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The development of the IEclusters *obstruent* + *t/s*(*d^h*)

[habilitation thesis]

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Hereby I state myself the sole author of the presented thesis, I used only the quoted literature as listed below.

1 On IE obstruents, examined clusters and used methods

1.0 Introduction remarks

The purpose of the present study is to describe the development of a particular set of consonantal clusters in the Indo-European languages and, in hindsight, to shed some light both on its earlier phase (shared in various degrees by the various sub-branches of the IE language family) and on the main tendencies present in the development of given Indo-European branches.

The set of consonantal clusters we will study are two-consonantal clusters (with a few exceptions, mentioned as such in the following text, used from necessity given by the lack of more suitable data) formed either by an Indo-European obstruent (in the context of the present study, an obstruent will be any IE plosive and a sibilant) in the left position and by either by *t- or *s- or *d^h- in the right position (the terms 'right' and 'left' are arbitrarily used to mark the mutual relative position within the speech act).

The method used is the principally traditional structural analysis of clusters of our interest, primarily those synchronically productive, secondarily those etymological (i.e., synchronically unanalysable and with structure revealed only through the etymological analysis). The analysis is based on the assumption that the phonemic alternation (indifferent if synchronic or diachronic) could reveal, in its nature, functions and relations otherwise invisible to the pure phonemic analysis in the way of simple registration of elements and their description; this is the reason why we use the term 'structural analysis' since we are focused on mutual relations between segments as much as on the segments themselves.

On the following lines of this chapter in we will bring forth the reconstructed set of IE obstruents, the classification of given consonantal classes and a few methodological remarks.

1.1 Indo-European obstruents

The set of the Indo-European obstruents consists of a single voiceless sibilant *s (split in languages affected by the Pedersen's Law/the *ruki-rule* into two sibilants – in such languages, we will deal with both sibilants independently) and a numerous set of plosives, their number differing according to the used models.

The main differences between given models of the plosive sets used could be classified according to the number of modal classes used and on local series; the main points of divergence we will sum up on following lines to express reasons for the list of plosive phonemes we will be using below.

1.1.1 Indo-European plosives I: the modal classes

The classification of IE obstruents according to their modality is a matter of debate both of their number and phonemic nature. The models used could be classified thus:

i. the **quaternary model**, containing the voiceless-nonaspirated, voiced-nonaspirated, voiceless aspirated and voiced aspirated classes, is, in fact, a projection of the Vedic system backwards in time, was first proposed by Curtius (1853), and became the standard model for another century, being used by influential grammarians, especially by Brugmann. Hirt (1927: 218–219, 224, 240-241; Hirt 1939: 161) followed the quaternary model, though considering the secondary origin of the voiceless aspirates (as proposed by ternary models). From later supporters we have to mention Hiersche (1964) and especially Szemerényi (1967: 84, 88–89; Szemerényi 1996: 54); Rasmussen (1987: 81–109 = 1998: 216–243), Elbourne (1998: 1–30; 2000: 2–28).

ii. the **ternary model** has numerous variants, all having in common a denial of the Indo-European origin of the voiceless-nonaspirates (since de Saussure 1892: 118), for its classical form see especially Pedersen (1926: 48); Kuryłowicz (1927: 202–204; Kuryłowicz 1973: 68–69); Lehmann (1952: 99). From its variants, we could mention the one assuming that the voiced-aspirates were originally the voiced spirants (cf. Brücke 1856: 59–60; Walde 1897: 466; Prokosch 1918–1919; Prokosch 1939: 39–41; Hammerich 1967: 839–849). More popular are various glottal models, denying the traditional values of three modal classes in various degrees, cf. Pedersen 1951: 10–16; Andreev 1957: 7–8; Griffen 1989. Often variant are purely glottalic models such as those by Martinet (1953: 67–68); Gamkrelidze/Ivanov (1972: 15–18); Hopper (1973: 141–166); Kortlandt (1978b: 107–108; Korlandt 1985); Huld (1984: 140); Collinge (1985: 259–269); Salmons (1993); Fallon (2002: 284–288, 317–318). An interesting variant replaces the voiced non-aspirated with an implosive, cf. Haider (1985); Kümmel (2012: 303–306); Brett Miller (2012: 95, 236–266).

Note: The **binary** model, using the simple opposition of the voice was introduced by Schleicher (1861[1]: 136–137; 1866[2]: 162–163) as the first stage in the common development of the IE languages; even Schleicher assumes the later existence of the ternary model. Erhart (1956; Erhart 1982: 39) later brings a similar model of the two-stages development with a later split of the voiced class on two modal classes.

Within the frame of this study, we will use the traditional variant of the ternary model, since it satisfyingly fits our purposes, especially since we will deal with plosives in the neutralization positions, where the distinction between the modal classes is subjected to various alternations. As we will see below, the contrast between the voiceless and voiced non-aspirates is always neutralized (as often are the voiced aspirates), and the distinction between both non-aspirated plosives on one side and the voiced aspirate on the other side is relevant only in some contexts of our interest for the Indo-Iranian languages (the contexts of Bartholomae’s law).

The phonetic properties of the reconstructed IE phonemes are always only better or worse approximatively due to their necessarily abstract nature, this being the result of the reconstruction, not of direct observation. As we saw above, the conventional modal classes are variously interpreted. The terms *voiceless non-aspirates*, *voiced non-aspirates* and *voiced aspirates* will be used on following lines, with approximate values given by the names (except with the third modal class where the phonetic nature as *voiced aspirate* could be successfully doubted, cf. Kümmel 2015: 293; we would prefer the values of *voiced spirants*, as mentioned above, but we will use both the traditional values and frame)[1]. However, Jakobson (1958: 22–23) and Hopper (1973: 141) are wrong when arguing that two voiced plosives in a single triadic system are impossible (cf. Kümmel 2012: 294–295), as demonstrate the typological parallel of Madurese or Kelabit (Blust 2009: 174–175, 182; added could be probably even Bintulu).

Note: The existence of the IE voiceless-aspirates we cannot be merely rejected, but we can surely assume that if such modal class did exist, it was not proportional to other classes (cf. Šefčík 2012; Šefčík 2016), as it is in Indic (the Indic state is a secondary leveling of the system, as we will demonstrate below). It should be noted that OIA, where the voiceless aspirates are a singular class (unlike in other languages – Greek voiceless aspirates usually reflect the IE voiced-aspirates), they never enter the context we will examine below, hence clearly demonstrating their unusual position in the whole phonemic system.

1.1.2 Indo-European plosives II: the local series

The reconstruction of the dental and labial series is not in doubt (though the status of the IE phoneme **b* is often questioned, the reconstructed existence rest of labials is accepted). However, the number and phonetic realization of a reconstructed velar series is a matter of debate.

To sum up, there are the following approaches to the ‘guttural question’:

i. the **monic model** reconstructs only three series: labial, dental and (plain) velar series. This type of model was first used by Schleicher (1861[1]: 136–1379; Schleicher 1866[2]: 162–165), who presupposed that other velar series (the terminology used today was not used in his days) developed due to the set of processes he even tried to list. Schleicher’s model in the original form was abandoned in favour of either dyadic or triadic models; however, even later the monic model was considered as a working model for an earlier stage of development of guttural series, i.e. used as a predecessor of later models with more series, cf. Pedersen (1897: 192; Pedersen 1900: 292–300; Pedersen 1908: 354; 1 Pedersen 951: 3); Ribezzo (1903; Ribezzo 1922–1923; Ribezzo 1929); Hirt (1927: 234–236; Hirt 1939: 162); Sturtevant (1930); Specht (1944: 316–317); Safarewicz (1945: 37); Vaillant (1950: 25); Otrębski (1963: 11–15). To the possibilities of the palatalization and labialization of velars see Solta (1965), who adds typological parallels. The monic model is, as an earlier stage of the development of IE guttural system, presupposed later by Markey (1980) and Szemerényi

[1] Peeters (1971) prefers to reconstruct non-phonemic voice (development later in context with the later creation of voiceless aspirates). Peeters assumes the non-occlusive character of IE $*D^h$, though he does not directly state the spirant value.

(1996: 149), first via the split of plain velars and labiovelars, followed (in *satəm*-languages) by the phonemization of palatovelars and the subsequent delabialization of labiovelars[2].

ii. the **dyadic *centum*-model** presupposes that system of guttural series we meet in *centum*-languages, is already traceable back to Indo-European and consequently, the *satəm*-language model is considered a later innovation. According to this model, the three guttural series model is a pure phantom given by a generalization and merging of two models in a single one, without any real existence. The first proponent of the dyadic *centum* model was Meillet (1893), later Hirt (1899; also Hirt 1927: 226f; 1939); Vaillant (1950: 25), Lehmann (1952: 8; Lehmann 1993: 100–102); Sihler (1995: 151–165). Generally, the satəmization is considered a process similar in its nature to later palatalizations of velars (in Indo-Iranian, Slavic, Romance etc.), though the specification of its conditions is quite vague. This satəmization lead to the split of original plain velar series into two, the palatovelars later (af)fricativized. Numerous authors pointed out that *satəm*-languages form a single innovation area (i.e. area of satəmization)[3], cf. József Schmidt (1912: 45); Sköld (1931, 56-79); Pisani (1961); Porzig (1954: 76); W. P. Schmid (1966: 11); Shields (1981: 210–211); Sihler (1995: 153); Schmitt-Brand (1998, 88–90). Burrows (1955: 72–73) considers satəmization in the *satəm*-languages as the first stage of a general process of palatalization ('first palatalization'), followed by a 'second palatalization' of velars (< original IE **K* and **K*ᵘ̯), occurring independently in the satəm Balto-Slavic and Armenian (Burrows 1955: 76-77), similarly Sihler (1995: 154–155); Sims-Williams N. (2017: 268–270). To generalize the thesis: the original state of IE was with plain velars and labiovelar, and some of the plain velars became secondarily palatalized (except in some positions like before *r, a* or after *u, ū* etc.) in the future *satəm*-languages. With a new marker in work, the original labiovelars lost their labiality and merged with original IE plain velar.

iii. the **dyadic *satəm*-model** mirrors the dyadic *centum*-model in presupposing that the three-valued model is a purely reconstructional phantom. The difference in the idea that the *satəm*-model (i.e. the model with distinguished palatovelars and plain velars) was the original model of IE since in this model, the labiovelar series is a secondary series, arising due to some process of labialization of plain velars ('centumization'), resulting in the secondary split of plain velar series into two. It is worthy of mention that this model was originally accepted by Brugmann in the first edition of his *Grundriss* (Brugmann 1886), though it was later abandoned and replaced by the triadic model. However, similar ideas were later stated by authors like Joh. Schmidt (KZ 25, 1881: 134); Ribezzo (1903; 1922–23; 1929); Jószef Schmidt (1912: 54) and Reichelt (1922: 40–81). Later the main proponent of this model was Kuryłowicz, who voiced his opinion repeatedly (Kuryłowicz 1956: 356–375; Kuryłowicz 1964: 12). The mechanism of centumization was described by Szemerényi as the result of simplification of **Ku̯* clusters (where *K* is any plain velar) (Szemerényi 1964: 401; Szemerényi 1996: 145–146); in this he follows Vaillant (1950: 171–173).

iv. the **dyadic equipollent model** assumes that there were two marked series (i.e. the labiovelar and the palatovelar series) and that the plain velar series, which are reconstructed for IE in an only very limited number (note that absolutely higher number of plain series in attested IE languages is given by the merging of one of marked guttural series with plain velar series, not inherited from IE), were not present in reconstructed Indo-European. As a proponent of this model, we can list Meillet (1893; Meillet 1934: 91–95), since in his model, plain velar is just an allophone of palatovelar and hence the phoneme is palatovelar in opposition to

[2] That the palatovelars must be arisen before the merging of plain velars and labiovelars is clear from the fact that there are no palatovelars arisen from original labiovelars since both sets of gutturals are clearly and strictly distinguished.

[3] Less probably is the idea supported by Georgiev (1937: 124; 1966: 46) and Abaev (1965: 140f.), who suppose the independent process of satəmization in given IE languages.

labiovelar. Steensland (1973, cf. especially 96–127) presupposes two series, marked in a purely algebraic way as *KA* and *KB*, the first of them developing in palatovelar series in the *satəm*-languages and plain velars in the *centum*-languages, the second of them developing into labiovelar series in the *centum*-languages and plain velars in the *satəm*-languages; plain velars are then a result of neutralization of one of his series. A very similar model was developed by Kortlandt (1978a; Kortlandt 1994a: 2–3) and Woodhouse (1998; 2000), who advances the opposition between prevelars and backvelars. Even Beekes (2011: 124–126), who otherwise reconstructed three guttural series, seems to tend to accept the opinion that plain velars were just positional allophones either of palatovelars or labiovelars (cf. Cavoto 2001: 51).

v. the **triadic model** assumes the original existence of all three velar series and was first introduced by Bezzenberger (Bezzenberger 1890), named by von Bradke (1890) and accepted by Brugmann (1897) (both by the second edition of his great comparative grammar and also by his concise grammar). Since that time, this model has been used by many authors; for example by Szemerényi (1990: 71). This model became a widely accepted standard, having the advantage of covering all possible guttural series. However, it could still contain a reconstructional error since the possibility of reconstructing three guttural series does not necessarily mean that the system with three series ever existed at the same time (cf. Sihler 1995: 154). This traditional model is accepted by Allen (1978); Tischler (1990: 93–94); Kapović (2017: 14–15, 21–28). The fact that attested Indo-European languages have only two guttural series[4], led Burrows (1955: 75–76), Kuryłowicz (1956: 356; Kuryłowicz 1973: 64); Meillet (1893: 278); Lehmann (1952: 100), Bernabé Pajares (1971: 84) and others to state that the triadic model is therefore impossible, but since there are external parallels in the Northern Caucasian and other languages, it is hardly possible to say that the system of three guttural series is impossible from the typological point of view, and we will demonstrate that some version of it even exists in Indo-European language. A slightly modified statement is that by Cavoto (2001: 51), who namely considers three phonetically distinct guttural series, but only two phonemic series for IE (cf. Beekes 2011: 126, too). A very similar statement was already earlier made by Safarewicz (1945: 37). Speaking about the triadic system, we have to mention the variants given by Huld (1986; 1997) and by Kümmel (2007: 310-327), working with the triad with traditional labiovelars, but where traditional palatalovelars are plain velars (hence there is no depalatalization in the *centum*-languages, but there is a palatalization in the *satəm*-languages), and traditional plain velars are uvulars (de-uvularized in both branches) (cf. also Huld 1986: 144–147; Huld 1997; Woodhouse 1998). Lipp (2009a, especially: 5–19) postulates two stages system, similar to that by Szemerényi (1996: 60–61), with an original distinction between plain- and labiovelars, but with a later split of palatovelars from the plain velars in languages which later became the *satəm*-languages; the satəmization as a first step in the general development of palatalization (cf. two stages of palatalization in Burrows 1955: 72–73).

The aforementioned lack of the whole triadic system in attested IE languages led numerous authors to raise grave objections against the triadic system (cf. Meillet 1893: 278; Lehmann 1952: 100; Burrows 1955: 75; Kuryłowicz 1956: 356; Kuryłowicz 1973: 64 as examples). However the traces of a triadic system were stated to be found in Albanian, since Pre-Albanian labiovelars *$k^{u̯}$ and *$g^{u̯}$ (< IE *$g^{u̯}$, *$g^{u̯h}$) were later palatalized to Albanian *s*, *z* before the palatal

[4] The question of preserving at least of traces of three guttural series in IE we will deal with below.

vowel but merged with plain velars in other positions and hence giving, as plain velars, **k* and **g* (< IE **g*, **g*ʰ); cf. Alb. *sjell* 'to bring' < IE *√*kᵘ̯elH₁-* but Alb. *pjek* 'to bake' < IE *√*pekᵘ̯-*; Alb. *zorrë* 'gut' < IE *√*gʰᵘ̯ērn-* but Alb. *djeg* 'to burn' < IE *√*dʰegᵘ̯ʰ-*. Moreover, since Albanian is a *satəm*-language (IE palatovelar **ḱ* developed into Alb. *th*, the IE palatovelars **ǵ, ǵʰ* merged into Albanian *dh*), Albanian preserved traces of the original triadic system. The first proponent of this theory was already Pedersen (1900a), similarly Jokl (1937), Huld (1984: 144; Huld 1997); Rusakov (2017: 569–571); for the opposing points of view cf. Ölberg (1976), Kortlandt (1980a), Orël (2000: 66–74).

A similar development was stated for Armenian, in which, again, the IE voiceless labiovelar[5] was in some cases palatalized before the merging of labiovelars and plain velars (cf. Stempel 1994; Kortlandt 1980; Kümmel 2007: 311; Olsen 2017: 426–428; for data see at least Schmitt 2007: 62–65): IE *√*ḱḗrdi-* > Arm. *sirt* 'heart'; IE *√*kér-ō* > Arm. *ḱerem* 'I scratch'; IE *√*kᵘ̯et(u̯)ores* > Arm. *č̣ork* 'four'. A contrary view that the distinction between original labiovelars and plain velars is secondary and accidental is held by Kortlandt (1975), Beekes (2003: 176–179) and Martirosyan (2010: 711), who consider the palatalization as regular for both original labiovelars and plain velars, the regularity of this process later being disrupted by the excessive analogy.

Note: A model of three velars series was proposed for Luvo-Lycian by Melchert (1987: 182–204; Melchert 1994: 251–256)[6] but was later distinctly decreased by Melchert himself (Melchert 2012: 206–218), not being unconditioned, but having conditioned palatalization of original palatovelars (but not plain velars) before front vowels, *i̯* and *u̯* (the phenomenon seems to be proved for voiceless palatovelars, but not fully affirmed for voiced palatovelars); cf. Cuneiform Luv. *ziyari,* Lyc. *sijẽni* 'lies' < IE **ḱĕ̄sāi̯e-* vs Cuneiform Luv. *kišā(i)-* 'to comb' < IE **kĕ̄s-* vs Cuneiform Luv. *kui-*, Lyc. *ti* 'who' < IE **kᵘ̯i-*. In contrast, the traces of three guttural series in Phrygian are assumed by Woodhouse (2005) as the result of the further development of the original IE dyadic two-valued model, based originally on front velar and back velar (in this respect he is following Steensland 1973: 96–107; Kortlandt 1978a: 237; see above).

