gmc	
*e	*e	a	a	e	e	e	ä	e, i	e	e	e	i; ai [ɛ] ²	
	*h ₁ e												
*a	(*a ³)			o	a	a	ā	ha, a	a	a	a	a	
	*h ₂ e												
*o	*h ₃ e	a, ā ₄	a, ā ₄			o, a	a, e	a	o	o	o		
	*o												
*ə	*h ₁	i	i, Ø	Ø	Ø	a, Ø	ā	a	e	a	a	a, Ø	
	*h ₂							h	a				
	*h ₃								o				
*-	*h ₁	Ø	Ø			e (a?)	Ø	a	e (o)	Ø	Ø	Ø	
	*h ₂							a	ha				a
	*h ₃							a	a, ha				o
*ē	*ē	ā	ā	ě	é	i	a/e?; ā? ⁸	e, i	ē	ē	ī	ē	
	*eh ₁												
*ā	(*ā ³)			a	o	a	a (A); o (B)	a, ah	ā > ē	ā	ā	ā	
	*eh ₂												
*ō	*ō				uo	u	a/ā?; ū? ⁸	a	ō	ō	ā; ū ⁸		
	*eh ₃												
*i	*i	i	i	ь	i	i	ä	i	i	i	i	i	
*ī	*ih ₁	ī	ī	i	y [i:]		i		ī	ī	ī	ei [i:]	

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	*ih ₂					i or (i)a? ⁷	yā		ī or (i)ā? ⁷				
	*ih ₃								ī or (i)ō? ⁷				
*ei	*ei	ē	ōi, aē ⁴		ei, ie ⁵	i	e	ei	ī	īa, ē ⁶			
	*h ₁ e i												
*oi	*oi			ě	ai, ie ⁵	e		oi	ū	oe	ai		
	*h ₃ e i												
*ai	(*ai ³)							ay	ai	ae		ae	
	*h ₂ e i												
*ēi	*ēi	āi; ā ⁸	āi; ā(i) ⁸	i					āi > ēi	ī?		ai	
*ōi	*ōi (*oe i)			y; u ⁸	ai; ui ⁸			ai	āi > ēi	ō	u ⁸		
*āi	*eh ₂ ei			ě					āi > ēi	ae			ai
*u	*u	u	u	ъ	u	u	ä	u	u	u	u; o ¹	u; au [ɔ] ²	
*ū	*uh ₁	ū	ū	y	ū	u or (w)a? ⁷	u	ū	ū	ū	ū	ū	
	*uh ₂						wā		ū or (w)ā? ⁷				
	*uh ₃								ū or (w)ō? ⁷				
*eu	*eu	ō	ēu, ao ⁴	ju	ia <u>u</u>	oy	u	u	eu	ū	ūa; ō ⁹	iu	
	*h ₁ e u												

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*ou	*ou			u	au		ou; o, au		ou			au
	*h ₃ e u											
*au	(*au ³)					aw			au	au		
	*h ₂ e u											
*ēu	*ēu	āu	āu	u	iau					ū?		au
*ōu	*ōu								ō			
*ṛ	*ṛ	a	a	ṛ	iṛ; uṛ ¹⁴	am	ām	am	a	em	em am	um
*ṝ	*mH	ā	ā		iṛ; m ¹⁴	ama	mā		mē, mā, mō	mā	mā	
*ṛ m		am	am	ьm/ъ m	iṛ; m ¹⁴	am			am	em	am	
*ṛ	*ṛ	a	a	ṛ	iṛ; uṛ ¹⁴	an	ān	an	a	en	en an	un
*ṝ	*nH	ā	ā		iṛ; m ¹⁴	ana	nā		nē, nā, nō	nā	nā	
*ṛ n		an	an	ьn/ъ n	iṛ; uṛ ¹⁴	an			an	en	an	
*ṛ	*ṛ	ṛ	erē	ьṛ/ъ ṛ	iṛ; uṛ ¹⁴	al	āl	al	la	ol	li	ul
*ṝ	*IH	iṛ; uṛ ¹³	arē		iṛ; uṛ ¹⁴	ala	lā		lē, lā, lō	lā	lā	
*ṛI		iṛ; ur ¹³	ar	ьI/ъ I	iṛ; uṛ ¹⁴	al, la			al	el	al	
*ṛ	*ṛ	ṛ	erē	ьṛ/ъ ṛ	iṛ; uṛ ¹⁴	ar	ār	ar	ra	or	ri	aur

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*ɸ	*rH	īr; ūr ¹³	arə		īr; ūr ¹⁴	ara	rā		rē, rā, rō	rā	rā	
*ɸr		īr; ur ¹³	ar	ьr/ър	īr; ur ¹⁴	ar			ar	ar	ar	