Other traces of the original existence of the labiovelars in the future *satəm*-languages are considered to be found in original reduced grades such as OIA *guru-* 'heavy' and *gūrta-* 'welcome', similarly in OCS *gъnati* (cf. *ženǫ* 'propel, drive, chase') from IE *√*gᵘ̯ʰen-* (cf. Burrows 1957; Pisani 1961; Mayrhofer 1986: 104–105).

The striking phenomenon of the *satəm*-languages, especially present in Balto-Slavic, but traceable in Indo-Iranian, too, is the existence of parallel roots with plain velar or original

[5] Surprisingly, this change did not affect IE **gᵘ̯*.

[6] Melchert (1987: 204) mentions an independent statement made by Warren Cowgill in his unpublished manuscript from the early seventies, though based on less evidence (which was probably the reason why the paper was never published). For another independent statement on the preservation of the IE triadic system in Luwian, see Morpurgo Davies/Hawkins (1988: 169–182).

palatovelar, not caused by any noticeable first-hand alternation-trigger, cf. OIA √*klam-* 'be tired' vs √*ślam-* 'be tired'; OIA √*ruc-* 'shine' vs *ruśant-* 'be bright'; OIA √*śru-* 'hear', OCS *slyšati* 'hear' vs Lith. *klausyti* 'hear'; Lith. *pekus* 'domestic animal' vs OIA *paśu-* 'cattle'; OIA *śvaśura-* 'father-in-law' vs OCS *svekrъ* 'father-in-law'; OIA *aśman-* 'stone', Lith. *ašmuõ*, Latv. *asmens* 'sharpness' vs Lith. *akmuõ*, Latv. *akmens*, OCS *kamy* 'stone' etc. (cf. Hirt 1927: 238–241; Vaillant 1950: 171–173; Burrows 1955: 75–76; Steensland 1972: 102–104; Čekman 1974; Allen 1978: 103; Shields 1981: 210–211; Mayrhofer 1986: 105–106; Szemerényi 1996: 146; Lipp 2009a: 5–98; Kapović 2017: 26–27; Young 2017: 497).

To the phonemic status of given velars: the labiovelars were determined as such[7] at least since Zupitza (1896: 1–2). Sköld doubted the monophonemic value of labiovelars (Sköld 1924: 128; similarly Whatmough 1937: 52–56) and preferred the double articulated labial-velar plosives (i.e. as Ewe *k͡p, g͡b*), Salmons and Smith (2005) returned to the monophonemic status of (voiced) labiovelars, independently confirming it. Palatovelars are not attested as such in a single *satəm*-language (here we usually meet sibilants or affricates); their phonetic value is then a reconstruction[8].

We will use the two-stages triadic model based on Lipp (2009a: 5–19), assuming the older distinction between the plain velar (unmarked) and the labiovelar (marked series). This model was replaced in the area of the later *satəm*-languages by the classical triadic model (this explains why there are traces of the old labiovelar vs plain velar distinction in the *satəm*-languages, but not the traces of the palatovelars in the *centum*-languages). However, it is highly probable that the 'palatovelars' were affricates at the same time, not true palatovelar plosives.[9] With such massive remodelling, the primordial distinction between old labiovelars and plain velars was neutralized in all positions, resulting in a merging of both guttural series (similar processes are known from the *centum*-languages, e.g. *k*-Celtic, Tocharian, later Germanic languages).

[7] Similar sounds are present in North-Caucasian, the Suto-Chuana subgroup of Bantu languages and Salish languages.

[8] Again, palatovelars as such are attested in Ubykh and other North-Caucasian languages.

[9] However, the classical triadic system has typological parallels in some non-Indo-European languages, especially in North-Caucasian; we should mention especially recently extinct Ubykh or in Abaza and Abkhaz. Edeľman (1973: 540–546) demonstrated that the guttural system based on three series (plain, palatalized, labialized) is attested in Yazghulami, an East Iranian dialect in the North Pamir, and it should be noted that this system is not a directly inheritance from IE, but secondarily created. It is worthy of mention that Yazghulani has not only three guttural series, but a plain uvular and labialized uvular series, too. Ossetian has a pair of guttural and uvular series in opposition plain vs labialized, too, again independently developed, not inherited from IE. That the triadic system of related series could exist, is demonstrated in OIA in Šefčík 2012.

However, for simplicity, we will use the traditional marking for the palatovelars, as we do for other reconstructed Indo-European phonemes.

1.1.3 Indo-European obstruents: the list

Considering the issues as mentioned above, the set of Indo-European obstruents we work with is then the seemingly conventional set (including the *ruki*-sibilant **š*), we can put as follows:

	plosives			sibilant
labiovelars:	kᵘ̯	gᵘ̯	gᵘ̯ʰ	
plain velars:	k	g	g^h	
palatovelars:	ḱ	ǵ	ǵʰ	(š)
dentals:	t	d	d^h	s
labials:	p	b	b^h	

This model does not probably reflect any actual state in the development of the Common Indo-European but serves as a panchronic working model (as we have already mentioned above, the guttural triad was limited to future *satəm*-languages and palatovelars were probably not phonetic palatovelar plosives, and we have to repeat that the modal values are probably simplified, etc.). For panchronic reasons, the *ruki*-palatal *š* is included in the list, though never reconstructable outside the *satəm*-area and even so it's existence is questionable for Pre-Albanian and Pre-Armenian).

1.2 Segments and contexts

The focus of our study is clusters of IE obstruents in three different contexts.

The obstruent segments (i.e., the left part) of clusters could be split into the following blocks:

i. the **central** block[10] containing IE dentals (phonetically could also be realized as alveovelars in some of the languages) and palatovelars (in the *satəm*-languages only);

ii. the **peripheral** block[11] containing IE labials, plain velars and labiovelar series (in the *centum*-languages only);

iii. the **sibilant** block[12] containing the old IE sibilant **s*, the most *satəm*-languages have a secondary sibilant **š*, arising due to Pedersen's Law/the *ruki*-law.

Similarly, the context (i.e., the right part) of clusters could be classified as:

i. the context of **t*-, causing the devoicing and deaspiration of the left obstruent in all Indo-European languages; the exception is languages with Bartholomae's Law;

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[10] In terms of Jakobson / Halle (1956: 31), we can term it an *acute* block.

[11] Using the terminology of Jakobson/Halle again, the block could be termed a *grave* block.

[12] This block is defined, as we see, not by its localization, but its sonority.

ii. the context of *d^h-; causing the voicing and deaspiration of the left obstruent in languages where the voicing is preserved (here especially in Indo-European);
iii. the context of *s-;[13] also causing the devoicing and deaspiration of the left obstruent; again; these clusters could be affected by Bartholomae's Law, the feature well preserved in Iranian only.

1.3 On trajectories of the development in general

The development from the Indo-European stage to a given language stage is the transformation between two (or more) states-of-arts; each state is a set of elements.

Within this analysis, we generally distinguish at least three stages of the development from the input Indo-European into a given output language:

i. the (Late) *Indo-European stage*, the initial state, arrived at by reconstruction;
ii. the *intermediate stage*, the transitional stage (or, more appropriately, a set of sub-stages) between Indo-European and an output language;
iii. the *given language stage*, the actually attested language[14].

The *Indo-European*-stage and the *given-language*-stage are hence both *termini* of the whole complex of the development processes, and both serve either as an *input* or respectively *output* of the complex transformation of the reconstructed Indo-European phonemic system into a given phonemic system. This transformation, concerning the processes involved, could be described more appropriately as a set of minor transformations, not as a single giant transformation of its own.

Note that the input (i.e., the *Indo-European*-stage) is a result of *reconstruction*, but the output is actual language matter, recorded as a hard fact. Both are fixed sets objects, though results of a different approach (output is simply observed, the input is reconstructed).

The *intermediate*-stage (or stages) is, on the contrary, a set of *trajectories* between the input and the output and hence a matter of more or less analytic nature.

It is a paradox that often the reconstructed stage (the input) can be quite securely reconstructed without a more profound analysis, e.g. the merging of both voiced modal classes of plosives in Iranian, Balto-Slavic, etc., since it can be based on a simple observation.

The *intermediate stage* is based both on a comparative reconstruction and an internal reconstruction and in this very aspect the *intermediate*-stage is a kind of *black box* since we do

[13] In some context realized as *š-; the distribution, in this case, is affected by the left phoneme in the cluster, i.e., by the Pedersen's Law/*ruki*-rule; securely attested in Indo-Iranian and Balto-Slavic);
[14] At this moment, we leave aside the often insecure knowledge of the phonetic realization (cf. the phonetic nature of the 'tau gallicum', the value of Hittite plosives, etc.).

not see immediately what is inside, but we project the possible trajectories in it and choose that which fits most the known data both of the input and the output.

INPUT		TRANSFORMATIONS		OUTPUT
Indo-European	→	intermediate stage(s)	→	a given language
(given by reconstruction)		(‘the black box’; the modelled trajectories)		(attested language facts)

When speaking about the trajectory from the input to the output, there are often multiple ways of plotting the trajectory, i.e., there could be competing scenarios, though leading from the same income towards the same outcome, as we will see on the examples of the development of various clusters below (a typical case is the development of the peripheral clusters + *t/s-* in Pre-Slavic).

Note: On the following lines, the terms ‘major’ and ‘minor’ developments will be sometimes used. A minor development is a development which in its results differs from the expected *lautgesetzlich* development according to a given known sound law but falls with a possible range of outputs, though the precise reasons for this special development are not clear (otherwise they would fit within a defined sound law).

1.4 On language material and its analysis

The focus of the present analysis is on clusters of Indo-European obstruents (in a sense described above) + **t/s-* clusters. The reason we have picked these clusters is obvious and apparent: formations of these two types are very numerous and well-attested, and the observation of their function could be applied, in the basic features, to all other clusters formed by voiceless obstruents.

The clusters of the same obstruents with *d^h- were used only with languages with extensive and productive use of this kind of formation, namely in Indo-Iranian (here especially since the comparison of the d^h-context clusters are important due to Bartholomae’s Law and subsequently for the *t*-context clusters), Baltic (more to illustrate the situation outside of Indo-Iranian) and Greek (besides the purely illustrative use, it was important to demonstrate the *d^h-context clusters after the phonemic revaluating of voice and subsequent remodelling of whole *d^h-context clusters in Greek). Again, the function of the *d^h-context clusters can be applied and generalized to other IE voiced aspirated contexts, namely to IE *b^h-context.

The reader will notice that a natural complement to the present study could be the ‘thorn’-question, which was deliberately and willingly omitted, since the sheer number of examples would increase the number of pages required – the author of the present lines could only recommend comprehensive study by Lipp (2009b – covering 350 print pages!).

The work on this analysis was made possible due to preceding important works, quoted in the lines below. Especially worthy of mention are authors of LIV (the second edition of it was used), the more so since our focus was mainly on the productive verbal formations, NIL (used when verbal data were not sufficient) and of various quoted etymological dictionaries of given languages (often of the Leiden origin) but also with the use of the classical works like Pokorny (IEW). Of valuable help were lists of OIA verbal forms by Whitney (1885) and MacDonell (1916), the list of the Avestan verbal forms by Kellens (1984) and the list of Tocharian verbal forms by Malzahn (2010). From monographs at least few of many should be noted in alphabetic order: Görtzen (1998), Hill (2003), Kümmel (2007) and two-part monumental volume by Lipp (2009a; 2009b). To the quoted literature, we should attribute all the positive sides of the present works; all mistakes are fully the author's alone.

The analysis is segmented in accordance with given branches of the IE languages, represented either by a single language (Old Church Slavonic for the whole Slavic family, Gothic for the whole Germanic) or more languages (OIA, Avestan, Persian and Nūrīstānī represent the Indo-Iranian branch; Italic languages are represented by both by Latin and Sabellian languages) if the data they bring are substantially and significantly different (the aforementioned Italic languages differ in their development of the peripheral series, Indo-Iranian languages substantially differ in the development of all local series). The ordering of the given branches is not accidental – first, we will follow the *satəm*-languages, followed by the *centum*-languages and finally by two peripheral (technically *centum*) languages with a remarkable difference in the development of the clusters of *dental* plosive + **t/s* (Hittite for Anatolian languages, and Tocharian). Each chapter on a given branch/language is then written as an independent study, both for convenience of the reader and for the simplicity of the present treatise as a whole.

2 The development of the two-obstruent clusters from Indo-European into Indo-Iranian

2.0 Indo-Iranian languages

The Indo-Iranian (Aryan) branch of Indo-European languages is one of the most influential sources of the whole discipline, due to its huge documentation.

Old Indo-Aryan is known from extensive Vedic texts, the most important source being *R̥g-veda*, assumed to be compiled by the middle of the second millennium BC, this oldest stratum is followed by younger documents, notably brāhmaṇas and post-Vedic works. The Old Indo-Aryan language was replaced by its Middle and New Indo-Aryan heirs, forming a natural laboratory of a language continuum (cf. Bloch 11–31; Masica 1991: 32–60; Cadorna 2017). The influence of Vedic (or precisely, of Classical Sanskrit) on the development (and results) of Indo-European comparative linguistics was enormous, especially in the 19th century.

There are two relatively well Old Iranian languages: Avestan, orally composed in the 2nd and 1st millennia BC (written down in the Sassanian Period ca 600 AD), the Old and Young Avestan are not different stages of a single language but are distinguished even spacially. The second language is Old Persian, attested in contemporary documents in cuneiform script, dated since the rule of Darius I until Alexander (cf. Skjærvo 2017: 472–474).

Nūristānī language are, on the other hand, a relatively small group of languages with an unclear relation to both main branches, attested from the 20th century AD and relatively worse both documented and examined.

2.1 On the reconstruction of the trajectory of the Indo-Iranian development

The development of two-obstruent clusters from Indo-European into given Indo-Iranian languages should be understood as a complex of sequences of at least three stages, which can be demonstrated by the development of Old Indo-Aryan: there is the IE stage, which is an input to the process, the Old Indo-Aryan stage, which is the output of the process and the intermediate transitory stage (or stages), which we can term the Indo-Iranian stage. We can similarly model the development of Avestan and Old Persian, differing in their respective outputs and later developments, specific for the Iranian branch of the Indo-European languages. Old Indo-Aryan, Avestan and Old Persian stages are mutually equivalent, being attested roughly at the same time. Nūristānī, on the other hand, which probably forms the third branch of Indo-Iranian languages, according to the prevailing opinion (but see note below), is attested since the early 20th century, which creates remarkable problems because of the relationship of its data to the old Indo-Iranian languages.

Note: The position of Nūristānī within the Indo-Iranian family was considered the third independent branch (Mayrhoffer 1951: 15; Morgenstierne 1961; Fussman 1972: 391; Strand 1973; Nelson 1986: 104–116; Kausen 2012: 661–667), closer to Iranian (Mayrhofer 1984; Mayrhoffer 1997: 107–108; Lipp 2009a: 156–157) or to Indo-Aryan languages (Bloch 1965: 54; Buddruss 1977: 33; Degener 2002; Blažek/Hegedüs 2012; Weba 2016), for the most actual discussions on the theme also see Cardona/Jain (2003: 22–25).

In the following lines, our analysis will be primarily focused on the development of Old Indic (represented by Vedic) and of Old Iranian languages (i.e., Avestan and Old Persian), since they are fully equivalent in the relative chronology, though Old Persian data are far worse attested than those of Avestan and Avestan worse than those of Vedic. Nūristānī data will serve more as a commentary and appendices to the main course of analysis, quoted when possible, visually marked from the bulk of Old Indo-Iranian languages by the size of the font used.

Note that the output stages contain the 'hard data' and these data are almost empirically approached, but both IE and II stages are reconstructed models[15], reconstructed via the comparison either of IE or Indo-Iranian languages, the approach being more 'algebraic' than 'empirical', 'models' than 'facts' in its very nature. The changes between given stages are expressed through trajectories; in some cases, parallel trajectories could be modelled, as we will demonstrate below.

Our primary focus is on two-obstruent clusters, formed either by any left-standing plosive or a sibilant in contexts of the right standing **t*-, *d^h*- or **s/š*. The main point of our interest will be clusters formed on the morphemic boundary between two morphs, i.e., on the clusters of obstruents synchronically produced; the 'etymological' clusters (not resulting from synchronic alternations) will be used only if the 'alternating' clusters will not be at hand. The alternating clusters have precedence, since being a very 'living flesh' of a given language, such alternations show active structures and can serve as a cornerstone for an internal reconstruction. The verbal systems offer a huge thesaurus of such productive alternations; nominal morphology will be used only occasionally.

Note: The two-obstruent clusters could either be preceded or followed by a non-obstruent consonant but since Indo-Iranian non-obstruents (liquids, sonants, nasals[16]) are always peripheries of the consonantal clusters, if the obstruents are present, such clusters will be accepted as well as obstruent-only clusters, especially since non-obstruents do not generally trigger any alternations of obstruents in observed languages (the exceptions will be pointed out in case of need).

2.2 The development of two-obstruent clusters in Vedic

In the forming of two-obstruent clusters in Vedic, there are the following general tendencies and rules (usually shared with other old Indo-Iranian languages as well):

i. voiceless and voiced non-aspirated plosives have the same developments before voiceless obstruents;
ii. voiced aspirated plosives, when concatenated by a voiceless non-aspirate plosive, form clusters of *DD^h*; this process is known as Bartholomae's law;
iii. the same result is given by the concatenation of two voiced aspirated plosives or by a concatenation of a voiceless or voiced non-aspirate with a voiced aspirate plosive[17];
iv. in contrast with above, all plosives are neutralized on a voiceless plosive before *s*- (Bartholomae's Law is not applied).

[15] However, even 'hard" Vedic, Avesta, Old Persian or Nūristānī data form some kind of a mental structure; they form a model sui generis, though based on empirical evidence.

[16] For good reasons, we deal with nasals as with phonemic non-obstruents, though phonetically, they are obstruents as well.

[17] But we will see below, there are some interesting exceptions of this generally assumed rule.

Beside those, we have to remark that:

v. the OIA voiceless aspirates never form a cluster with the following obstruent in the same way as their counterparts. The OIA voiceless aspirated plosives are always separated by *i* from the following obstruent; hence, all examples of voiceless aspirates will be absent from our overview;

vi. for both for diachronic and synchronic reasons we have to distinguish two series: the original Indo-European palatovelars (and though this series is in no way palatalovelar in its phonetic realization, we will stick for simplicity to this name): *ś*, j_1, h_1 and true palatals: *c*, j_2, h_2 arising from the later palatalization from merged original IE plain velars and labiovelars. The synchronic reason to distinguish both series is as follows: original palatovelars are realized before plosives in OIA as cerebrals (or as zero), as we will see below, the palatals are neutralized to plain velars (in contrast with that both series are neutralized on plain velar before the sibilant).

vii. Since the number of examples on the alternations of left standing cerebrals is insignificant, the cerebrals (diachronically moreover of the late origin) are in generally omitted, except *-ṣ*, which is generally the result of Pedersen's Law and in its diachronic aspect definitely at least of Indo-Iranian origin. Some notes on cerebrals are included as a special note to section 2.3 dealing with dentals.

2.2.1 Clusters of *labial + t/d^h/s*

The clusters with the labial obstruent on the left form following patterns:

P + t = OIA pt:

ppp. *āptá-*, inf. *ā́ptum* (√*āp-* 'obtain'; cf. pr. *āpnóti*; < IE *√*H₂ep-*; cf. Hitt. *ēpzi*, *appanzi* 'grab', OL. *apiō* 'fasten'; cf. Whitney 1885: 6; MacDonell 1916: 371; Pokorny IEW: 50–51; EWAi I: 167; LIV^2: 237; NIL: 311–317);

ao. *táptam*, ppp. *taptá-* (√*tap-* 'heat'; cf. pr. *tápati*; < IE *√*tep-*; cf. L. *tepeō* 'be warm', OCS *teplostъ* 'heat'; cf. Whitney 1885: 61; MacDonell 1916: 386; Pokorny IEW: 1169–1170; EWAi I: 623–624; LIV^2: 629–630; NIL: 698–670);

ppp. *tṛptá-* (√*tṛp-* 'be pleased'; cf. pr. *tṛpṇóti*; < IE *√*terp-*; cf. Lith. *tarpstù* 'satisfy'; cf. Whitney 1885: 65–66; MacDonell 1916: 386; Pokorny IEW: 1077–1078; EWAi I: 634–635; LIV^2: 636);

pr. *sváptu*, ppp. *suptá-* (√*svap-* 'sleep'; cf. pr. *svápati*; < IE *√*su̯ep-*; cf. L. *sopiō*, OCS *sъpljǫ* 'sleep'; cf. Whitney 1885: 201; MacDonell 1916: 432; Pokorny IEW: 1048–1049; EWAi II: 791; LIV^2: 612; NIL: 675–680);

num. *saptá-* 'seven' (< IE *√*septm̥-*; cf. Gr. ἑπτά, L. *septem* 'seven'; cf. Pokorny IEW: 1048–1049; Emmerick 1992a: 169–170, 181–182; Blažek 1999: 246; EWai II: 700);

b^h + t = OIA bd^h:

ppp. *ubdhá-* (√*ubh-* 'stick'; cf. pr. *áumbhat*; < IE *√*u̯eb^h-*; cf. Hitt. *wepta*, OHG *weban* 'weave'; cf. Whitney 1885: 13; MacDonell 1916: 373; Pokorny IEW: 1114; EWAi II: 506; LIV^2: 658);

ppp. *rabdhá-* (√*rambh-* 'grasp'; cf. pr. *rábhate*; < IE *√*lemb^h-*; cf. Gr. λάφῡρα 'spoils of war'; cf. Whitney 1885:136; MacDonell 1916: 411; Pokorny IEW: 652; EWAi II: 434–435; LIV^2: 411–412); etymologically the same root as the following one:

ppp. *labdhá-*, gd. *labdhvā́* (√*labh-* 'take'; cf. pr. *lábhate*; < IE *√*lembʰ-*; cf. Gr. λάφῡρα 'spoils of war'; cf. Whitney 1885: 145–146; MacDonell 1916: 414; Pokorny IEW: 652; EWAi II: 434–435; LIV²: 411–412);
ppp. *dabdhá-* (√*dabh-* 'harm'; cf. pr. *dábhati*; < IE *√*dʰebʰ-*; cf. Hitt. *tepnuzzi* 'downsize', Lith. *dóbiu* 'invalidate'; cf. Whitney 1885: 70; MacDonell 1916: 388; Pokorny IEW: 240; EWAi II: 694–696; LIV²: 132–133; NIL: 85–86);

P + dʰ = OIA *bdʰ:
not attested

bʰ + dʰ = OIA *bdʰ:
not attested

P + s = OIA ps:
ft. *āpsyáti*, ds. *ī́psati* (√*āp-* 'obtain'; cf. pr. *āpnóti*; < IE *√*H₂ep-*; cf. Hitt. *ēpzi*, *appanzi* 'grab', OL *apiō* 'fasten'; cf. Whitney 1885: 6; MacDonell 1916: 371; Pokorny IEW: 50–51; EWAi I: 167; LIV²: 237; NIL 311–317);
ao. *átapsīt* (√*tap-* 'heat'; cf. pr. *tápati*; < IE *√*tep-*; cf. L. *tepeō* 'be warm', OCS *teplostь* 'heat'; cf. Whitney 1885: 61; MacDonell 1916: 386; Pokorny IEW: 1169–1170; EWAi I: 623–624; LIV²: 629–630; NIL: 698–670);
co. *átarpsyat* B, ds. *títṛpsati* (√*tṛp-* 'be pleased'; cf. pr. *tṛpṇóti*; < IE *√*terp-*; cf. Lith. *tarpstù* 'satisfy'; cf. Whitney 1885: 65–66; MacDonell 1916: 386; Pokorny IEW: 1077–1078; EWAi I: 634–635; LIV²: 636);
ft. *svapsyáti* B (√*svap-* 'sleep'; cf. pr. *svápati*; < IE *√*su̯ep-*; cf. L. *sopiō*, OCS *sъpljǫ* 'sleep'; cf. Whitney 1885: 201; MacDonell 1916: 432; Pokorny IEW: 1048–1049; EWAi II: 791; LIV²: 612; NIL:675–680);

bʰ + s = OIA ps:
ps. *rípsate* B (√*rambh-* 'grasp'; cf. pr. *rábhate*; < IE *√*lembʰ-*; cf. Gr. λάφῡρα 'spoils of war'; cf. Whitney 1885:136; MacDonell 1916: 411; Pokorny IEW: 652; EWAi II: 434–435; LIV²: 411–412); etymologically the same root as the following one
ds. *álapsata*, ft. *lapsyáti*, ds. *lípsate* AV, ps. *lipsyáte* B (√*labh-* 'take'; < IE *√*lembʰ-*; cf. Gr. λάφῡρα 'spoils of war'; cf. Whitney 1885: 145–146; MacDonell 1916: 414; Pokorny IEW: 652; EWAi II: 434–435; LIV²: 411–412);
ds. *dípsati* (√*dabh-* 'harm'; cf. pr. *dábhati*; < IE *√*dʰebʰ-*; cf. Hitt. *tepnuzzi* 'downsize', Lith. *dóbiu* 'invalidate'; cf. Whitney 1885: 70; MacDonell 1916: 388; Pokorny IEW: 240; EWAi II: 694–696; LIV²: 132–133; NIL: 85–86);

The *bʰt*-clusters are subjected to Bartholomae's law (but not *bʰs*-clusters), as are all clusters resulting from original voiced aspirated plosive + *t*. There are no secure examples of clusters from *p/b* + *dʰ* and *bʰ* + *dʰ*, though we can assume, due to analogy with other series (see below), for both as **dbʰ*, i.e., the same outcome as for clusters of *bʰt*.

2.2.2 Clusters of *velar palatal + t/d^h/s*

The true velars are generally scarce at the end of roots, and the (secondary) palatals are products of the palatalization of original IE plain velars and labiovelars. Both series are in privative opposition to the related series in the sense of Trubetzkoy, and palatals neutralize to plain velars before obstruents, hence, both series are treated as a single one.

The clusters with the velar/palatal obstruent on the left form the following patterns:

K$^{(\text{u̯})}$ + t = OIA kt:

ao. *śaktám*, inf. *śaktave* (√*śak*- 'be able': cf. ao. *śákat*; < IE *√*ḱek*$^{(u)}$-; cf. OIr *cecht* 'might'; cf. Whitney 1885: 169; MacDonell 1916: 422; Pokorny IEW: 522; EWAi II: 600–601; LIV^2: 322);

pf. *mumóktu*, ppp. *muktá*- (√*muc*- 'release'; cf. ao. *ámoci*; < IE *√*meu̯k*-; cf. L. *ē-mungō* 'blow out', Lith. *munkù* 'get loose'; cf. Whitney 1885: 122; MacDonell 1916: 406; Pokorny IEW: 744; EWAi II: 382–383; LIV^2: 443–444);

pr. *pṛṅkté*, impf. *apipṛktá* (√*pṛc*- 'mix'; cf. pr. *pṛñcáte*; < IE *√*perk*-; cf. L. *parcō* 'spare'; cf. Whitney 1885: 101; MacDonell 1916: 398–399; Pokorny IEW: 820; EWAi II: 96; LIV^2: 476);

inf. *páktave,* gd. *paktvā́*, nom. *paktar*- (√*pac*- 'cook'; cf. pr. *pácati*; < IE *√*pek*^{u}-; cf. L. *coquō*, OCS *pekǫ* 'cook'; cf. Whitney 1885: 92–93; MacDonell 1916: 396; Pokorny IEW: 798; EWAi II: 64; LIV^2: 468; NIL: 548–552);

pr. *vívakti*, ppp. *uktá*- (√*vac*- 'speak'; cf. ao. *ávāci*; < IE *√*u̯ek*^{u}-; cf. Gr. εἶπον 'say'; cf. Whitney 1885: 151; MacDonell 1916: 415; Pokorny IEW: 1135–1136; EWAi II: 489–491; LIV^2: 673–674);

pr. *niniktá*, ppp. *niktá*-, int. *nenikté* (√*nij*- 'wash'; cf. ao. *ánijam*; < IE *√*nei̯g*^{u}-; cf. Gr. νίζω 'wash', OIr. *-nenaig* 'wash'; cf. Whitney 1885: 90; MacDonell 1916: 395; Pokorny IEW: 761; EWAi II: 54; LIV^2: 450; NIL: 519–520);

ppp. *tyaktá*- B (√*tyaj*- 'forsake'; cf. pf. *tityā́ja*; < IE *√*ti̯eg*^{u}-; cf. Gr. σέβομαι 'feel awe/shame'; cf. Whitney 1885: 66; MacDonell 1916: 387; Pokorny IEW: 1086; EWAi I: 673–674; LIV^2: 643; NIL: 660–661);

pr. *yunákti*, *yunákta*, ao. *yukta* (√*yuj*- 'join'; cf. pr. *yuñjánti*; < IE *√*i̯eu̯g*-; cf. L. *iungō* 'harnesss', OCS *igo* 'yoke'; cf. Whitney 1885: 132–133; MacDonell 1916: 410; Pokorny IEW: 508–510; EWAi II: 417–418; LIV^2: 316; NIL: 397–404);

ao. *viktá*, ps. *viktá*- (√*vij*- 'tremble'; cf. pr. *vijánte*; < IE *√*u̯ei̯g*-; cf. Gr. εἴκω, OE *wīcan* 'give way'; cf. Whitney 1885: 159; MacDonell 1916: 418; Pokorny IEW: 1130–1131; EWAi II: 577–578; LIV^2: 667–668);

num. *pakthá*- 'fifth', *pa*(*ṅ*)*ktí*- 'set of five' (< IE *√*penk*^{u}*-t*-; cf. L. *quīnctus*, OCS *pętъ* 'fifth'; cf. Pokorny IEW: 1048–1049; Emmerick 1992a: 168–169, 180–181; Blažek 1999: 246; EWai II: 65–66);

g$^{(\text{u̯})\text{h}}$ + t = OIA gd^h:

prc. *dhaktám* (√*dagh*- 'reach to'; cf. pr. *daghnuyā́t* B; < IE *√*d*^{h}*eu̯g*^{uh}*H*$_2$-; cf. Gr. Hom. φθάνω 'come first'; cf. Whitney 1885: 69; MacDonell 1916: 388; Pokorny IEW: 250; EWAi I: 691; LIV^2: 134–135);

ppp. *dagdhá*- (√*dah*- 'burn'; cf. pr. *dáhati*; < IE *√*d*^{h}*eg*^{uh}-; cf. Lith. *degù* 'burn'; cf. Whitney 1885: 71; MacDonell 1916: 388–389; Pokorny IEW: 240–241; EWAi I: 712–713; LIV^2: 133–134);

pr. *dógdhi*, *dugdhé*, ppp. *dugdhá-* (√*duh-* ‘milk’; cf. pr. *duhánti*; < IE *√*d^{h}eu̯g^{h}-*; cf. Gr. τεύχω ‘make ready’, OE *ge-dȳgan* ‘overcome’; cf. Whitney 1885: 76; MacDonell 1916: 390; Pokorny IEW: 271; EWAi I: 747–748; LIV^{2}: 148–149);

K$^{(u̯)}$ + d^{h} = OIA gd^{h}:

ao. *śagdhí* (√*śak-* ‘be able’: cf. ao. *śákat*; < IE *√*ḱek$^{(u̯)}$-*; cf. OIr *cecht* ‘might’; cf. Whitney 1885: 169; MacDonell 1916: 422; Pokorny IEW: 522; EWAi II: 600–601; LIV^{2}: 322);

pr. *pípṛgdhí*, *pṛṅdhí* (= *pṛṅgdhí*) (√*pṛc-* ‘mix’; cf. pr. *pṛñcáte*; < IE *√*perk-*; cf. L. *parcō* ‘spare’; cf. Whitney 1885: 101; MacDonell 1916: 398–399; Pokorny IEW: 820; EWAi II: 96; LIV^{2}: 476);

pf. *mumugdhí*, ao. *ámugdhvam* (√*muc-* ‘release’; cf. ao. *ámoci*; < IE *√*meu̯k-*; cf. L. *ē-mungō* ‘blow out’, Lith. *munkù* ‘get loose’; cf. Whitney 1885: 122; MacDonell 1916: 406; Pokorny IEW: 744; EWAi II: 382–383; LIV^{2}: 443–444);

pf. *tityagdhí* (√*tyaj-* ‘forsake’; cf. pf. *tityā́ja*; < IE *√*ti̯eg$^{u̯}$-*; cf. Gr. σέβομαι ‘feel awe/shame’; cf. Whitney 1885: 66; MacDonell 1916: 387; Pokorny IEW: 1086; EWAi I: 673–674; LIV^{2}: 643);

int. *nenigdhí* (√*nij-* ‘wash’; cf. ao. *ánijam*; < IE *√*nei̯g$^{u̯}$-*; cf. Gr. νίζω ‘wash’, OIr. *-nenaig* ‘wash’; cf. Whitney 1885: 90; MacDonell 1916: 395; Pokorny IEW: 761; EWAi II: 54; LIV^{2}: 450; NIL: 519–520; NIL: 660–661);

ao. *áyugdham* (√*yuj-* ‘join’; cf. pr. *yuñjánti*; < IE *√*i̯eu̯g-*; cf. L. *iungō* ‘harness’, OCS *igo* ‘yoke’; cf. Whitney 1885: 132–133; MacDonell 1916: 410; Pokorny IEW: 508–510; EWAi II: 417–418; LIV^{2}: 316; NIL: 397–404);

g$^{(u̯)h}$ + d^{h} = *gd^{h}:

not attested

K$^{(u̯)}$ + s = OIA kṣ:

ft. *śakṣyáti* (√*śak-* ‘be able’: cf. ao. *śákat*; < IE *√*ḱek$^{(u̯)}$-*; cf. OIr *cecht* ‘might’; cf. Whitney 1885: 169; MacDonell 1916: 422; Pokorny IEW: 522; EWAi II: 600–601; LIV^{2}: 322);

ao. *ápṛkṣi* (√*pṛc-* ‘mix’; cf. pr. *pṛñcáte*; < IE *√*perk-*; cf. L. *parcō* ‘spare’; cf. Whitney 1885: 101; MacDonell 1916: 398–399; Pokorny IEW: 820; EWAi II: 96; LIV^{2}: 476);

ao. *mukṣata*, ds. *múmukṣati* (√*muc-* ‘release’; cf. ao. *ámoci*; < IE *√*meu̯k-*; cf. L. *ē-mungō* ‘blow out’, Lith. *munkù* ‘get loose’; cf. Whitney 1885: 122; MacDonell 1916: 406; Pokorny IEW: 744; EWAi II: 382–383; LIV^{2}: 443–444);

ao. *pákṣat*, ft. *pakṣyáti* (√*pac-* ‘cook’; cf. pr. *pácati*; < IE *√*pek$^{u̯}$-*; cf. L. *coquō*, OCS *pekǫ* ‘cook’; cf. Whitney 1885: 92–93; MacDonell 1916: 396; Pokorny IEW: 798; EWAi II: 64; LIV^{2}: 468; NIL: 548–552);

ft. *vakṣyáti*, ds. *vívakṣati* (√*vac-* ‘speak’; cf. ao. *ávāci*; < IE *√*u̯ek$^{u̯}$-*; cf. Gr. εἶπον ‘say’; cf. Whitney 1885: 151; MacDonell 1916: 415; Pokorny IEW: 1135–1136; EWAi II: 489–491; LIV^{2}: 673–674);

ao. *nikṣi*, *ánaikṣīt* (√*nij-* ‘wash’; cf. ao. *ánijam*; < IE *√*nei̯g$^{u̯}$-*; cf. Gr. νίζω ‘wash’, OIr. -*nenaig* ‘wash’; cf. Whitney 1885: 90; MacDonell 1916: 395; Pokorny IEW: 761; EWAi II: 54; LIV^{2}: 450; NIL: 519–520);

g$^{(u̯)h}$ + s = OIA kṣ:

ao. *ádhākṣīt*, ft. *dhakṣyáti* (√*dah-* ‘burn’; cf. pr. *dáhati*; < IE *√*d^{h}eg$^{u̯h}$-*; cf. Lith. *degù* ‘burn’; cf. Whitney 1885: 71; MacDonell 1916: 388–389; Pokorny IEW: 240–241; EWAi I: 712–713; LIV^{2}: 133–134);

ao. *ádhukṣata*, *dhukṣata* (√*duh*- 'milk'; cf. pr. *duhánti*; < IE *√*d*^{h}*eu̯g*^{h}-; cf. Gr. τεύχω 'make ready', OE *ge-dȳgan* 'overcome'; cf. Whitney 1885: 76; MacDonell 1916: 390; Pokorny IEW: 271; EWAi I: 747–748; LIV^2: 148–149);

As above, a solid example of clusters resulting from a concatenation of *g*$^{h/}$*h*$_2$+*d*^{h} is missing, the reconstruction is given purely by analogy either with 'Bartholomae's clusters' of *g*^{h}*t/h*$_2$*t* or with the dental series. As in other cases, the *g*^{h}*s/h*$_2$*s* clusters are not subjected to Bartholomae's Law, in contrast with *g*^{h}*t/h*$_2$*t*.