NOTES: ¹ Before *wa*. ² Before *r*, *h*. ³ The existence of PIE non-allophonic *a* is disputed. ⁴ In open syllables (Brugmann's law). ⁵ Under stress. ⁶ Before palatal consonants. ⁷ The so-called breaking is disputed (typical examples are *proti-h₃k^wo- > Ved. *prāṭīkam* ~ Gk. πρόσωπον; *g^wih₃u_o- > Ved. *jīvā-* ~ Arm. *keank'*, Gk. ζῶος; *duh₂ro- > Ved. *dūrā-* ~ Arm. *erkar*, Gk. δηρός) ⁸ In a final syllable. ⁹ Before velars and unstressed ¹⁰ Before *ā* in the following syllable. ¹¹ Before *i* in the following syllable. ¹² In a closed syllable. ¹³ In the neighbourhood of labials. ¹⁴ In the neighbourhood of labiovelars.

II.3. THE LARYNGEAL THEORY

1. The laryngeal theory is a generally accepted theory of historical linguistics which proposes the existence of a set of three (or up to nine) consonant sounds that appear in most current reconstructions of the Proto-Indo-European language, which usually target Middle PIE or Indo-Hittite (PIH), i.e. the common IE language that includes Anatolian. These sounds have since disappeared in all existing IE languages, but some laryngeals are believed to have existed in the Anatolian languages.

NOTE. In this Modern Indo-European grammar, such uncertain sounds are replaced by the vowels they yielded in Late PIE dialects (an *-a* frequently substitutes the traditional *schwa indogermanicum*), cf. MIE **patér** for PIH **ph₂tér*, MIE **ōktō(u)**, *eight*, for PIH **h₃ekteh₃*, etc. Again, for a MIE based on the northwestern dialects, such stricter reconstruction would give probably a simpler language in terms of phonetic irregularities (*ablaut* or *apophony*), but also a language phonologically too different from Latin, Greek, Germanic and Balto-Slavic dialects. Nevertheless, reconstructions with laryngeals are often shown in this grammar as 'etymological sources', so to speak, as Old English forms are shown when explaining a Modern English word in modern dictionaries. The rest of this chapter offers a detailed description of the effects of laryngeals in IE phonology and morphology.

2. The evidence for them is mostly indirect, but serves as an explanation for differences between vowel sounds across Indo-European languages. For example, Sanskrit and Ancient Greek, two descendents of PIE, exhibit many similar words that have differing vowel sounds. Assume that the Greek word contains the vowel *e* and the corresponding

Sanskrit word contains *i* instead. The laryngeal theory postulates these words originally had the same vowels, but a neighboring consonant which had since disappeared had altered the vowels. If one would label the hypothesized consonant as **h_l*, then the original PIE word may have contained something like **eh_l* or **ih_l*, or perhaps a completely different sound such as **ah_l*. The original phonetic values of the laryngeal sounds remain controversial (v.i.)

3. The beginnings of the theory were proposed by Ferdinand de Saussure in 1879, in an article chiefly devoted to something else altogether (demonstrating that **a* and **o* were separate phonemes in PIE). Saussure's observations, however, did not achieve any general currency until after Hittite was discovered and deciphered in the early 20th century. Hittite had a sound or sounds written with symbols from the Akkadian syllabary conventionally transcribed as *ḫ*, as in *te-iḫ-ḫi*, "I put, am putting". Various more or less obviously unsatisfactory proposals were made to connect these (or this) to the PIE consonant system as then reconstructed. It remained for Jerzy Kuryłowicz (*Études indoeuropéennes I*, 1935) to propose that these sounds lined up with Saussure's conjectures. Since then, the laryngeal theory (in one or another form) has been accepted by most Indo-Europeanists.

4. The late discovery of these sounds by Indo-Europeanists is largely due to the fact that Hittite and the other Anatolian languages are the only Indo-European languages where at least some of them are attested directly and consistently as consonantal sounds. Otherwise, their presence is to be seen mostly through the effects they have on neighboring sounds, and on patterns of alternation that they participate in; when a laryngeal is attested directly, it is usually as a vowel (as in the Greek examples below). Most Indo-Europeanists accept at least some version of laryngeal theory because their existence simplifies some otherwise hard-to-explain sound changes and patterns of alternation that appear in the Indo-European languages, and solves some minor mysteries, such as why verb roots containing only a consonant and a vowel have only long vowels e.g. PIE **dō-* "give"; re-reconstructing PIE **deh₃* instead not only accounts for the patterns of alternation more economically than before, but brings the root into line with the basic consonant - vowel - consonant Indo-European type.