2.2.3 Clusters of *palatovelar + t/d*^{h}*/s*

The original IE palatovelars (realized in OIA as *ś, j*$_1$*, h*$_1$ respectively) form clusters of the following patterns:

Ḱ + t = OIA ṣṭ:

pf. *dídeṣṭu*, ao. *ádiṣṭa*, ppp. *diṣṭá*-, int. *dédiṣṭi* (√*diś*- 'point'; cf. pr. *diśátu*; < IE *√*dei̯ḱ*-; cf. L. *dīcō* 'say'; cf. Whitney 1885: 73; MacDonell 1916: 389; Pokorny IEW: 188–189; EWAi I: 744–746; LIV^2: 108–109);

ppp. *dṛṣṭá*-, gd. *dṛṣṭvā́* (√*dṛś*- 'see'; cf. pf. *dadárśa*; < IE *√*derḱ*-; cf. Gr. δέρκομαι 'see'; cf. Whitney 1885: 391; MacDonell 1916: 78; Pokorny IEW: 213; EWAi I: x; LIV^2: 122);

pr. *vā́ṣṭi, vā́ṣṭu, vivaṣṭi, vivaṣṭu* (√*vaś*- 'desire'; cf. pr. *vā́śmi*; < IE *√*u̯eḱ*-; cf. Hitt. *wēkzi* 'wish'; cf. Whitney 1885: 155; MacDonell 1916: 416; Pokorny IEW: 1135; EWAi II: 527–528; LIV^2: 672–673);

ao. *áyaṣṭa*, ppp. *iṣṭá*- (√*yaj*- 'sacrifice'; cf. pr. *yájati*; < IE *√*Hi̯aǵ*-; cf. Gr. ἅζομαι 'stand in awe' (?); cf. Whitney 1885: 129; MacDonell 1916: 408; Pokorny IEW: 501; EWAi II: 392–394; LIV^2: 254–255);

ppp. *mṛṣṭá*- (√*mṛj*- 'wipe'; cf. pr. *mṛjánti*; < IE *√*H*$_2$*merǵ*-; cf. Gr. ἀμέργω 'pluck, pull'; cf. Whitney 1885: 125; MacDonell 1916: 407; Pokorny IEW: 738; EWAi II: 324–326; LIV^2: 280–281);

ao. *ásṛṣṭa*, ppp. *sṛṣṭá*- (√*sṛj*- 'emit'; cf. pr. *sṛjáti*; < IE *√*selǵ*-; cf. Gr. λαγαίω, 'release' (?); cf. Whitney 1885: 189–190; MacDonell 1916: 428–429; Pokorny IEW: 900–901; EWAi II: 709; LIV^2: 528–529);

ǵ^h + t = OIA 0ḍ^h:

ppp. *gūḍhá*-, gd. *gūḍhvī́* (√*guh*- 'hide'; cf. ao. *guháḥ*; < IE *√*g*^{uh}*eu̯ǵ*^{h}-; cf. Whitney 1885: 38; MacDonell 1916: 379–380; Pokorny IEW: 450; EWAi I: 502–503; LIV^2: 199);

pr. *léḍhi* B (√*lih*- 'lick'; cf. caus. *leháyati*; < IE *√*lei̯ǵ*^{h}-; cf. Gr. λείχω, OCS *ližǫ* 'lick'; cf. Whitney 1885: 148; MacDonell 1916: 414; Pokorny IEW: 668; EWAi II: 463; LIV^2: 404);

ppp. *rūḍhá*-, gd. *rūḍhvā́* (√*ruh*- 'ascend'; cf. pr. *róhati*; < IE *√*H*$_1$*leu̯d*^{h}-; cf. Gr. Hom. ἤλυθον 'come, start'; cf. Whitney 1885: 143–144; MacDonell 1916: 414; Pokorny IEW: 306–307, 684–685; EWAi II: 467–469; LIV^2: 248–249; NIL: 245–246);

ppp. *ūḍhá*-, inf. *vóḍhum* (√*vah*- 'carry'; cf. pr. *váhati*; < IE *√*u̯eǵ*^{h}-; cf. L. *uehō*, OCS *vezǫ* 'ride'; cf. Whitney 1885: 157; MacDonell 1916: 417; Pokorny IEW: 1118–1120; EWAi II: 535–537; LIV^2: 661–662);

ppp. *sā̄ḍhá-* (√*sah-* ‘prevail’; cf. pr. *sáhate*; < IE *√*seǵ*^{h}-; cf. Gr. ἔχω ‘have, hold’; cf. Whitney 1885: 184–185; MacDonell 1916: 427; Pokorny IEW: 888–889; EWAi II: 717–718; LIV^2: 515–516; NIL: 600–604);

Ḱ + d^h = OIA ḍḍ^h:

pf. *didiḍḍhí* (√*diś-* ‘point’; cf. pr. *diśátu*; < IE *√*dei̯ḱ-*; cf. L. *dīcō* ‘say’; cf. Whitney 1885: 73; MacDonell 1916: 389; Pokorny IEW: 188–189; EWAi II: 744–746; LIV^2: 108–109);

pr. *mṛḍḍhvám* (√*mṛj-* ‘wipe’; cf. pr. *mṛjánti*; < IE *√*H$_2$merǵ-*; cf. Gr. ἀμέργω ‘pluck, pull’; cf. Whitney 1885: 125; MacDonell 1916: 407; Pokorny IEW: 738; EWAi II: 324–326; LIV^2: 280–281);

ǵ^h + d^h = OIA 0ḍ^h:

ao. *voḷhám*, *voḍhvám* (√*vah-* ‘carry’; cf. pr. *váhati*; < IE *√*u̯eǵ*^{h}-; cf. L. *uehō*, OCS *vezǫ* ‘ride’;cf. Whitney 1885: 157; MacDonell 1916: 417; Pokorny IEW: 1118–1120; EWAi II: 535–537; LIV^2: 661–662);

Ḱ + s = OIA kṣ:

ao. *ádikṣi, ádikṣat* B (√*diś-* ‘point’; cf. pr. *diśátu*; < IE *√*dei̯ḱ-*; cf. L. *dīcō* ‘say’; cf. Whitney 1885: 73; MacDonell 1916: 389; Pokorny IEW: 188–189; EWAi II: 744–746; LIV^2: 108–109);

pr. *dadṛkṣé*, ao. *ádrākṣīt* B, ds. *dídṛkṣate* (√*dṛś-* ‘see’; cf. pf. *dadárśa*; < IE *√*derḱ-*; cf. Gr. δέρκομαι ‘see’; cf. Whitney 1885: 391; MacDonell 1916: 78; Pokorny IEW: 213; EWAi I: x; LIV^2: 122);

pr. *vákṣi*, *vavákṣi* (√*vaś-* ‘desire’; cf. pr. *váśmi*; < IE *√*u̯eḱ-*; cf. Hitt. *wēkzi* ‘wish’; cf. Whitney 1885: 155; MacDonell 1916: 416; Pokorny IEW: 1135; EWAi II: 527–528; LIV^2: 672–673);

ao. *yákṣva, yákṣat*, ft. *yákṣyáte,* ds. *íyakṣati*[18](√*yaj-* ‘sacrifice’; cf. pr. *yájati*; < IE *√*Hi̯aǵ-*; cf. Gr. ἅζομαι ‘stand in awe’ (?); cf. Whitney 1885: 129; MacDonell 1916: 408; Pokorny IEW: 501; EWAi II: 392–394; LIV^2: 254–255);

pr. *mṛkṣvá*, ao. *ámārkṣīt* B, ft. *mrakṣyáte* B (√*mṛj-* ‘wipe’; cf. pr. *mṛjánti*; < IE *√*H$_2$merǵ-*; cf. Gr. ἀμέργω ‘pluck, pull’; cf. Whitney 1885: 125; MacDonell 1916: 407; Pokorny IEW: 738; EWAi II: 324–326; LIV^2: 280–281);

ao. *ásṛkṣí*, *ásṛkṣmahí*, ft. *srakṣyáti* B, ds. *sísṛkṣati* B (√*sṛj-* ‘emit’; cf. pr. *sṛjáti*; < IE *√*selǵ-*; cf. Gr. λαγαίω, ‘release’ (?); cf. Whitney 1885: 189–190; MacDonell 1916: 428–429; Pokorny IEW: 900–901; EWAi II: 709; LIV^2: 528–529);

ǵ^h + s = OIA kṣ:

ao. *ághukṣat*, ds. *júgukṣati* (√*guh-* ‘hide’; cf. ao. *guháḥ*; < IE *√*g*^{uh}*eu̯ǵ*^{h}-; cf. Whitney 1885: 38; MacDonell 1916: 379–380; Pokorny IEW: 450; EWAi I: 502–503; LIV^2: 199);

ao. *rukṣā́s*, *árukṣat*, ft. *rokṣyáti* B, ds. *rúrukṣati* (√*ruh-* ‘ascend’; cf. pr. *róhati*; < IE *√*H$_1$leu̯d*^{h}-; cf. Gr. Hom. ἤλῠθον ‘come, start’; cf. Whitney 1885: 143–144; MacDonell 1916: 414; Pokorny IEW: 306–307, 684–685; EWAi II: 467–469; LIV^2: 248–249; NIL: 245–246);

[18] An atypical reduplication, the expecting outcome would be **yíyakṣati* (cf. caus. ao. *áyīyajat* B. from the same root).

ao. *ávākṣur*, ft. *vakṣyáti* (√*vah*- 'carry'; cf. pr. *váhati*; < IE *√*u̯eǵ^h*-; cf. L. *uehō*, OCS *vezǫ* 'ride'; cf. Whitney 1885: 157; MacDonell 1916: 417; Pokorny IEW: 1118–1120; EWAi II: 535–537; LIV^2: 661–662);
ao. *ásākṣi, sákṣat*, ft. *sakṣyáte* B (√*sah*- 'prevail'; cf. pr. *sáhate*; < IE *√*seǵ^h*-; cf. Gr. ἔχω 'have, hold'; cf. Whitney 1885: 184–185; MacDonell 1916: 427; Pokorny IEW: 888–889; EWAi II: 717–718; LIV^2: 515–516; NIL: 600–604);

An interesting feature in the development is the secondary cerebralization of clusters, which is triggered by the *ruki*-rule (Pedersen's Law), affecting clusters with a right dental plosive, clearly distinguishing them from clusters of velars/palatals + plosive (see above). What is remarkable is that h_1 + *t* ('Bartholomae's clusters') and h_1 + d^h clusters both tend to the outcome *0ḍ^h*, where 0 stands for the lost element (probably an approximant), causing either diphthongization of the preceding *a* to *o* or *e*, dependent on the vowel of the next syllable (cf. *voḍhvám* from √*vah*- 'carry', *tṛṇédhi* from √*tṛh*- 'crush' for diphthongic outcome; *ūḍhá*- from √*vah*- 'carry', *sāḍhá*- from √*sah*- 'prevail' for a simple lengthening of a preceding vowel). In contrast, clusters resulting from *ś/j₁*+d^h have as the outcome a geminate *ḍḍ^h* (cf. pf. *didiḍḍhí* from √*diś*- 'point' or pr. *mṛḍḍhvám* from √*mṛj*- 'wipe'). As in other cases, the h_1s cluster is not subjected to Bartholomae's Law, in contrast with h_1t.

2.2.4 Clusters of *dental* + *t/d^h/s*

The dentals form clusters of the following patterns:

T + t = OIA tt:
ppp. *kṛttá*- (√*kṛt*- 'cut'; cf. pr. *kṛntáti*; < IE *√(*s*)*kert*-; cf. Lith. *kertù* 'cut off'; cf. Whitney 1885: 22–23; MacDonell 1916: 376; Pokorny IEW: 941–942; EWAi I: 315–316; LIV^2: 559–560);
ppp. *vṛttá*- (√*vṛt*- 'turn'; cf. pr. *vártate*; < IE *√*u̯ert*-; cf. L *uertor*, Goth. *waírþan* 'turn'; cf. Whitney 1885: 164; MacDonell 1916: 420–421; Pokorny IEW: 1156–158; EWAi II: 518–519; LIV^2: 691–692);
pr. *unátti*, ppp. *uttá*- B (√*ud*- 'wet'; cf. pr. *undánti*; < IE *√*u̯ed*-; cf. Whitney 1885: 13; MacDonell 1916: 373; Pokorny IEW: 346; EWAi II: 215–216, 279; LIV^2: 658–659; NIL: 706–715);
pr. *átti* inf. *áttum* (√*ad*- 'eat'; cf. pr. *ádmi*; < IE *√*H₁ed*-; cf. Hitt. *ēdmi*, L. *edō* 'eat'; cf. Whitney 1885: 3; MacDonell 1916: 370; Pokorny IEW: 287–289; EWAi I: 61–62; LIV^2: 230–231; NIL: 208–220);
pr. *bhinátti*, gd. *bhittvā́* (√*bhid*- 'split'; cf. pr. *bhinádmi*; < IE *√*b^heid*-; cf. L. *findō* 'split', Goth. *beitan* 'bit'; cf. Whitney 1885: 111; MacDonell 1916: 402; Pokorny IEW: 116–117; EWAi II: 273–274; LIV^2: 70–71; NIL: 11–12);
ppp. *vittá*-, gd. *vittvā́* (√*vid*- 'find'; cf. pr. *vindáti*; < IE *√*u̯eid*-; cf. L. *uīdī* 'see', Arm. *egit* 'find'; cf. Whitney 1885: 159–160; MacDonell 1916: 418; Pokorny IEW: 1125–1127; EWAi II: 579–581; LIV^2: 665–667; NIL: 717–722);

d^h + t = OIA dd^h:

pr. *inddhé*, ppp. *iddhá-* (√*idh-* ‘kindle’; cf. pr. *indháte*; < IE *√*H$_2$eịd^h*-; cf. Gr. αἴθω ‘kindle’; cf. Whitney 1885: 8; MacDonell 1916: 371–372; Pokorny IEW: 11-12; EWAi II: 267; LIV^2: 259);

ppp. *baddhá-*, gd. *baddhvā́* (√*bandh-* ‘bind’; cf. pr. *badhnáte*; < IE *√*b^{h}end^h*-; cf. Goth. *band* ‘bind’; cf. Whitney 1885: 105; MacDonell 1916: 400; Pokorny IEW: 127; EWAi II: 208; LIV^2: 75);

ppp. *buddhá-* (√*budh-* ‘wake’; cf. pr. *bódhati*; < IE *√*b^{h}eụd^h*-; cf. Gr. πεύθομαι ‘give notice’, OCS *bljudǫ* ‘beware’; cf. Whitney 1885: 106–107; MacDonell 1916: 400–401; Pokorny IEW: 150–152; EWAi II: 233–235; LIV^2: 82–83; NIL: 36–37);

ppp. *yuddhá-*, gd. *yuddhvī́* (√*yudh-* ‘fight’; cf. pr. *yúdhyate*; < IE *√*Hịeụd^h*-; cf. OL. *ioubē* ‘command’; cf. Whitney 1885: 133; MacDonell 1916: 410; Pokorny IEW: 511–512; EWAi II: 418–419; LIV^2: 225–226);