5. There are many variations of the Laryngeal theory. Some scholars, such as Oswald Szemerényi, reconstruct just one. Some follow Jaan Puhvel's reconstruction of eight or more (in his contribution to *Evidence for Laryngeals*, ed. Werner Winter). Most scholars work with a basic three:

- **h₁*, the “neutral” laryngeal
- **h₂*, the “a-colouring” laryngeal
- **h₃*, the “o-colouring” laryngeal

Many scholars, however, either insist on or allow for a fourth consonant, **h₄*, which differs from **h₂* only in not being reflected as Anatolian *ḫ*. Accordingly, except when discussing Hittite evidence, the theoretical existence of an **h₄* contributes little. Another such theory, but much less generally accepted, is Winfred P. Lehmann's view that **h₁* was actually two separate sounds, due to inconsistent reflexes in Hittite. (He assumed that one was a glottal stop and the other a glottal fricative.)

Some direct evidence for laryngeal consonants from Anatolian:

PIE **a* is a rarish sound, and in an uncommonly large number of good etymologies it is word-initial. Thus PIE (traditional) **antí*, *in front of and facing* > Greek *antí* “against”; Latin *ante* “in front of, before”; (Sanskrit *ánti* “near; in the presence of”). But in Hittite there is a noun *ḫants* “front, face”, with various derivatives (*ḫantezzi* “first”, and so on, pointing to a PIH root-noun **h₂ent-* “face” (of which **h₂enti* would be the locative singular).

NOTE. It does not necessarily follow that all reconstructed PIE forms with initial **a* should automatically be rewritten as PIH **h₂e*.

Similarly, the traditional PIE reconstruction for ‘sheep’ is **owí-*, whence Skt *ávi-*, Latin *ovis*, Greek *óis*. But now Luvian has *ḫawi-*, indicating instead a reconstruction **h₃ewí-*.

But if laryngeals as consonants were first spotted in Hittite only in 1935, what was the basis for Saussure's conjectures some 55 years earlier? They sprang from a reanalysis of how the patterns of vowel alternation in Proto-Indo-European roots of different structure aligned with one another.

6. A feature of Proto-Indo-European morpheme structure was a system of vowel alternations christened ablaut (‘alternate sound’) by early German scholars and still

generally known by that term, except in Romance languages, where the term *apophony* is preferred. Several different such patterns have been discerned, but the commonest one, by a wide margin, is e/o/zero alternation found in a majority of roots, in many verb and noun stems, and even in some affixes (the genitive singular ending, for example, is attested as *-es*, *-os*, and *-s*). The different states are called ablaut grades; *e*-grade or “*full grades*”, *o*-grade and “*zero-grade*”.

Thus the root **sed-*, “*to sit (down)*” (roots are traditionally cited in the *e*-grade, if they have one), has three different shapes: **sed-*, **sod-*, and **sd-*. This kind of patterning is found throughout the PIE root inventory and is transparent:

- **sed-*: in Latin *sedeō* “am sitting”, Old English *sittan* “to sit” < **set-ja-* (with umlaut) < **sed-*; Greek *hédra* “seat, chair” < **sed-*.

- **sod-*: in Latin *solium* “*throne*” (Latin *l* sporadically replaces *d* between vowels, said by Roman grammarians to be a Sabine trait) = Old Irish *suide*ⁿ /suð’e/ “a sitting” (all details regular from PIE **sod-jo-m*); Gothic *satjan* = Old English *settan* “to set” (causative) < **sat-ja-* (umlaut again) < PIE **sod-eje-*. PIE **se-sod-e* “*sat*” (perfect) > Sanskrit *sa-sād-a* per Brugmann’s law.

- **sd-*: in compounds, as **ni-* “*down*” + **sd-* = **nisdos* “*nest*”: English *nest* < Proto-Germanic **nistaz*, Latin *nīdus* < **nizdos* (all regular developments). The 3 pl. (third person plural) of the perfect would have been **se-sd-ŕ* whence Indo-Iranian **sazdŕ*, which gives (by regular developments) Sanskrit *sedur* /*sēdur*/.

Now, in addition to the commonplace roots of consonant + vowel + consonant structure there are also well-attested roots like **dʰē-* “*put, place*”: these end in a vowel, which is always long in the categories where roots like **sed-* have full grades; and in those forms where zero grade would be expected, before an affix beginning with a consonant, we find a short vowel, reconstructed as **ə*, or *schwa* (more formally, *schwa primum indogermanicum*). The cross-language correspondences of this vowel are different from the other five short vowels.

NOTE. Before an affix beginning with a vowel, there is no trace of a vowel in the root, as shown below.