T + d^h = OIA dd^h/0d^h:

pr. *addhí* (√*ad-* ‘eat’; cf. pr. *ádmi*; < IE *√*H$_1$ed-*; cf. Hitt. *ēdmi*, L. *edō* ‘eat’; cf. Whitney 1885: 3; MacDonell 1916: 370; Pokorny IEW: 287–289; EWAi I: 61–62; LIV^2: 230–231; NIL: 208–220);

pr. *viddhí* (√*vid-* ‘find’; cf. pr. *vindáti*; < IE *√*ụeịd-*; cf. L. *uīdī* ‘see’, Arm. *egit* ‘find’; cf. Whitney 1885: 159–160; MacDonell 1916: 418; Pokorny IEW: 1125–1127; EWAi II: 579–581; LIV^2: 665–667; NIL: 717–722);

pr. *dehí*,[19] *daddhí* (√*dā-* ‘give’; cf. pr. *dádāti*; < IE *√*deH$_3$*-; cf. Gr. δίδωμι, L. *dō*, OLith. *duosti* ‘give’; cf. Whitney 1885: 71–72; MacDonell 1916: 388–389; Pokorny IEW: 223–225; EWAi I: 713–715; LIV^2: 105–106; NIL: 60–69);

pr. *undhí* (-ddh-) (√*ud-* ‘wet’; cf. pr. *undánti*; < IE *√*ụed-*; cf. Whitney 1885: 13; MacDonell 1916: 373; Pokorny IEW: 346; EWAi II: 215–216, 279; LIV^2: 658–659; NIL: 706–715);

pr. *bhindhí* (-ddh-) (√*bhid-* ‘split’; cf. pr. *bhinádmi*; < IE *√*b^{h}eịd-*; cf. L. *findō* ‘split’, Goth. *beitan* ‘bit’; cf. Whitney 1885: 111; MacDonell 1916: 402; Pokorny IEW: 116–117; EWAi II: 273–274; LIV^2: 70–71; NIL: 11–12);

d^h + d^h = OIA 0d^h:

pr. *bodhí* (-ddh-) (√*budh-* ‘wake’; cf. pr. *bódhati*; < IE *√*b^{h}eụd^h*-; cf. Gr. πεύθομαι ‘give notice’, OCS *bljudǫ* ‘beware’; cf. Whitney 1885: 106–107; MacDonell 1916: 400–401; Pokorny IEW: 150–152; EWAi II: 233–235; LIV^2: 82–83; NIL: 36–37);

ao. *yodhí* (-ddh-) (√*yudh-* ‘fight’; cf. pr. *yúdhyate*; < IE *√*Hịeụd^h*-; cf. OL. *ioubē* ‘command’; cf. Whitney 1885: 133; MacDonell 1916: 410; Pokorny IEW: 511–512; EWAi II: 418–419; LIV^2: 225–226);

pr. *dhehí*[20] (√*dhā-* ‘put’; cf. pr. *dádhāmi*; < IE *√*d^{h}eH$_1$*-; cf. Gr. τίθημι ‘put’, Lith. *desti*; cf. Whitney 1885: 82; MacDonell 1916: 392–393; Pokorny IEW: 235–239; EWAi I: 783–786; LIV^2: 136–138; NIL: 99–117);

pr. *indhvám* (-ddh-) (√*idh-* ‘kindle’; cf. pr. *indháte*; < IE *√*H$_2$eịd^h*-; cf. Gr. αἴθω ‘kindle’; cf. Whitney 1885: 8; MacDonell 1916: 371–372; Pokorny IEW: 11-12; EWAi II: 267; LIV^2: 259);

[19] From *-d+d^h*, output is simplified instead of the expected *dadd^{h}i* or *ded^{h}i* (= *-0d^h-*).

[2020] From *-d^h+d^h*, output is simplified instead of the expected *d^{h}ed^{h}i* (= *-0d^h-*).

T + s = OIA ts:

ft. *kartsyā́mi* (√*kṛt*- 'cut'; cf. pr. *kṛntáti*; < IE *√(*s*)*kert*-; cf. Lith. *kertù* 'cut off'; cf. Whitney 1885: 22–23; MacDonell 1916: 376; Pokorny IEW: 941–942; EWAi I: 315–316; LIV^2: 559–560);

ao. *ávṛtsaṭa*, ft. *vartsyáti* (√*vṛt*- 'turn'; cf. pr. *vártate*; < IE *√*u̯ert*-; cf. L *uertor*, Goth. *waírþan* 'turn'; cf. Whitney 1885: 164; MacDonell 1916: 420–421; Pokorny IEW: 1156–158; EWAi II: 518–519; LIV^2: 691–692);

pr. *átsi* (√*ad*- 'eat'; cf. pr. *ádmi*; < IE *√*H₁ed*-; cf. Hitt. *ēdmi*, L. *edō* 'eat'; cf. Whitney 1885: 3; MacDonell 1916: 370; Pokorny IEW: 287–289; EWAi I: 61–62; LIV^2: 230–231; NIL: 208–220);

pr. *bhinátsi*, ft. *bhetsyáte* B, ds. *bíbhitsati* (√*bhid*- 'split'; cf. pr. *bhinádmi*; < IE *√*b^{h}ei̯d*-; cf. L. *findō* 'split', Goth. *beitan* 'bit'; cf. Whitney 1885: 111; MacDonell 1916: 402; Pokorny IEW: 116–117; EWAi II: 273–274; LIV^2: 70–71; NIL: 11–12);

pr. *vitsé*, ao. *ávitsi*, ds. *vívitsati* B (√*vid*- 'find'; cf. pr. *vindáti*; < IE *√*u̯ei̯d*-; cf. L. *uīdī* 'see', Arm. *egit* 'find'; cf. Whitney 1885: 159–160; MacDonell 1916: 418; Pokorny IEW: 1125–1127; EWAi II: 579–581; LIV^2: 665–667; NIL: 717–722);

ds. part. *dítsant*- (√*dā*- 'give'; cf. pr. *dádāti*; < IE *√*deH₃*-; cf. Gr. δίδωμι, L. *dō*, OLith. *duosti* 'give'; cf. Whitney 1885: 71–72; MacDonell 1916: 388–389; Pokorny IEW: 223–225; EWAi I: 713–715; LIV^2: 105–106; NIL: 60–69);

d^h + s = OIA ts:

ft. *bhantsyáti* (√*bandh*- 'bind'; cf. pr. *badhnáte*; < IE *√*b^{h}end^h*-; cf. Goth. *band* 'bind'; cf. Whitney 1885: 105; MacDonell 1916: 400; Pokorny IEW: 127; EWAi II: 208; LIV^2: 75);

ao. *ábhutsi*, ft. *bhotsáti* B (√*budh*- 'wake'; cf. pr. *bódhati*; < IE *√*b^{h}eu̯d^h*-; cf. Gr. πεύθομαι 'give notice', OCS *bljudǫ* 'beware'; cf. Whitney 1885: 106–107; MacDonell 1916: 400–401; Pokorny IEW: 150–152; EWAi II: 233–235; LIV^2: 82–83; NIL: 36–37);

pr. *yótsi*, ds. *yúyutsati* (√*yudh*- 'fight'; cf. pr. *yúdhyate*; < IE *√*Hi̯eu̯d^h*-; cf. OL. *ioubē* 'command'; cf. Whitney 1885: 133; MacDonell 1916: 410; Pokorny IEW: 511–512; EWAi II: 418–419; LIV^2: 225–226);

ds. *dhítsati* (√*dhā*- 'put'; cf. pr. *dádhāmi*; < IE *√*d^{h}eH₁*-; cf. Gr. τίθημι 'put', Lith. *desti*; cf. Whitney 1885: 82; MacDonell 1916: 392–393; Pokorny IEW: 235–239; EWAi I: 783–786; LIV^2: 136–138; NIL: 99–117);

Especially worthy of note are *t/d* + *d^h* clusters, since they result either in *dd^h* (as do 'Bartholomae's *d^{h}t* clusters'), but sometimes in *0d^h*; cf. the root √*dā*- 'give' which has both forms: *daddhí*, *dehí*. The cluster of *d^h* + *d^h* results in *0d^h* regularly. As in other cases, the *d^{h}s* cluster is not subjected to Bartholomae's Law, in contrast with *d^{h}t*.

Note: Few examples demonstrate the development of clusters with a cerebral plosive in the left. From the root √*īḍ*- 'praise' there is ppp. *ī́ṭṭe*. from √*taḍ*- 'beat' there is pr. *tāḍhi* (from roots √*pīḍ*- 'press', √*vīḍ*- 'make strong', √*hīḍ*- 'be hostile' etc., have no attested forms with direct contact of a left cerebral plosive + *t/d^h/s*, since this clusters are prevented often by the anaptyctic *i*; cf. ppp. *vīḷitá*-, *hīḍitá*-). The clusters ending in -*ṣ* are dealt with below.

2.2.5 Clusters of *sibilant* + *t/d^h/s*

Both OIA sibilants are inherited from Indo-Iranian, *ṣ* arose from Indo-Iranian **š* (and from IE **s* due to Pedersen's law/*ruki*-rule).

s + t = OIA st:

pr. *ásti*, *stás*, *ástu* (√*as*- ‘be’; cf. pr. *ásat*; < IE *√*H_1es*-; cf. Gr. ἐστί, L. *est* ‘be’; cf. Whitney 1885: 5; MacDonell 1916: 370–371; Pokorny IEW: 340–341; EWAi I: 144; LIV^2: 241–242; NIL: 235–238);

ao. *ághasta* (√*ghas*- ‘eat’; cf. pf. *jaghása*; < IE *√*g*$^{(u)h}$*es*-; cf. Whitney 1885: 42; MacDonell 1916: 381; Pokorny IEW: 452; EWAi I: 514; LIV^2: 198–199);

ppp. *ustá*-, inf. *vástave* (√*vas*- ‘shine’; cf. ao. *ávasran*; < IE *√*u̯es*-; cf. Lith. *aũšti* ‘break dawn’; cf. Whitney 1885: 155-156; MacDonell 1916: 417; Pokorny IEW: 86–87; EWAi II: 530–532; LIV^2: 292–293; NIL: 357–367);

pr. *śāste* (√*śās*- ‘order’; cf. pr. *śā́smi*; < IE *√*ḱeHs*-; cf. Alb. *thom* ‘say’; cf. Whitney 1885: 172; MacDonell 1916: 423; Pokorny IEW: 533; EWAi II: 632–633; LIV^2: 318–319);

ṣ + t = OIA ṣṭ:

pr. *dvéṣṭi*, ppp. *dviṣṭá*- (√*dviṣ*- ‘hate’; cf. pr. *dvéṣat*; < IE *√*du̯ei̯s*-; cf. OAv. *d*^{ai}*bišəṇtī*; cf. Whitney 1885: 81; MacDonell 1916: 392; Pokorny IEW: 228; EWAi I: 770–771; LIV^2: 131);

pr. *pináṣṭi*, ppp. *piṣṭá*- (√*piṣ*- ‘crush’; cf. pf. *pipéṣa*; < IE *√*pei̯s*-; cf. Lith. *pisù* ‘copulate’, OCS *pьхотъ* ‘push’; cf. Whitney 1885: 97–98; MacDonell 1916: 398; Pokorny IEW: 796; EWAi II: 169; LIV^2: 466–467);

pr. *víveṣṭi*, *viviṣṭás*, ppp. *viṣṭá*- (√*viṣ*- ‘be active’; cf. pr. *víveṣaḥ*; < IE *√*u̯ei̯s*- 3; cf. Whitney 1885: 161; MacDonell 1916: 419; EWAi II: 585–586; LIV^2: 672);

s + d^h= OIA 0d^h:[21]

pr. *edhí* (√*as*- ‘be’; cf. pr. *ásat*; < IE *√*H_1es*-; cf. Gr. ἐστί, L. *est* ‘be’; cf. Whitney 1885: 5; MacDonell 1916: 370–371; Pokorny IEW: 340–341; EWAi I: 144; LIV^2: 241–242; NIL: 235–238);

pr. *ā́dhvam* (√*ās*- ‘sit’; cf. pr. *ā́sāthe*; < IE *√*x*-; cf. Hith. *ēsa*, Gr. ἧσται ‘sit’; cf. Whitney 1885: 6-7; MacDonell 1916: 371; Pokorny IEW: 342–343; EWAi II: x; LIV^2: 232);

pr. *śādhí*, pf. *śaśādhí* (√*śās*- ‘order’; cf. pr. *śā́smi*; < IE *√*ḱeHs*-; cf. Alb. *thom* ‘say’; cf. Whitney 1885: 172; MacDonell 1916: 423; Pokorny IEW: 533; EWAi II: 632–633; LIV^2: 318–319);

ṣ + d^h= OIA ḍḍ^h:

pf. *viviḍḍhí* (√*viṣ*- ‘be active’; cf. pr. *víveṣaḥ*; < IE *√*u̯ei̯s*- 3; cf. Whitney 1885: 161; MacDonell 1916: 419; EWAi II: 585–586; LIV^2: 672);

s + s = OIA ts/ss/0s:

ds. *jíghatsati* AV (√*ghas*- ‘eat’; cf. pf. *jaghása*; < IE *√*g*$^{(u)h}$*es*-; cf. X *x* ‘x’; cf. Whitney 1885: 42; MacDonell 1916: 381; Pokorny IEW: 452; EWAi I: 514; LIV^2: 198–199);

co. *ávatsyat* B (√*vas*- ‘shine’; cf. ao. *ávasran*; < IE *√*u̯es*-; cf. Lith. *aũšti* ‘break dawn’; cf. Whitney 1885: 155-156; MacDonell 1916: 417; Pokorny IEW: 86–87; EWAi II: 530–532; LIV^2: 292–293; NIL: 357–367);

but

pr. *śāssi* (√*śās*- ‘order’; cf. pr. *śā́smi*; < IE *√*ḱeHs*-; cf. Alb. *thom* ‘say’; cf. Whitney 1885: 172; MacDonell 1916: 423; Pokorny IEW: 533; EWAi II: 632–633; LIV^2: 318–319);

[21] Cf. later √*vas*- 2. ‘wear’: pr. *vaddhvam* S. for the form with two plosives. This form is clearly construed as analogical to *šd*^{h} > *ḍḍ*^{h}.

but

pr. *ási*[22] (√*as*- 'be'; cf. pr. *ásat*; < IE *√*H₁es*-; cf. Gr. ἐστί, L. *est* 'be'; cf. Whitney 1885: 5; MacDonell 1916: 370–371; Pokorny IEW: 340–341; EWAi I: 144; LIV^2: 241–242; NIL: 235–238);

ṣ + s = OIA kṣ:

ao. *dvikṣát*, *dvikṣata* AV (√*dviṣ*- 'hate'; cf. pr. *dvéṣat*; < IE *√*du̯ei̯s*-; cf. OAv. *d^{ai}bišəṇtī*; cf. Whitney 1885: 81; MacDonell 1916: 392; Pokorny IEW: 228; EWAi I: 770–771; LIV^2: 131);

ao. *apikṣan* ŚB (√*piṣ*- 'crush'; cf. pf. *pipéṣa*; < IE *√*pei̯s*-; cf. Lith. *pisù* 'copulate', OCS *pьxotъ* 'push'; cf. Whitney 1885: 97–98; MacDonell 1916: 398; Pokorny IEW: 796; EWAi II: 169; LIV^2: 466–467);

pr. *vívekṣi*, ft. *vekṣyáti* (√*viṣ*- 'be active'; cf. pr. *víveṣaḥ*; < IE *√*u̯ei̯s*- 3; cf. Whitney 1885: 161; MacDonell 1916: 419; EWAi II: 585–586; LIV^2: 672);

Clusters with *t*- and *d^h*- are cerebralized after *ṣ*. Clusters from *ṣd^h* are realized in two variants, either as *ḍḍ^h* or as *0ḍ^h* (cf. development of clusters of palatovelars + *d^h* and dentals + *d^h* above). Clusters of two sibilants are usually dissimilated as a plosive + sibilant.

2.2.6 Overview of attested Vedic alternations

For a summary of the attested alternations of Vedic clusters formed either by any plosive + *t/d^h/s* or a sibilant + *t/d^h/s* see the following table. Not attested forms are omitted, and the assumed analogous forms are in brackets:

IE	**OIA**	t-	d^h-	s-
-k$^{(u̯)}$/g$^{(u̯)}$	-k/c/g/j_2	*kt*	*gd^h*	*kṣ*
-g$^{(u̯)h}$	-g^h/h_2	*gd^h*		(*kṣ*)
-ḱ/ǵ	-ś/j_1	*ṣṭ*	*ḍḍ^h*	*kṣ*
-ǵ^h	-h_1	*0ḍ^h*	*0ḍ^h*	(*kṣ*)
-t/d	-t/d	*tt*	*dd^h* *0d^h*	*ts*
-d^h	-d^h	*dd^h*	*0d^h*	(*ts*)
-p/b	-p/b	*pt*		*ps*
-b^h	-b^h	*bd^h*		(*ps*)
-s	-s	*st*	*0d^h*	*ts*
-š	-ṣ	*ṣṭ*	*ḍḍ^h*	*kṣ*

Note: Since Indo-Iranian does not distinguish between original IE plain velars and labiovelars, we omit this distinction for its irrelevance for the analysed data.

Note: For simplicity, the contrast between *s* and *š* is ahistorically translated to Indo-European, though the applicance of Pedersen´s Law (*ruki*-law) was limited just to the part of the IE dialect continuum, similar 'ahistorical' introduction of *š* will also be used below for other languages.

[22] It seems that in this case the simplification of IE **ss* to **s* is already Indo-European, hence older than here listed examples of the later development, since we meet not only Av. *ahi*, but also Gr. εἶ, OLith. *esi*, OCS *jesi*, see more below.

2.3 The development of two-obstruent clusters in Avestan

Iranian development differs in some of its aspects from that of Indic, though on the other hand, there are striking similarities.

The Old-Iranian phase is represented by two languages, Avestan and Old Persian. Our primary source language is Avestan, which is better attested and hence, offers more data. Old Persian will serve as complementary material to Avestan (an overview will be given below independently).

From the typical features of Avestan development, we have to emphasize:

i. the original voiced non-aspirates and voiced aspirated are neutralized to voiced non-aspirated in all positions, the originally voiced aspirates could be internally reconstructed only using Bartholomae's Law (see iv);
ii. the left plosives are generally spirantized in the cluster, dentals are sibilantized (and see v);
iii. though Bartholomae's Law is operating in Iranian, it is often eroded due to analogy;
iv. in contrast with Indo-Aryan, clusters of original voiced aspirate + *s* are generally subjected to Bartholomae's law (again, this process is often eroded by analogy);
v. the clusters of original palatovelar plosive + *t/d*^{h} are sibilantized in Iranian to *št/žd*$^{(h)}$, the analogical clusters of **Ḱ+s* and **ǵ*^{h}*+s* are realized as *0š* and *0ž;*
vi. the clusters of two sibilants are simplified as a single sibilant.

2.3.1 Clusters of *labial + t/d*^{h}*/s*

A remarkable feature of the Avestan development is that the IE cluster **Pt* is realized, contrary to the expected results, as Av. *pt* (see below about this peculiarity), similarly the **b*^{h}*t* and **Pd*^{h} clusters, both realized as *bd* without spirantization. the IE cluster **Ps* is regularly realized as *fs/fš* (irregularly subjected to Pedersen's Law!):

P + t = Av. pt:

ppp. YAv. *hąm.tapta-* (√*tap-* 'heat'; cf. caus. YAv. *tāpaiieiti*; < IE *√*tep-*; cf. L. *tepeō* 'be warm', OCS *teplostъ* 'heat'; cf. Pokorny IEW: 1069; Kellens 1995: 24; LIV^2: 629–630; NIL: 698–700; Cheung 2007: 378–380);

pr. OAv. *haptī* (√*hap-* 'keep'; < IE *√*sep-*; cf. Gr. ἕπω 'to be about', L. *sepeliō* 'bury'; cf. Pokorny IEW: 909; Kellens 1995: 71; LIV^2: 534; Cheung 2007: 129);

num. *hapta-* 'seven' (< IE *√*septm̥-*; cf. Gr. ἑπτά, L. *septem* 'seven'; cf. Pokorny IEW: 909; Emmerick 1992b: 299; Blažek 1999: 246);

ppp. YAv. *vipta-* (*vaēp-* 'engage in homosexual activities'; cf. pr. YAv. *vaēpənti*; < IE *√*u̯ei̯p-*; cf. OIA *vépate* 'tremble, shake', L. *uibrāre* 'vibrate'; cf. Pokorny IEW: 1131–1132; Kellens 1995: 55; LIV^2: 671; Cheung 2007: 415);

b^h + t = OAv. bd/YAv. βδ (pt):

nom. YAv. *dərəβδa* 'bundle of muscles' (< Ir. *√*darb-* 'join'; < IE *√*d*^{h}*erb*^{h}*-*; cf. Lith. *dirbù* 'work'; cf. Pokorny IEW: 211-212, 257; LIV^2: 121; Cheung 2007: 60);

but without the Bartholomae's Law:

ppp. YAv. *dapta-* 'cheated' (√*dab-* 'deceive'; cf. pr. OAv. *dəbənaotā* < IE *√*dʰebʰ-*; cf. Lith. *dóbiu* 'subdue'; cf. Pokorny IEW: 240; Kellens 1995: 27; LIV²: 132–133; NIL: 85–86; Cheung 2007: 42–43);

P + dʰ = Av. bd:

pr. YAv. *auuaŋhabdaēta*, caus. YAv. *nixᵛabdaiieiti* (√*xᵛap-* 'sleep', pf. YAv. *hušxᵛafa* < IE *√*su̯ep-*; cf. L. *sopiō*, OCS *sъpljǫ* 'sleep'; cf. Pokorny IEW: 1048–1149; Kellens 1995: 17–18; LIV²: 612–613; NIL: 675–680; Cheung 2007: 145–146);

bʰ + dʰ = Av. *bd:

not attested

P + s = Av. fš/fs:

pr. *hafšī* OAv. (√*hap-* 'keep'; < IE *√*sep-*; cf. Gr. ἕπω 'to be about', L. *sepeliō* 'bury'; cf. Pokorny IEW: 909; Kellens 1995: 71; LIV²: 534; Cheung 2007: 129);

inch. YAv. *xᵛafsa, xᵛafsata* (√*xᵛap-* 'sleep', pf. YAv. *hušxᵛafa* < IE *√*su̯ep-*; cf. L. *sopiō,* OCS *sъpljǫ* 'sleep'; cf. Pokorny IEW: 1048–1149; Kellens 1995: 17–18; LIV²: 612–613; NIL: 675–680; Cheung 2007: 145–146);

pr. inch. YAv. *tafsat̰* (√*tap-* 'heat'; cf. caus. YAv. *tāpaiieiti*; < IE *√*tep-*; cf. L. *tepeō* 'be warm', OCS *teplostъ* 'heat'; cf. Pokorny IEW: 1069; Kellens 1995: 24; LIV²: 629–630; NIL: 698–700; Cheung 2007: 378–380);

bʰ + s = Av. βž:

ds. OAv *diβžaidiiāi* (√*dab-* 'deceive'; cf. pr. OAv. *dəbənaotā*; < IE *√*dʰebʰ-*; cf. Lith. *dóbiu* 'subdue'; cf. Pokorny IEW: 240; Kellens 1995: 27; LIV²: 132–133; NIL: 85–86; Cheung 2007: 42–43);

YAv. *vaβžaka-* 'scorpion' (< IE **u̯obʰsā*; cf. L. *uespa*, OHG *wafsa*; cf. Pokorny IEW: 1179;);

but without the Bartholomae's law:

ao. subj. YAv. *haṇgərfšānē* (√*grab-* 'seize', ao. inj. *grabəm*; < IE *√*gʰrebH₂-/gʰrebʰ-* (?); cf. Lith. *grė́biu*, OCS *grablǫ* 'rob'; cf. Pokorny IEW: 455; Kellens 1995: 20–21; LIV²: 201; Cheung 2007: 119–121);

pr. inch. YAV. *xšufsąn* (√*xšub-* 'rustle, tremble'; < IE *√*k⁽ᵘ⁾seu̯bʰ-*; cf. OIA *cukṣubhe* 'quake'; cf. Pokorny IEW: 625; Kellens 1995: 17; LIV²: 372; Cheung 2007: 454–455);

A remarkable feature is the preservation of the *pt* in Avestan clusters as two-plosive clusters, which is in strong contrast to the development of analogous clusters (see below). The Avestan development of the cluster *Pt* is irregular, not only in comparison to the development of the analogous clusters but also in other Iranian languages, since Av. *hapta* 'seven' has the Pahlavi and New Persian counterpart *haft* (< OIr. **hafta*). The question is whether the Avestan *pt* is an archaism, or whether it represents an innovation (despirantization/occlusivization), since, in Avestan, we encounter the following forms of *pitar-* 'father': nom. sg. OAv. *ptā*, *tā*, YAv. *ptā, pita*, dat. sg. OAv. *fᵊδrōi*, *piϑrē*, YAv. *piϑre*. The form *tā* is easy to explain as the result of development from **ftā* (i.e., *pt* > *ft* > *ht* > *0t*) but Hoffmann and Forssman (1996: 94) assume the direct simplification of the word-initial *pt-* > *t-*). Beekes (1988: 73) and Hoffmann and

Forssman (1996: 94) reckon with the preservation of inherited *pt*, contrary to Reichelt (1909: 40), whereas for eastern dialects of Iranian Kümmel (2007: 65) assumes partial restitution of the spirants **f*, **θ*, **χ* by the aspirates p^h, t^h, k^h, which partially, however, can be considered as original according to Morgenstierne (cf. Lipp 2009a: 158–160 with further ref.). The outcome of the cluster *b^hd^h is not directly attested; it is modelled according to the assumed analogy with 'Bartholomae's cluster' *b^ht.

Note: The confusing outcomes of *labial* + *s* as *pš* or *ps* could be due to morphology, since inchoatives and *sa*-presents (both parallel to OIA *-ccha-* and from IE **sḱo-*) regularly have *ps* but aorists and desideratives *fš*. The extension to the 'ruki'-rule in Avestan is hence limited to original single sibilants, not clusters.

2.3.2 Clusters of *velar/palatal* + *t/d^h/s*

The Indo-European plain and labiovelars are merged, secondarily often palatalized, but this palatalization is neutralized before obstruents. The plosives are spirantized before **t-/d^h-/s-*, the clusters ending in *$g^{(u̯)h}$ are subjected to Bartholomae's Law (often neglected by the analogy with voiceless clusters):

$K^{(u̯)}$ + t: = Av. xt:

ppp. YAv. *yuxta-* (√*yuj-* 'yoke'; cf. ao. OAv. *yaojā*; < IE *√*i̯eu̯g-*; cf. L. *iungō* 'harness', OCS *igo* 'yoke'; cf. Pokorny IEW: 508–509; Kellens 1995: 47; LIV²: 316; NIL: 397–404; Cheung 2007: 217–218);

YAv. pr. *irinaxti* (√*raēc-* 'leave'; cf. caus. YAv. *raēcaiieiṇti*; < IE *√*lei̯ku̯-*; cf. Gr. λείπω, L. *linquō* 'leave'; cf. Pokorny IEW: 669–670; Kellens 1995: 58; LIV²: 406–408; NIL: 451–452; Cheung 2007: 307–308);

$g^{(u̯)h}$ + t: = OAv. gd/YAv. γδ:

ppp. YAv. *bərəγδa-* (√*barj-* 'honour'; cf. ps. *bərəjaēm*; < IE *√*b^herg^h-*; cf. Goth. *bairgan* 'protect, shelter', OCS *ne-brěšti* 'neglect'; cf. Pokorny IEW: 145; Kellens 1995: 38; LIV²: 79–80; Cheung 2007: 10–12);

pr. OAv. *aog^ədā* but. pr. YAV *aoxte* (√*aoj-* 'say'; cf. pr. OAV. *aojōi*; < IE *√*H₁eu̯g^{(u̯)h}-* (?); cf. Gr. εὔχομαι 'pray', L. *uoueō* 'vow'; cf. Pokorny IEW: 348; Kellens 1995: 9,14; LIV²: x; Cheung 2007: 169–170);

but without Bartholomae's law:

ppp. YAv. *handraxta-*, int. YAv. *dąδrąxti* (√*draṇj-* 'fix'; cf. caus. *drəṇjaiieiti*; < IE *√*dreg^h-*; cf. Gr. δράσσομαι 'grasp', OCS *drъžǫ* 'hold'; cf. Pokorny IEW: 254; Kellens 1995: 32; LIV²: 126; Cheung 2007: 76);

YAv. ppp. *anādruxta-* (√*druj-* 'lie, deceive'; cf. pr. YAv. *družaite*; < IE *√*d^hreu̯g^h-*; cf. OHG *triugan* 'deceit'; cf. Pokorny IEW: 276; Kellens 1995: 32; LIV²: 157; Cheung 2007: 80–81);

$K^{(u̯)}$ + d^h = Av. gd:

OAv. *mərəṇgəduiiē* (√*marc-* 'destroy'; cf. pr. *mərəṇcaite*; < IE *√*melku̯-*; cf. Gr. βλάπτω 'damage'; cf. Pokorny IEW: 737; Kellens 1995: 43; LIV²: 434–435; Cheung 2007: 265–266);

$g^{(u̯)h} + d^h$ = Av. *gd:

not attested;

$K^{(u̯)} + s$ = Av. xš:

ao. OAv. *uruuāxšat̰* (√*uruuaj-* 'go forth'; < IE *√*u̯reg-*; cf. L. *urgēre* 'urge', Goth. *wrikan* 'pursue'; cf. Pokorny IEW: 1181; Kellens 1995: 60; LIV²: 697; Cheung 2007: 438);

YAv. ao. *raēkšīša* (√*raēc-* 'leave'; cf. caus. YAv. *raēcaiieiṇti*; < IE *√*lei̯kᵘ-*; cf. Gr. λείπω, L. *linquō* 'leave'; cf. Pokorny IEW: 669–670; Kellens 1995: 58; LIV²: 406–408; NIL: 451–452; Cheung 2007: 307–308);

pr. YAv. *takše*, ds. YAv. ˣ*tíxšəṇti* (√*tac-* 'run', pr. YAv. *fratacaiti*; < IE *√*tekᵘ-*; cf. OCS *tekǫ*, Lith. *tekù* 'run, flow'; cf. Pokorny IEW: 1059–1060; Kellens 1995: 24; LIV²: 620–621; Cheung 2007: 372–374);

nom. *vāxš* 'voice' (~ *vācəm*), fut. OAv. *vaxšiiā* (√*vac-* 'speak'; cf. OAv. ao *vaocat̰*; < IE *√*u̯ekᵘ-*; cf. Gr. εἶπον 'say'; cf. Pokorny IEW: 1135–1136; Kellens 1995: 48–49; LIV²: 673–674; Cheung 2007: 402–404);

$g^{(u̯)h} + s$ = Av. γž (xš):

ds. OAv. *dīdraγžō.duiiē* (√*draṇj-* 'fix'; cf. caus. *drənjaiieiti*; < IE *√*dregʰ-*; cf. Gr. δράσσομαι 'grasp', OCS *drъžǫ* 'hold'; cf. Pokorny IEW: 254; Kellens 1995: 32; LIV²: 126; Cheung 2007: 76);

ds. OAv. *mimaγžō* (√*mag-* 'offer'; cf. OIA *maghá-* 'gift, reward'; < IE *√*meH₂gʰ-* (?); cf. Goth. *mag*, OCS *mogǫ* 'can', Lith. *magù* 'want, like'; cf. Pokorny IEW: 695; Kellens 1995: 43; LIV²: 422; Cheung 2007: 254);

pr. OAv. *paⁱrii-aoγžā* (√*aoj-* 'say'; cf. pr. OAV. *aojōi*; < IE *√*H₁eu̯g^(u̯)h-* (?); cf. Gr. εὔχομαι 'pray', L. *uoueō* 'vow'; cf. Pokorny IEW: 348; Kellens 1995: 9,14; LIV²: x; Cheung 2007: 169–170);

but without the Bartholomae´s Law:

nom. *miϑrō.druxš* 'oathbreaker' (√*druj-* 'lie, deceive'; cf. pr. YAv. *družaite*; < IE *√*dʰreu̯gʰ-*; cf. OHG *triugan* 'deceit'; cf. Pokorny IEW: 276; Kellens 1995: 32; LIV²: 157; Cheung 2007: 80–81);

Again, the outcome of *gʰdʰ/jʰdʰ* clusters is not directly attested, being modelled according to the assumed analogy with 'Bartholomae's cluster' *gʰt/jʰt*.

2.3.3 Clusters of *palatovelar + t/dʰ/s*

The old IE palatovelars are realized as a palatal sibilant before obstruents and lost before a sibilant (which is, according to Pedersen's Law/the *ruki*-rule, usually palatalized). The final original aspirate, if followed by a voiceless obstruent, is subjected to Bartholomae's Law, if it is not neglected by the analogy:

Ḱ + t = Av. št:

int. OAv. *daēdōišt* (√*daēs-* 'show', pr. YAv. *daēsaiiən*; < IE *√*dei̯ḱ-*; cf. cf. Gr. δείκνυμι, 'show'; L. *dīcō* 'say'; cf. Pokorny IEW: 188–189; Kellens 1995: 30; LIV²: 108–109; Cheung 2007: 51–52);

pr. OAv *vaštī* (√*vas-* 'desire', pr. OAv. *vasəmi*; < IE *√*u̯eḱ-*; cf. Hitt. *wēkzi* 'wish'; cf. Pokorny IEW: 1135; Kellens 1995: 52; LIV²: 672–673; Cheung 2007: 427);

ppp. YAv. *pairi.aŋharšta-* (√*harz-* 'release', pr. YAv. *auuaŋhərəzāmi*; < IE *√*selǵ-*; cf. Hith. *salk-* 'knead, mingle', OHG *selken* 'fall down'; cf. Pokorny IEW: 900–901; Kellens 1995: 72; LIV²: 528–529; Cheung 2007: 132–133);

pr. YAv. *ište* (√*is-* 'be able, rule', pr. OAv. *isāmaidē*; < IE *√*H₂ei̯ḱ-*; cf. OCS *iskati* 'seek'; cf. Pokorny IEW: 16; Kellens 1995: 13; LIV²: 260; Cheung 2007: 158);

ppp. YAv. *uzvaršta-* (√*varz-* 'work', OAv. *vərəziiāmahī*; < IE *√*u̯erǵ-*; cf. Gr. ἔργω 'work'; cf. Pokorny IEW: 1168–1169; Kellens 1995: 51–52; LIV²: 689–690; Cheung 2007: 425–427);

num. *ašta* 'eight' (< IE **oḱt* -; cf. OIA *aṣṭáu*, L. *octō* 'eight'; cf. Pokorny IEW: 775; Emmerick 1992b: 299–300; Blažek 1999: 263);

ǵʰ + t = Av. žd (št):

OAv. pr. *gərəždā* (√*garz-* 'complain, pr. OAV. *gərəzōi*; < IE *√*g⁽ᵘ̯⁾eRǵʰ-*; cf. OIA *gr̥hate* 'complain'; cf. Pokorny IEW: 350–351; Kellens 1995: 19–20; LIV²: 187; Cheung 2007: 111–112);

OAv. nom. *važdra-* but without Bartholomae's law: ppp. YAv. *vašta-*, nom. *vaštar-* 'drag animal' (?) (√*vaz-* 'drive', pr. YAv. *vazaiti*; < IE *√*u̯eǵʰ-*; < IE *√*u̯eǵʰ-*; cf. L. *uehō*, OCS *vezǫ* 'ride'; cf. Pokorny IEW: 1118–1119 ; Kellens 1995: 52; LIV²: 661–662; Cheung 2007: 429–432);

Ḱ + dʰ = Av žd:

OAv. inf. *āždiiāi* (√(*n*)*as/š-* 'reach'; cf. ao. OAv. *nąsat̰*; < IE *√*H₂neḱ-*; cf. Gr. διηνεκής 'continuous'; cf. Pokorny IEW: 316–317; Kellens 1995: 40–41; LIV²: 282–283; Cheung 2007: 183-184);

OAv. inf. *mərąždiiāi* (√*marz-* 'rub'; cf. pr. OAv. *marəzaiti*; < IE *√*H₂merǵ-*; cf. Gr. ἀμέργω 'pluck, pull'; cf. Pokorny IEW: 722–723; Kellens 1995: 44; LIV²: 280–281; Cheung 2007: 180–182);