Whatever caused a short vowel to disappear entirely in roots like **sed-*/**sod-*/**sd-*, it was a reasonable inference that a long vowel under the same conditions would not quite

disappear, but would leave a sort of residue. This residue is reflected as *i* in Indic while dropping in Iranian; it gives variously *e*, *a*, *o* in Greek; it mostly falls together with the reflexes of PIE **a* in the other languages (always bearing in mind that short vowels in non-initial syllables undergo various adventures in Italic, Celtic, and Germanic):

- **dō-* “give”: in Latin *dōnum* “gift” = Old Irish *dán* /*dān*/ and Sanskrit *dāna-* (*ā* = *ā* with tonic accent); Greek *dí-dō-mi* (reduplicated present) “I give” = Sanskrit *dádāmi*. But in the participles, Greek *dotós* “given” = Sanskrit *ditá-*, Latin *datus* all < **də-tó-*.
- **stā-* “stand”: in Greek *hístēmi* (reduplicated present, regular from **si-stā-*), Sanskrit *a-sthā-t* aorist “stood”, Latin *testāmentum* “testimony” < **ter-stā-* < **tri-stā-* (“third party” or the like). But Sanskrit *sthítá-* “stood”, Greek *stasís* “a standing”, Latin supine infinitive *statum* “to stand”.

Conventional wisdom lined up roots of the **sed-* and **dō-* types as follows:

<i>Full Grades</i>	<i>Weak Grades</i>	
<i>sed-, sod-</i>	<i>sd-</i>	“sit”
<i>dō-</i>	<i>də-, d-</i>	“give”

But there are other patterns of “normal” roots, such as those ending with one of the six resonants (**j w r l m n*), a class of sounds whose peculiarity in Proto-Indo-European is that they are both syllabic (vowels, in effect) and consonants, depending on what sounds are adjacent:

Root **b^her-/b^hor-/b^hr̥-* ~ *b^hr-* “carry”

- **b^her-*: in Latin *ferō* = Greek *phérō*, Avestan *barā*, Old Irish *biur*, Old English *bera* all “I carry”; Latin *ferculum* “bier, litter” < **b^her-tlo-* “implement for carrying”.
- **b^hor-*: in Gothic *barn* “child” (= English dial. *bairn*), Greek *phoréō* “I wear [clothes]” (frequentative formation, “carry around”); Sanskrit *bhâra-* “burden” (**b^hor-o-* via Brugmann’s law).

• **b^hr-* before consonants: Sanskrit *bhr̥-tí-* “a carrying”; Gothic *gabaurþs* /gaborþs/, Old English *gebyrd* /yebürd/, Old High German *geburt* all “birth” < **gaburdi-* < **b^hr̥-tí-*

• **b^hr-* before vowels: Ved *bibhrati* 3pl. “they carry” < **b^hi-b^hr-ṇti*; Greek *diphros* “chariot footboard big enough for two men” < **dwi-b^hr-o-*.

Saussure’s insight was to align the long-vowel roots like **dō-*, **stā-* with roots like **b^her-*, rather than with roots of the **sed-* sort. That is, treating “schwa” not as a residue of a long vowel but, like the **r* of **b^her-/*b^hor-/*b^hr̥-*, an element that was present in the root in all grades, but which in full grade forms coalesced with an ordinary *e/o* root vowel to make a long vowel, with ‘coloring’ (changed phonetics) of the *e*-grade into the bargain; the mystery element was seen by itself only in zero grade forms:

Full Grades	Zero Grade	
<i>b^her-, b^hor-</i>	<i>b^hr̥- / b^hr-</i>	“carry”
<i>deX, doX-</i>	<i>dĀ- / dX-</i>	“give”

* *Ā* = syllabic form of the mystery element

Saussure treated only two of these elements, corresponding to our **h₂* and **h₃*. Later it was noticed that the explanatory power of the theory, as well as its elegance, were enhanced if a third element were added, our **h₁*, which has the same lengthening and syllabifying properties as the other two but has no effect on the color of adjacent vowels. Saussure offered no suggestion as to the phonetics of these elements; his term for them, “*coefficientants sonantiques*”, was not however a fudge, but merely the term in general use for glides, nasals, and liquids (i.e., the PIE resonants) as in roots like **b^her-*.

As mentioned above, in forms like **dwi-b^hr-o-* (etymon of Greek *diphros*, above), the new “*coefficientants sonantiques*” (unlike the six resonants) have no reflexes at all in any daughter language. Thus the compound PIE **m̥ns-d^heh-* “to ‘fix thought’, be devout, become rapt” forms a noun **m̥ns-d^hh-o-* seen in Proto-Indo-Iranian **mazdha-* whence Sanskrit *medhá-* /*mēdha*/ “sacrificial rite, holiness” (regular development as in *sedur* < **sazdur*, above), Avestan *mazda-* “name (originally an epithet) of the greatest deity”.

There is another kind of unproblematic root, in which obstruents flank a resonant. In the zero grade, unlike the case with roots of the **b^her-* type, the resonant is therefore always syllabic (being always between two consonants). An example would be **b^hend^h-* “*tie, bind*”:

- **b^hend^h-*: in Germanic forms like Old English *bindan* “to tie, bind”, Gothic *bindan*; Lithuanian *beñdras* “chum”, Greek *peĩsma* “rope, cable” /pēsma/ < **phenth-sma* < **b^hend^h-sm̥n̥*.
- **b^hond^h-*: in Sanskrit *bandhá-* “bond, fastening” (**b^hond^h-o-*; Grassmann’s law) = Old Icelandic *bant*, OE *bænd*; Old English *bænd*, Gothic *band* “he tied” < **(b^he)b^hond^h-e*.
- **b^hṛd^h-*: in Sanskrit *baddhá-* < **b^hṛd^h-tó-* (Bartholomae’s law), Old English *gebunden*, Gothic *bundan*; German *Bund* “league”. (English *bind* and *bound* show the effects of secondary (Middle English) vowel lengthening; the original length is preserved in *bundle*.)

This is all straightforward and such roots fit directly into the overall patterns. Less so are certain roots that seem sometimes to go like the **b^her-* type, and sometimes to be unlike anything else, with (for example) *long* syllabics in the *zero* grades while at times pointing to a two-vowel root structure. These roots are variously called “*heavy bases*”, “*dis(s)yllabic roots*”, and “*seṭ roots*” (the last being a term from *Pāṇini’s grammar*. It will be explained below).

For example, the root “be born, arise” is given in the usual etymological dictionaries as follows:

A. PIE **gen-*, **gon-*, **gṇn-*

B. PIE **genə-*, **gonə-*, **gṇ̥-* (where $\bar{\eta}$ = a long syllabic η)

The (A) forms occur when the root is followed by an affix beginning with a vowel; the (B) forms when the affix begins with a consonant. As mentioned, the full-grade (A) forms look just like the **b^her-* type, but the zero grades always and only have reflexes of syllabic resonants, just like the **b^hend^h-* type; and unlike any other type, there is a second root vowel (always and only **ə*) following the second consonant:

*gen(ə)-

•PIE *genos- neut *s*-stem “race, clan” > Greek (Homeric) *génos*, -eos, Sanskrit *jānas*-, Avestan *zanō*, Latin *genus*, -eris.

•Greek *gené-tēs* “begetter, father”; *gêne-sis* < *genə-ti- “origin”; Sanskrit *jāni-man*- “birth, lineage”, *jāni-tar*- “progenitor, father”, Latin *genitus* “begotten” < *genatos*.

*gon(e)-

•Sanskrit *janayati* “beget” = Old English *cennan* /*kennan*/ < *gon-eje- (causative); Sanskrit *jāna*- “race” (*o*-grade *o*-stem) = Greek *gónos*, -ou “offspring”.

•Sanskrit *jajāna* 3sg. “was born” < *ge-gon-e.

*gṇn-/*gṇ̄-

•Gothic *kuni* “clan, family” = OE *cynn* /*künn*/, English *kin*; Rigvedic *jajanūr* 3pl.perfect < *ge-gṇn- (a relic; the regular Sanskrit form in paradigms like this is *jajñur*, a remodeling).

•Sanskrit *jātā*- “born” = Latin *nātus* (Old Latin *gnātus*, and cf. forms like *cognātus* “related by birth”, Greek *kasí-gnētos* “brother”); Greek *gnésios* “belonging to the race”. (The *ē* in these Greek forms can be shown to be original, not Attic-Ionic developments from Proto-Greek **ā*.)

NOTE. The Pāṇinian term “seṭṭ” (that is, sa-i-ṭ) is literally “with an /i/”. This refers to the fact that roots so designated, like *jan*- “be born”, have an /i/ between the root and the suffix, as we’ve seen in Sanskrit *jānitar*-, *jāniman*-, *janitva* (a gerund). Cf. such formations built to “aniṭ” (“without an /i/”) roots, such as *han*- “slay”: *hāntar*- “slayer”, *hanman*- “a slaying”, *hantva* (gerund). In Pāṇini’s analysis, this /i/ is a linking vowel, not properly a part of either the root or the suffix. It is simply that some roots are in effect in the list consisting of the roots that (as we would put it) ‘take an -i’.

The startling reflexes of these roots in zero grade before a consonant (in this case, Sanskrit *ā*, Greek *nē*, Latin *nā*, Lithuanian *in*) is explained by the lengthening of the (originally perfectly ordinary) syllabic resonant before the lost laryngeal, while the same laryngeal protects the syllabic status of the preceding resonant even before an affix

beginning with a vowel: the archaic Vedic form *jajanur* cited above is structurally quite the same (**ge-g_hh₁-r*) as a form like **da-d_hs-ur* “they saw” < **de-d_hk-r*.