ǵʰ + dʰ = Av. *žd:

not attested;

Ḱ + s = Av. 0š/0s:

ao. OAv. *dāiš, dōišā* (√*daēs-* 'show', pr. YAv. *daēsaiiən*; < IE *√*dei̯ḱ-*; cf. cf. Gr. δείκνυμι, 'show'; L. *dīcō* 'say'; cf. Pokorny IEW: 188–189; Kellens 1995: 30; LIV²: 108–109; Cheung 2007: 51–52);

pr. OAv. *vašī* (√*vas-* 'desire', pr. OAv. *vasəmi*; < IE *√*u̯eḱ-*; cf. Hitt. *wēkzi* 'wish'; cf. Pokorny IEW: 1135; Kellens 1995: 52; LIV²: 672–673; Cheung 2007: 427);

inch. OAv. *pərəsā*, YAv. *pərəse*, ao. OAv. *frašī* (√*fras-* 'ask', pr. *pərəsaniieiti*; < IE *√*preḱ-*; cf. L. *poscō* 'demand', Toch. A *prak-*, B *prek-*, OCS *prositi* 'ask'; cf. Pokorny IEW: 821–822; Kellens 1995: 35; LIV²: 490–491; Cheung 2007: 88–90);

ft. YAv. *harəšiiamna-* (√*harz-* 'release', pr. YAv. *auuaŋhərəzāmi*; < IE *√*selǵ-*; cf. Hith. *salk-* 'knead, mingle', OHG *selken* 'fall down'; cf. Pokorny IEW: 900–901; Kellens 1995: 72; LIV²: 528–529; Cheung 2007: 132–133);

pr. YAv. *išē* (√*is-* 'be able, rule', pr. OAv. *isāmaidē*; < IE *√*H₂ei̯ḱ-*; cf. OCS *iskati* 'seek'; cf. Pokorny IEW: 16; Kellens 1995: 13; LIV²: 260; Cheung 2007: 158);

OAv. ao. *varəšā* (√*varz-* 'work', OAv. *vərəziiāmahī*; < IE *√*u̯erǵ-*; cf. Gr. ἔργω 'work'; cf. Pokorny IEW: 1168–1169; Kellens 1995: 51–52; LIV²: 689–690; Cheung 2007: 425–427);

$\acute{g}^h$ + s = Av. 0ž (0š):

YAv. ao. *uzuuažat̰* (√*vaz-* 'drive', pr. YAv. *vazaiti*; < IE *√*u̯eǵʰ-*; < IE *√*u̯eǵʰ-*; cf. L. *uehō,* OCS *vezǫ* 'ride'; cf. Pokorny IEW: 1118–1119 ; Kellens 1995: 52; LIV[2]: 661–662; Cheung 2007: 429–432); but analogical without the Bartholomae´s Law ao. YAv. *vašata* (? – cf. Narten 1964: 368 fn1; Kellens 1995: 52; Cheung 430) ;

Note: It should be mentioned that Kellens (1976) found examples for a minor development **Ḱt* in Iranian *xšt*; Av. *paiti.fraxštar-* 'interrogator', *yaoxšti* 'branch', *spaxšti-* 'vision', Kellens considers this a proof that clusters from *Ḱ+t* and *š+t* did not merge fully even in Proto-Iranian, which contrasts with the known merging of both clusters not only in Indic but also in Baltic (and Slavic). Lubotsky (2018: 1884) follows such data as a proof of a dialectal development in Eastern Iranian (similar reflexes are found in Sogdian and Bactrian). Bartholomae (1895–1901: 36) considers the anlauting clusters of *xšt-* (not only those from **Ḱt-*, since even YAv. *xštāt̰* 'stands' has such a for) as a prothetic consonant, which is acceptable only in a word-initial, but hardly for the internal consonantal clusters (Kellens 1976: 68 rejects the idea of the prothesis as whole). To this question we will return below.

As previously, the outcome of the *ǵʰdʰ* cluster is not directly attested, being modelled according to the assumed analogy with 'Bartholomae's cluster' of **ǵʰt*.

2.3.4 Clusters of *dental + t/dʰ/s*

The old IE dentals are realized as a non-palatal sibilant before obstruents and lost before a sibilant. The final original aspirate, if followed by a voiceless obstruent, is subjected to the Bartholomae's Law, if it is not neglected by analogy:

T + t = Av. st:

ao. OAv. *cistā* (<√*cōit-* 'observe'; cf. pf. *cikaēθa*; < IE *√(*s*)*kʷei̯t-*; cf. OCS *čьtǫ* 'count, read'; cf. Pokorny IEW: 636–637; Kellens 1995: 22; LIV[2]: 382; Cheung 2007: 31);

pr. OAv. *vīnastī*, pr. YAv. *vinasti* (√*vid-* 'find'; cf. YAv. *vindənti*; < IE *√*u̯ei̯d-*; cf. L. *uīdī* 'see', Arm. *egit* 'find'; cf. Pokorny IEW: 1125–1127; Kellens 1995: 54–55; LIV[2]: 665–667; Cheung 2007: 409–410);

pf. OAv. *vōistā* (√*vid-* 'know'; cf. OAv. pf. *vaēdā*; < IE *√*u̯ei̯d-*; cf. L. *uīdī* 'see', Arm. *egit* 'find'; cf. Pokorny IEW: 1125–1127; Kellens 1995: 54; LIV[2]: 665–667; NIL: 717–722; Cheung 2007: 408–409);

ppp. YAv. *xᵛāsta* (√*hᵛad-* 'to become savoury', OAv. nom. *hudəma-* 'sweetness; < IE *√*su̯ed-*; cf. OIA *svádant* 'make tasty', OE *swēte* 'sweet'; cf. Pokorny IEW: 1039–1040; LIV[2]: 606–607; NIL: 670–672; Cheung 2007: 141);

ppp. YAv. *xšusta* (√*xšud-* 'to become liquid', YAv. nom. *xšudra-* 'liquid' ;< IE *√*kseu̯d-*; cf. OIA *kṣódante* 'dissolve'; cf. Pokorny IEW: 625; LIV[2]: 372; Cheung 2007: 455–456);

dʰ + t > Av. zd (st):

pr. OAv. *dazdā* but YAv *dasta* (√*dā-* 'put'; cf. impf. YAv. *ādadat̰*; < IE *√*dʰeH₁-*; cf. Gr. τίθημι 'put', Lith. *desti*; cf. Pokorny IEW: 235–236; Kellens 1995: 29; LIV[2]: 136–137; Cheung 2007: 45–46);

ppp. OAv. *vərəzda-* (√*vard-* 'grow', OAv. pr. *varədaitī*; < IE *√*Hu̯eRdʰ-*; cf. OIA *várdhate* 'grow'; cf. Pokorny IEW: 1167; Kellens 1995: 51; LIV[2]: 228; Cheung 2007: 208);

ppf. OAv. *urūraost* (√*raud-* ‘hinder’; cf. ps. YAv. °*raoδəṇti*; < IE *√*leu̯dʰ*-; cf. OIA *arodham* ‘restrain’; cf. Kellens 1995: 59–60; LIV²: 415; Cheung 2007: 317);

ppp. YAv. *niuruzda-* but without the Bartholomae’s law: YAv. *urusta-* (√*raud-* ‘grow bigger’; cf. pr. *raoδahe*; < IE *√*H₁leu̯dʰ*-; cf. Gr. Hom. ἤλῠθον ‘come, start’; cf. Pokorny IEW: 306–307, 684–685; Kellens 1995: 59; LIV²: 248–249; NIL: 245–246; Cheung 2007: 193–194);

but without the Bartholomae’s law:

ppp. YAv. *busta-* (√*baod-* ‘feel, sense’, part. ps. OAv. *baodaṇt-*; < IE *√*bʰeu̯dʰ*-; cf. Gr. πεύθομαι ‘give notice’, OCS *bljudǫ* ‘beware’; cf. Pokorny IEW: 150–151; Kellens 1995: 39; LIV²: 83–84; NIL : 36–37; Cheung 2007: 14–15);

T + dʰ = Av. zd:

pr. imp. YAv. *dazdi*, OAv. *mąz-dazdūm* (√*dā-* ‘give’; cf. OAv. pr. *dadē*; < IE *√*deH₃*-; cf. Gr. δίδωμι, L. *dō*, OLith. *duosti* ‘give’; cf. Pokorny IEW: 223–225; Kellens 1995: 29; LIV²: 105–106; NIL: 60–69; Cheung 2007: 43–45);

inf. OAv. *vōizdiiāi*, ao. OAv. *frauuōizdūm* (√*vid-* ‘know’; cf. OAv. pf. *vaēdā*; < IE *√*u̯ei̯d*-; cf. L. *uīdī* ‘see’, Arm. *egit* ‘find’; cf. Pokorny IEW: 1125–1127; Kellens 1995: 54; LIV²: 665–667; NIL: 717–722; Cheung 2007: 408–409);

dʰ + dʰ = Av. zd:

inf. YAv. *dazdiiāi* (√*dā-* ‘put’; cf. impf. YAv. *ādadat̰*; < IE *√*dʰeH₁*-; cf. Gr. τίθημι ‘put’, Lith. *desti*; cf. Pokorny IEW: 235–236; Kellens 1995: 29; LIV²: 136–137; NIL: 99–11; Cheung 2007: 45–46);

T + s = Av. 0s:

YAv. nom. *masiia-* ‘fish’ (< IE *√*mad-si̯o*-; cf. OIA *mátsya-*; cf. Pokorny IEW: 694 ; NIL: 455–457);

OAv. nom. *grəguuasū* (< *-t-su*) ‘liable’ (√*x-* ‘x’; cf. pr. *x*; < IE *√*x*-; cf. X *x* ‘x’; cf. Pokorny IEW: x; Kellens 1995: x; LIV²: x; Cheung 2007: x);

ao. OAv. *sąs* (√*sənd-* ‘appear’, YAv. pr. *saδaiiemi*; < IE *√(*s*)*ḱend*-; cf. OIA *chádayati* ‘appear’; cf. Kellens 1995: 61; LIV²: 546; Cheung 2007: 332–334

dʰ + s = Av. 0z:

(?) pr. YAv. *uruuāza-* (√*uruuād-* ‘be proud’; cf. Kellens 1995: 60; Cheung 2007: 438);

The sibilantization of all dental plosives before **t/*dʰ* is systematic (and shared with other Indo-European languages but not with OIA). The development before **s* could be considered as a simplification of the original **ss*-cluster.

2.3.5 Clusters of *sibilant +t/dʰ/s*

Sibilants are, in contrast to Vedic, preserved in all clusters. The voiceless sibilants became voiced before **dʰ*, while clusters of two sibilants are simplified on a single one (degemination):

**st* = Av. *st*:

pr. OAv. *astī*, YAv. *asti* (√*ah-* ‘be’; cf. pr. OAv. *ahmī*; < IE *√*H₁es*-; cf. Gr. ἐστί, L. *est* ‘be’; cf. IEW: 340–341; Kellens 1995: 10–11; LIV²: 241; Cheung 2007: 151–152);

pr. YAv. *vastē* (√*vah*- 'be dressed'; cf. pr. YAv. *vaŋhata*; < IE *√*u̯es*-; cf. Hitt. *wēsta* 'wear', Gr. ἕννῡμι, ἐννύω 'put clothes on', L. *uestis* 'cloth'; cf. Pokorny IEW: 1172–1173; Kellens 1995: 53; LIV²: 692–693; Cheung 2007: 405);

ppp. YAv. *aiβi.sasta*-, inf. ao. OAv. *sasté* (√*sąnh*- 'declare', pr. YAv. *saŋhaite*; < IE *√*ḱens*-; cf. L. *cēnseō* 'judge'; cf. Pokorny IEW: 566; Kellens 1995: 62; LIV²: 326; Cheung 2007: 334–335);

***št = Av. št:**

ao. OAv. *cōišt*, YAv. *cōišta* (√*ciš*- 'assign'; cf. pr. OAv. *cīšmahī* < IE *√*kᵘei̯s*-; cf. OIr. *ad-cí* 'see'; cf. Pokorny IEW: 637; Kellens 1995: 22–23; LIV²: 381–382; Cheung 2007: 30);

nom. OAv. *būštīš* 'endeavours' (√*būš*- 'endeavour'; < IE *√*bʰeu̯H₂-s*-; cf. Lith. *bùs* 'will be'; cf. Pokorny IEW: 146–147; Kellens 1995: 39–40; LIV²: 98–101; Cheung 2007: 25–26);

ppp. YAv. *paiti.θβaršta*- (√*θβars*- 'cut'; cf. pr. YAv. *θβərəsaiti*; < IE *√*tu̯ers*- (?); cf. Pokorny IEW: 1102; Kellens 1995: 26; LIV²: 656; Cheung 2007: 399–400);

***sdʰ = Av. zd:**

pr. OAv. *zdī* (√*ah*- 'be'; cf. pr. OAv. *ahmī*; < IE *√*H₁es*-; cf. Gr. ἐστί, L. *est* 'be'; cf. IEW: 340–341; Kellens 1995: 10–11; LIV²: 241; Cheung 2007: 151–152);

ao. OAv. *θrāzdūm* (√*θrā*- 'protect'; cf. YAv. pr. *θrāiieṇte*; < IE *√*treH*-; cf. OIA *trā́yate* 'protect, save'; cf. Pokorny IEW: 1075; Kellens 1995: 27; LIV²: 646; Cheung 2007: 394);

inf. OAv. *sazdiiāi*[23] (√*sąnh*- 'declare', pr. YAv. *saŋhaite*; < IE *√*ḱens*-; cf. L. *cēnseō* 'judge'; cf. Pokorny IEW: 566; Kellens 1995: 62; LIV²: 326; Cheung 2007: 334–335);

***šdʰ = Av. žd:**

ao. OAv. *θβarōždūm* (√*θβars*- 'cut'; cf. pr. YAv. *θβərəsaiti*; < IE *√*tu̯ers*- (?); cf. Pokorny IEW: 1102; Kellens 1995: 26; LIV²: 656; Cheung 2007: 399–400);

pr. (ao.?) OAv. *cīždī* (√*ciš*- 'assign'; cf. pr. OAv. *cīšmahī* < IE *√*kᵘei̯s*-; cf. OIr. *ad-cí* 'see'; cf. Pokorny IEW: 637; Kellens 1995: 22–23; LIV²: 381–382; Cheung 2007: 30);

Av. inf. *būždiiāi* (√*būš*- 'endeavour'; < IE *√*bʰeu̯H₂-s*-; cf. Lith. *bùs* 'will be'; cf. Pokorny IEW: 146–147; Kellens 1995: 39–40; LIV²: 98–101; Cheung 2007: 25–26);

***ss = Av. 0s:**[24]

YAv. part. inch. (*vī*)*usaitī*- f. (√*vah*- 'shine', < IE *√*u̯es*-; cf. Lith. *aũšti* 'break dawn'; cf. Pokorny IEW: 86–87; Kellens 1995: 53; LIV²: 292–293; Cheung 2007: 202);

ppp. (?) YAv. *ustriiamna*- (= *us*-√*stər*- 'throw down'; < IE *√*ster*-; cf. L. *prosternō* 'cause to fall'; cf. Pokorny IEW: 1029–1030; Kellens 1995: 64; LIV²: 597–598; Cheung 2007: 363–364);

***šs = Av. 0š/0s:**

pr. inch. YAv. *tusən* (√*tuš*- 'be empty'; cf. pr. caus. YAv. -*taošaiieiti*; < IE *√*teu̯s*-; cf. OCS *tъštь* 'empty, vain', Lith. *tùščias* 'empty, poor'; cf. Pokorny IEW: 1085; Kellens 1995: 26; LIV²: 642; Cheung 2007: 388–389);

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[23] This from could be from √*sąnd*- 'appear", cf. Cheung 334, but it seems to be doubtful. Kellens lists it as derived from √*sąnh*- 'declare" without any doubts (Kellens 62).

[24] But from √*ah*- 'be" is 2nd sg. OAv. *ahī*, YAv. *ahi*, probably because the cluster of *ss was merged into *s already in IE, cf. OIA *asi* from √*as*- 'be", cf. Hoffmann/Forssmann: 109.

Again, the cluster of two sibilants is simplified, as it was in case of (secondary) sibilants from dentals and palatovelars + *s* (cf. above).

2.3.6 The overview of the Avestan development

See the following table for a summary of the attested alternations of the Avestan clusters formed either by any plosive + *t/d^h/s* or a sibilant + *t/d^h/s*. Not attested forms are omitted, and the forms clearly formed by an analogy (especially those parallel to forms formed according to the Bartholomae's Law) are marked by round brackets:

IE	**Avestan**	t-	d^(h)-	s-
-ḱ/ǵ	-s/z	*št*	*žd*	*0š* (*0s*)
-ǵ^h	-z	*žd* (*št*)		*0ž* (*0š*)
-k^(u̯)/g^(u̯)	-k/c/g/j	*xt*	*gd*	*xš*
-g^(u̯)h	-g/j	*gd* (*xt*)		*γž* (*xš*)
-t/d	-t/d	*st*	*zd*	*0s*
-d^h	-d	*zd* (*st*)	*zd*	*0z* (*0s*)
-p/b	-p/b	*pt* (**ft*)	*bd*	*fš* (*fs*)
-b^h	-b	*bd* (*pt*)		*βž* (*fš, fs*)
-s	-s	*st*	*zd*	*0s*
-š	-š	*št*	*žd*	*0š* (*0s*)

2.4 The development of two-obstruent clusters in Old Persian

Old Persian data are far more scarcely attested than those of Avestan (or Vedic) but offer some useful parallels to those of Avestan. The remarkable advantage of Old Persian is its antiquity; the remarkable disadvantage is the attested corpus, which is far more limited than that of Avestan or Vedic. For these reasons, the Old Persian data are overshadowed by those of Avestan.