Incidentally, redesigning the root as **genh-* has another consequence. Several of the Sanskrit forms cited above come from what look like *o*-grade root vowels in open syllables, but fail to lengthen to *-ā-* per Brugmann’s law. All becomes clear when it is understood that in such forms as **gonh-* before a vowel, the **o* is not in fact in an open syllable. And in turn that means that a form like O.Ind. *jajāna* “was born”, which apparently *does* show the action of Brugmann’s law, is actually a false witness: in the Sanskrit perfect tense, the whole class of *seṭ* roots, en masse, acquired the shape of the *aniṭ* 3 sing. forms.

There are also roots ending in a stop followed by a laryngeal, as **pleth₂-/*p_lth₂-* “spread, flatten”, from which Sanskrit *pr_ṛthú-* “broad” masc. (= Avestan *pərəθu-*), *pr_ṛthivī-* fem., Greek *platús* (zero grade); Skt. *prathimán-* “wideness” (full grade), Greek *platamón* “flat stone”. The laryngeal explains (a) the change of **t* to **th* in Proto-Indo-Iranian, (b) the correspondence between Greek *-a-*, Sanskrit *-i-* and no vowel in Avestan (Avestan *pərəθwī* “broad” fem. in two syllables vs Sanskrit *pr_ṛthivī-* in three).

Caution has to be used in interpreting data from Indic in particular. Sanskrit remained in use as a poetic, scientific, and classical language for many centuries, and the multitude of inherited patterns of alternation of obscure motivation (such as the division into *seṭ* and *aniṭ* roots) provided models for coining new forms on the “wrong” patterns. There are many forms like *tṛṣita-* “thirsty” and *tániman-* “slenderness”, that is, *seṭ* formations to to unequivocally *aniṭ* roots; and conversely *aniṭ* forms like *píparti* “fills”, *pr_ṛta-* “filled”, to securely *seṭ* roots (cf. the ‘real’ past participle, *pūrṇá-*). Sanskrit preserves the effects of laryngeal phonology with wonderful clarity, but looks upon the historical linguist with a threatening eye: for even in Vedic Sanskrit, the evidence has to be weighed carefully with due concern for the antiquity of the forms and the overall texture of the data.

Stray laryngeals can be found in isolated or seemingly isolated forms; here the three-way Greek reflexes of syllabic **h₁*, **h₂*, **h₃* are particularly helpful, as seen below.

- **h₁* in Greek *ánemos* “wind” (cf. Latin *animus* “breath, spirit; anger”, Vedic *aniti* “breathes”) < **anə-* “breathe; blow” (now **h₂enh₁-*). Perhaps also Greek

híeros “mighty, super-human; divine; holy”, cf. Sanskrit *īśirá-* “vigorous, energetic”.

- **h*₂ in Greek *patḗr* “father” = Sanskrit *pitár-*, Old English *fæder*, Gothic *fadar*, Latin *pater*. Also **megh*₂ “big” neut. > Greek *méga*, Sanskrit *máhi*.

- **h*₃ in Greek *árottron* “plow” = Welsh *aradr*, Old Norse *arðr*, Lithuanian *árklas*.

The Greek forms *ánemos* and *árottron* are particularly valuable because the verb roots in question are extinct in Greek as verbs. This means that there is no possibility of some sort of analogical interference, as for example happened in the case of Latin *arātrum* “plow”, whose shape has been distorted by the verb *arāre* “to plow” (the exact cognate to the Greek form would have been **aretrum*). It used to be standard to explain the root vowels of Greek *thetós*, *statós*, *dotós* “put, stood, given” as analogical. Most scholars nowadays probably take them as original, but in the case of “wind” and “plow”, the argument can’t even come up.

Regarding Greek *híeros*, the pseudo-participle affix *-*ro-* is added directly to the verb root, so **ish*₁-*ro-* > **isero-* > **ihero-* > *híeros* (with regular throwback of the aspiration to the beginning of the word), and Sanskrit *īśirá-*. There seems to be no question of the existence of a root **ejsh-* “vigorous move/cause to move”. If the thing began with a laryngeal, and most scholars would agree that it did, it would have to be **h*₁-, specifically; and that’s a problem. A root of the shape **h*₁*ejsh*₁- is not possible. Indo-European had no roots of the type **mem-*, **tet-*, **d^hred^h-*, i.e., with two copies of the same consonant. But Greek attests an earlier (and rather more widely-attested) form of the same meaning, *híaros*. If we reconstruct **h*₁*ejsh*₂-, all of our problems are solved in one stroke. The explanation for the *híeros/híaros* business has long been discussed, without much result; laryngeal theory now provides the opportunity for an explanation which did not exist before, namely metathesis of the two laryngeals. It’s still only a guess, but it’s a much simpler and more elegant guess than the guesses available before.

The syllabic **h*₂ in PIH **ph*₂*ter-* “father” is not really isolated. The evidence is clear that the kinship affix seen in “mother, father” etc. was actually *-*h*₂*ter-*. The laryngeal syllabified after a consonant (thus Greek *patḗr*, Latin *pater*, Sanskrit *pitár-*; Greek *thugátēr*, Sanskrit *duhitár-* “daughter”) but lengthened a preceding vowel (thus say

Latin *māter* “mother”, *frāter* “brother”) — even when the “vowel” in question was a syllabic resonant, as in Sanskrit *yātaras* “husbands’ wives” < **jṛ̥t-* < **jṛ̥-h₂ter-*).

LARYNGEALS IN MORPHOLOGY

Like any other consonant, Laryngeals feature in the endings of verbs and nouns and in derivational morphology, the only difference being the greater difficulty of telling what’s going on. Indo-Iranian, for example, can retain forms that pretty clearly reflect a laryngeal, but there is no way of knowing which one.

The following is a rundown of laryngeals in Proto-Indo-European morphology.

**h₁* is seen in the instrumental ending (probably originally indifferent to number, like English expressions of the type *by hand* and *on foot*). In Sanskrit, feminine *i-* and *u-* stems have instrumentals in *-ī*, *-ū*, respectively. In the Rigveda, there are a few old *a-* stems (PIE *o-* stems) with an instrumental in *-ā*; but even in that oldest text the usual ending is *-enā*, from the *n-* stems.

Greek has some adverbs in *-ē*, but more important are the Mycenaean forms like *e-re-pa-te* “with ivory” (i.e. *elephantē?* -*ě?*)

The marker of the neuter dual was **-ih₁*, as in Sanskrit *bharatī* “two carrying ones (neut.)”, *nāmanī* “two names”, *yuge* “two yokes” (< *yuga-ī?* **yuga-ī?*). Greek to the rescue: the Homeric form *ósse* “the (two) eyes” is manifestly from **h₃ek^w-ih₁* (formerly **ok^w-ī*) via fully-regular sound laws (intermediately **ok^wje*).

**-eh₁-* derives stative verb senses from eventive roots: PIE **sed-* “sit (down)”: **sed-eh₁-* “be in a sitting position” (> Proto-Italic **sed-ē-je-mos* “we are sitting” > Latin *sedēmus*). It is clearly attested in Celtic, Italic, Germanic (the Class IV weak verbs), and Balto-Slavic, with some traces in Indo-Iranian (In Avestan the affix seems to form past-habitual stems).

It seems likely, though it is less certain, that this same **-h₁* underlies the nominative-accusative dual in *o-* stems: Sanskrit *vṛkā*, Greek *lúkō* “two wolves”. (The alternative ending *-āu* in Sanskrit cuts a small figure in the Rigveda, but eventually becomes the standard form of the *o-* stem dual.)

**-h₁s-* derives desiderative stems as in Sanskrit *jighāṃsati* “desires to slay” < **g^{wh}i-g^{wh}ṛ̥-h₂s-e-ti-* (root **g^{wh}en-*, Sanskrit *han-* “slay”). This is the source of Greek future

tense formations and (with the addition of a thematic suffix **-je/o-*) the Indo-Iranian one as well: *bhariṣyati* “will carry” < **bher-ḥ₁s-je-ti*.

**-jeh₁-/*-ih₁-* is the optative suffix for root verb inflections, e.g. Latin (old) *siet* “may he be”, *sīmus* “may we be”, Sanskrit *syāt* “may he be”, and so on.

**h₂* is seen as the marker of the neuter plural: **-ḥ₂* in the consonant stems, **-eh₂* in the vowel stems. Much leveling and remodeling is seen in the daughter languages that preserve any ending at all, thus Latin has generalized **-ā* throughout the noun system (later regularly shortened to *-a*), Greek generalized *-ǎ* < **-ḥ₂*.

The categories “masculine/feminine” plainly did not exist in the most original form of Proto-Indo-European, and there are very few noun types which are formally different in the two genders. The formal differences are mostly to be seen in adjectives (and not all of them) and pronouns. Interestingly, both types of derived feminine stems feature **h₂*: a type that is patently derived from the *o*-stem nominals; and an ablauting type showing alternations between **-jeh₂-* and **-ih₂-*. Both are peculiar in having no actual marker for the nominative singular, and at least as far as the **-eh₂-* type, two things seem clear: it is based on the *o*-stems, and the nom.sg. is probably in origin a neuter plural. (An archaic trait of Indo-European morpho-syntax is that plural neuter nouns construe with *singular* verbs, and quite possibly **jugeh₂* was not so much “yokes” in our sense, but “yokage; a harnessing-up”.) Once that much is thought of, however, it is not easy to pin down the details of the “*ā*-stems” in the Indo-European languages outside of Anatolia, and such an analysis sheds no light at all on the **-jeh₂-/*-ih₂-* stems, which (like the **eh₂-* stems) form feminine adjective stems and derived nouns (e.g. Sanskrit *devī-* “goddess” from *deva-* “god”) but unlike the “*ā*-stems” have no foundation in any neuter category.

**-eh₂-* seems to have formed factitive verbs, as in **new-eh₂-* “to renew, make new again”, as seen in Latin *novāre*, Greek *neáō* and Hittite *ne-wa-aḥ-ḥa-an-t-* (participle) all “renew” but all three with the pregnant sense of “plow anew; return fallow land to cultivation”.

**-h₂-* marked the 1st person singular, with a somewhat confusing distribution: in the thematic active (the familiar *-ō* ending of Greek and Latin, and Indo-Iranian *-ā(mi)*), and also in the perfect tense (not really a tense in PIE): **-h₂e* as in Greek *oīda* “I know” < **wojd-h₂e*. It is the basis of the Hittite ending *-ḥḥi*, as in *da-aḥ-ḥi* “I take” < **-ḥa-i*

(original **-h₁a* embellished with the primary tense marker with subsequent smoothing of the diphthong).

**-eh₃* may be tentatively identified in a “*directive case*”. No such case is found in Indo-European noun paradigms, but such a construct accounts for a curious collection of Hittite forms like *ne-pi-ša* “(in)to the sky”, *ták-na-a* “to, into the ground”, *a-ru-na* “to the sea”. These are sometimes explained as *o*-stem datives in *-a* < **-ōj*, an ending clearly attested in Greek and Indo-Iranian, among others, but there are serious problems with such a view, and the forms are highly coherent, functionally. And there are also appropriate adverbs in Greek and Latin (elements lost in productive paradigms sometimes survive in stray forms, like the old instrumental case of the definite article in English expressions like *the more the merrier*): Greek *ánō* “upwards”, *kátō* “downwards”, Latin *quō* “whither?”, *eō* “to that place”; and perhaps even the Indic preposition/preverb *â* “to(ward)” which has no satisfactory competing etymology. (These forms must be distinguished from the similar-looking ones formed to the ablative in **-ōd* and with a distinctive “fromness” sense: Greek *ópō* “whence, from where”.)

PRONUNCIATION

Considerable debate still surrounds the pronunciation of the laryngeals and various arguments have been given to pinpoint their exact place of articulation. Firstly the effect these sounds have had on adjacent phonemes is well documented. The evidence from Hittite and Uralic is sufficient to conclude that these sounds were “guttural” or pronounced rather back in the buccal cavity. The same evidence is also consistent with the assumption that they were fricative sounds (as opposed to approximants or stops), an assumption which is strongly supported by the behaviour of laryngeals in consonant clusters.

The assumption that **h₁* is a glottal stop [ʔ] is still very widespread. A glottal stop would however be unlikely to be reflected as a fricative in Uralic borrowings, as appears to be the case, for example in the word *lehti* < **lešte* <= PIE **bhlh₁-to*. If, as some evidence suggests, there were two **h₁* sounds, then one may have been the glottal stop [ʔ] and the other may have been the h sound [h] of English “hat”.

Rasmussen suggests a consonantal realization for $*h_1$ as [h] with a vocalic allophone [ə]. This is supported by the closeness of [ə] to [e] (with which it coalesces in Greek), its failure (unlike $*h_2$ and $*h_3$) to create an auxiliary vowel in Greek and Tocharian when it occurs between a semivowel and a consonant, and the typological likelihood of a [h] given the presence of aspirated consonants in PIE.

From what is known of such phonetic conditioning in contemporary languages, notably Semitic languages, $*h_2$ (the “a-colouring” laryngeal) could have been a pharyngeal or epiglottal fricative such as [ħ], [ʕ], [ħ], or [ʕ]. Pharyngeal/epiglottal consonants (like the Arabic letter ح (h) as in Muḥammad) often cause a-coloring in the Semitic languages.

Rasmussen suggests a consonantal realization for $*h_2$ as [x], with a vocalic allophone [e].

Likewise it is generally assumed that $*h_3$ was rounded (labialized) due to its o-coloring effects. It is often taken to be voiced based on the perfect form $*pi-bh_3-$ from the root $*peh_3$ “drink”. Based on the analogy of Arabic, some linguists have assumed that $*h_3$ was also pharyngeal/epiglottal [ʕ^w ~ ʕ^w] like Arabic ع (ayin, as in Arabic muʕallim = “teacher”) plus labialization, although the assumption that it was velar [ɣ^w] is probably more common. (The reflexes in Uralic languages could be the same whether the original phonemes were velar or pharyngeal.)