The whole development of Old Persian is in its nature very similar and close to that of Avestan, as just the original IE palatovelars are realized as follows: **ḱ* > OP *ϑ*, **ǵ* and **ǵ^h* > OP *d*.

In its general features Old Persian follows same trajectories as Avestan do, we should mention specially that:

i. the originally voiced non-aspirates and voiced aspirates are neutralized as voiced non-aspirates as in Avestan;
ii. the dentals are sibilantized before dentals as happens in Avestan;
iii. the left plosives of the clusters are always neutralized according to the right plosive or sibilant in voice. There are no traces of Bartholomae's Law, which was probably replaced by an analogy, similar to processes of leveling known from Avestan, being possibly regular in Old Persian (this does not affect, of course, regular clusters with the dominance of the right voiced element *d^h-, where the voiced nature of the outcome cluster is regular and in accord with the routine dominance of a right plosive over a left one).

P + t = OP **ft:*

**haftā* (reconstructed on np. *haft*, Yaghnobi *aft*, *avt* etc.; < IE **septm̥-*; cf. Av. *hapta-*, Gr. ἑπτά, L. *septem* 'seven'; cf. Pokorny IEW: 909; Brandenstein/Mayrhofer 1964: 37; Emmerich 1992b: 299; Blažek 1999: 246);

K + s = OP xš:

nom. *xšaça-* 'rule' (cf. Av. *xšaϑra-* 'rule, control', OIA. *kṣatrā* 'power'; cf. Kent 1950: 181; Pokorny IEW: 626; Brandenstein/Mayrhofer 1964: 126; LIV^2: 618–616; Cheung 2007: 451–452; Brust 2018: 165–166);

g^h + t = OP xt:

nom. *duruxta-* (√d^u*ruj-* 'lie'; cf. impf. *ad*^{u}*rujiya*; < IE *√d^h*reu̯g*^{h}-; cf. Av. √*druj-*, OE driogan 'deceit'; cf. Kent 1950: 192; Pokorny IEW: 276; Brandenstein/Mayrhofer 1964: 117; LIV^2: 157; Cheung 2007: 80–81; Brust 2018: 227–228);

Ḱ + t = OP št/st:

ppp. *ufrasta-/ufrašta-* (√*fraϑ-* 'punish, ask, inquire', ps. *fraϑiyaiš*; < IE *√*preḱ-*; cf. Av. √*fras-* 'inquire'; cf. Kent 1950: 198; Pokorny IEW: 321–322; Brandenstein /Mayrhofer 1964: 119; LIV^2: 490–491; Cheung 2007: 88–90; Brust 2018: 260);

ppp. *ni-pišta-*, inf. *ni-pištanayi* (√*paiϑ-* 'cut, engrave, adorn'; cf. impf. ps. ^{x}*niyapiϑiya*; < IE *√*pei̯ḱ-*; cf. Av. √*paēs-* 'adorn', L. *pingī* 'paint', OCS *pьšǫ* 'write'; cf. Kent 1950: 194; Pokorny IEW: 794–795; Brandenstein/Mayrhofer 1964: 136; LIV^2: 465-466; Cheung 2007: 291–292; NIL: 546–548; Brust 2018: 239–240);

adj. *arštā* f. 'justice', adj. *rāsta-* 'right' (cf. Av. *arštāt* f. 'Iustitia', Av. *rāšta-* 'ordered'; < IE *√H_3*reǵ* -; cf. L. *regō* 'rule'; cf. Kent 1950: 206; Pokorny IEW: 854–855; Brandenstein/Mayrhofer 1964: 106, 141; LIV^2: 304–305; Cheung 2007: 196–197; Brust 2018: 123–124, 298);

Ḱ + s = OP 0s/0š:

pr. inch. *p*(*a*)*rsāmiy*, *ap*(*a*)*rsam* (√*fraϑ-* 'punish, ask, inquire', ps. *fraϑiyaiš*; < IE *√*preḱ-*; cf. Av. √*fras-* 'inquire'; cf. Kent 1950: 198; Pokorny IEW: 321–322; Brandenstein /Mayrhofer 1964: 119; LIV^2: 490–491; Cheung 2007: 88–90; Brust 2018: 260);

ao. *niya-paišam* (√*paiϑ-* 'cut, engrave, adorn'; cf. impf. ps. ^{x}*niyapiϑiya*; < IE *√*pei̯ḱ-*; cf. Av. √*paēs-* 'adorn', L. *pingī* 'paint', OCS *pьšǫ* 'write'; cf. Kent 1950: 194; Pokorny IEW: 794–795; Brandenstein/Mayrhofer 1964: 136; LIV^2: 465-466; Cheung 2007: 291–292; Brust 2018: 239–240);

T + t = OP st:

nom. *pastiš* 'foot soldier' (= **ped-ti-*; < IE *√*ped-*; cf. Av. *pad-*, L. *pēs* 'foot'; cf. Kent 1950: 197; Pokorny IEW: 790-792; Brandenstein/Mayrhofer 1964: 138; Brust 2018: 254–255);

nom. *ustašanām* f. 'staircase' (= *ud*-√*taϑ-* 'work', < IE *√*teti-*; cf. Gr. τέκτων 'carpenter'; cf. Kent 1950: 178, 185; Pokorny IEW: 1058–1059; Brandenstein/Mayrhofer 1964: 148; LIV^2: 638–639; Cheung 2007: 384–385; Brust 2018: 151);

d^h + t = OP st:

without the Bartholomae's Law (due to analogy?)

ppp. *basta-* (√*band-* 'bind', pr. YAv. *baṇdāmi*; < IE *√*b^h^end^h^-*; cf. Goth. *band* 'bind'; cf. Kent 1950: 199; Pokorny IEW: 127; Brandenstein/Mayrhofer 1964: 110; Kellens 1995: 37; LIV^2: 75–76; Cheung 2007: 4–6; Brust 2018: 265);

ppp. *gasta-* 'evil, repugnant' (√*gant-* 'stink'; < IE *√*g^u̯^ed^h^-*; cf. OIA *gandháḥ* 'smell'; cf. Kent 1950: 183; Pokorny IEW: 466–467; Brandenstein/Mayrhofer 1964: 121; Cheung 2007: 103–104; Brust 2018: 177–178);

d^h + d^h = OP zd:

adv. *azdā* (?) 'known' (cf. Av. *azdā*, OIA *addhā*; but it could be either from *ad^h^-tā* or *ad^h^-tā* or *ad-dā*, < IE *√*H₂ed^h^-* (?); cf. OIA *āha* 'say'; cf. Kent 1950: 173–174; Pokorny IEW: 291; EWAi 1: 64, Brandenstein/ Mayrhofer 1964: 109; LIV^2 222; Lipp 2009b: 87; Cheung 2007: 153; Brust 2018: 132–133);

s + t = OP st:

pr. *astiy* (√*ah-* 'be'; cf. impf. *āham*; < IE *√*H₁es-*; cf. OIA *asti*, Gr. εἰμί, L. *est* 'be'; cf. Kent 1950: 174; Pokorny IEW: 340–341; Brandenstein/Mayrhofer 1964: 101; LIV^2: 241; Cheung 2007: 151–152; Brust 2018: 133);

caus. impf. *avāstāyam* (√*stā-* 'stand'; < IE *√*steH₂-*; cf. OIA *tiṣṭhati*, Gr. ἵστημι 'stand'; cf. Kent 1950: 210; Pokorny IEW: 1004–1005; Brandenstein/Mayrhofer 1964: 146; LIV^2: 590–591; Cheung 2007: 358–361; Brust 2018: 311–313);

š + t = OP št:

nom. *dauštā* 'friend' (√*x-* 'x'; cf. pr. *x*; < IE *√*x-*; cf. X *x* 'x'; cf. Kent 1950: 189; Pokorny IEW: 399–400; Brandenstein/Mayrhofer 1964: 116; Cheung 2007: 473; Brust 2018: 209);

impf. *aištatā*, caus. *niyaštāyam*, *frāstāyam* (√*stā-* 'stand'; < IE *√*steH₂-*; cf. OIA *tiṣṭhati*, Gr. ἵστημι 'stand'; cf. Kent 1950: 210; Pokorny IEW: 1004–1005; Brandenstein/Mayrhofer 1964: 146; LIV^2: 590–591; Cheung 2007: 358–361; Brust 2018: 311–313);

s + d^h = OP zd:

nom. *Auramazdā* m. (= *aura-*+*mazdā*; cf. Av. *Ahurō mazdå̊*; *mazdā* = **mas-*+ *d^h^ā* < IE **m̥s-* + *√*d^h^eH₁*; cf. OIA *medhā* ; cf. Kent 1950: 165, 188; Pokorny IEW: 235–236; EWAi 2: 378, Brandenstein/Mayrhofer 1964: 108 ; LIV^2: 136–137; Cheung 2007: 45–46; Brust 2018: 93–95);

To sum up, for the attested Old Persian development, see the following table. As in the case of Old Indo-Aryan or Avestan above, round brackets mark the attested forms given by an analogy (not attested forms are not reconstructed here):

IE	OP	t-	$d^{(h)}$-	s-
-ḱ/ǵ	-ϑ/d	*št* (*st*)		*0š* (*0s*)
$-ǵ^h$	-z			
$-k^{(u̯)}/g^{(u̯)}$	-k/c/g/j			*xš*
$-g^{(u̯)h}$	-g/j	(*xt*)		
-t/d	-t/d	*st*		
$-d^h$	-d	(*st*)	*zd*	
-p/b	-p/b	**ft*		
$-b^h$	-b			
-s	-s	*st*	*zd*	
-š	-š	*št*		

2.5 The development of Nūristānī clusters

As we have said above, the Nūristānī data are not principally on a similar level as the above mentioned Vedic, Avestan or Old Persian data, especially since we are dealing with living dialects, not with a long-dead language. It is hence not of the age comparable with Old Indo-Iranian languages examined above, but a result of more than a thousand years of development necessarily affecting the state of the data. However, and surprisingly, due to the political situation in the area, the data are scarce, and furthermore, from a very 'thin' source, since the linguistic description of Nūristānī languages is sketchy and incomplete[25].

For these reasons, we will treat Nūristānī as a background to data from Old Indo-Iranian languages, with its credibility well beyond them. Moreover, there is another important distinction: the OIA, Avestan, even Old Persian clustering-data in general are taken from **synchronic** situations, i.e., from the living synchronic alternations on a contact of morphs, but Nūristānī data are **etymological** in general, reflecting synchronically closed situations. Comparing Nūristānī to Old Persian, we can state that Old Persian is both ancient and relict, Nūristānī then modern and evasive, for our use both languages are necessarily fragmentary, but this fragmental nature is different for Old Persian (being by its archaicity and structural composition closer to other ancient Indo-Iranian languages) than for Nūristānī (which is sketchy and more than two thousand years younger than any of the ancient Indo-Iranian languages we dealt with until now).

It should be noted that the independent status of Nūristānī as the third branch of Indo-Iranian is often disputed and though Morgenstierne (1965) and others support the third-branch status (cf. Mayrhofer 1951: 15; Fussman 1972: 391; Nelson 1986: 104–116; Kausen 2012: 662–663), others stand either for Indian (cf. Bloch 1965: 54; Budruss 1977: 33; Degener 2002; Blažek/Hegedüs 2012; Werba 2016) or Iranian origin of Nūristānī (Mayrhofer 1984; Mayrhofer 1997: 107–108; Lipp 2009a: 156–157).

From attested Nūristānī data (quotations of sources are given directly with data) we can assume the following development of old clusters plosive + *t*, plosive + d^h, plosive + *s* (the reconstructed forms are approximative, for the reasons stated above, each symbol marks the whole local series):

[25] The first survey by Morgenstierne (1926) was done from Kabul for safety reasons, which did not improve at all for another century.

P + t = N. 0t:

Ashkun *nōt*, Prasun *natī, nätix, nətik*, Kati, Waigali *nūt* ‘little girl’ (< IE **nept-*; cf. OIA *naptī*, OAv. *nafšu*; cf. Fussman 1972: 271–272; Pokorny IEW: 746; EWai II: 11–12);

Kati *lot*, Waigali *lāt* ‘peace’, Kalaṣa/Waigali *lātoy* ‘he has found’ (< Indo-Iranian *√*lab*^{h}*-ta-*;[26] < IE *√*lemb*^{h}*-*; cf. OIA *labdhá-*; cf. Nelson 1986: 99; Degener 2002: 109; Pokorny IEW: 652; EWai II: 434; LIV^{2}: 411–412);

Kati *sut*, Waigali *sōt*, Ashkun *sūt* (< IE **septm̥-*; cf. OIA *sapta-*, Av. *hapta* ‘seven’; cf. Gr. ἑπτά, L. *septem* ‘seven’; cf. Nelson 1986: 99; Pokorny IEW: 909; Blažek 1999: 246; EWai II: 700; Lipp 2009a: 158; Werba 2016: 347);

K + t = N. 0t:

Kati *yit* ‘a pair’ (< IE *√*i̯eu̯g-*; cf. OIA *yuktá-*, *yukti*, YAv. *yuxta*; Nelson 1986: 99; Pokorny IEW: 508–509; EWai II: 417; LIV^{2}: 316; Cheung 2007: 217–218);

g^{h} + t = N. 0g:

Prasun *ḍogū, ḍūgu, ḍuge* ‘milk’ (< IE **d*^{h}*eu̯g-* (?); cf. OIA *dugdhá-*; Fussman 1972: 200–201; Pokorny IEW: 271; EWai I: 747–748; LIV^{2}: 153; Cheung 2007: 66–67);

Note: The outcome of the cluster *g*^{h}*t* seems to be: *g*^{h}*t* > *gd*^{h} > *gg*$^{(h)}$ with atypical assilation of location (?).

Ḱ + t = N. ṣṭ:

Kati (*w*)*uṣṭ*, Waigali *oṣṭ*, Ashkun *ōṣt*, Prasun *āstë*, Tregani *wūṣṭ* ‘eight’ (< IE **oḱto-*; cf. OIA *aṣṭáu*, Av. *ašta*, L. *octō*; cf. Fussman 1972: 196–197; Nelson 1986: 58; Pokorny IEW: 775; Blažek 1999: 263; EWai I: 142);

T + t = N. 0t:

Kati *ptå*, Kalaṣa/Waigali *pratoy* ‘he has given’ (< **pra-tta-* < IE *√*deH*$_{3}$*-to-*; cf. Morgenstierne 1926: 60; Degener 2002: 105);

Kati, Waigali, Prasun *čit* ‘aim’ (< IE *√(*s*)*k*^{u}*ei̯t-*; cf. OIA *cittá-*, Av. *cisti-*; cf. Lipp 2009a: 169; Werba 2016: 349; Pokorny IEW: 636–637; LIV^{2}: 382; EWai I: 547; Cheung 2007: 31);

d^{h} + t = N. ṛ/0d:

Ashkun *būṛə* ‘mind, spirit’, Waigali *buṛā́, buṛṓk* ‘meaning, intent’ (< **būḍhi* < **būṣḍhi* < **b*^{h}*ud*^{z}*dhi* < IE **b*^{h}*ud*^{h}*-ti*; cf. Turner 1964; Turner 1966: 525; Hill 2003: 44–45), but cf. Kati *bədi* ‘mind’, Prasun *büdü, büt* ‘sense, mind’ (cf. Degener 2002: 105; Lipp 2009a: 169; Morgenstierne 1926: 60 assumes it a loanword); Ashkun *batu* ‘understood’ (< **bud*^{h}*-ta*; cf. OIA *buddhá-*, YAv. *busta-*; < IE *√*b*^{h}*eu̯d*^{h}*-*; cf. Degener 2002: 109; Lipp 2009a: 169; Pokorny IEW: 150–151; EWai II: 233; LIV^{2}: 83–84; Cheung 2007: 14–15);

The above quoted Nūristānī form of **d*^{h}*t* has cerebralization (from older palatalization ?) more probably not due to Pedersen’s Law, but due to analogy or some later process (the parallel froms with *0d* are allegedly from similar formations!), since it would be a singlular example of working of the *ruki*-rule on a sibilant from an original dental. The extraordinariness of the process is clear especially from the fact that from cluster *Tt* has Nūristānī an an outcome not *ṭ*, but *t*; cf. examples above.

K + s = N. č:

Ashkun *čuʾai* ‘this night’, *çū*, *čū* ‘last night’ (< IE *√*k*$^{(u)}$*sep-*; cf. OIA *kṣáp-* ‘night’; YAV. *xšap* ‘darkness’; cf. Pokorny IEW: 649; EWai I: 424);

Ashkun *aʾci, acī*, Kati *achẽ*, *ācē* ‘eye’, Prasun *iži*, *ižī*, Waigali *ačẽ*, *ačē*, Tregami *açẽ* ‘eye’ (< IE **H*$_{3}$*ek*^{u} -; cf. OIA *akṣi-*, Av. *aši* ‘eye’ (cf. Fussman 1972: 248; Hegedüs 2012: 151–153; Pokorny IEW: 775–777; EWai I: 42–43);

Kati *čuŕi, çūŕi, ču(ŕ)ī*, Waigali *čō̆i* ‘sickle’ (< IE *√*kseu̯-ro*; cf. OIA *kṣura-* ‘sickle’, Fussman 1972: 155–156; Hegedüs 2012: 151; Pokorny IEW: 586; EWai I: 435–436);

[26] Not attested in Iranian.

Ḱ + s = N. c:

Ashkun *da'cun*, Kati *daciẽ* 'right' (< IE **deḱs-in-o-*; cf. OIA *dakṣiṇa-*, Av. *dašinō* 'right'; cf. Nelson 1986: 82; Degener 2002: 105; Lipp 2009a:150–151, 155; Hegedüs 2012: 148–149; Werba 2016: 351; Pokorny IEW: 190–191; EWai I: 690–691);

Ashkun *kūc* 'middle; belly', Kati *kűc*, *kuc*, *kyűc* 'stomach, belly', Prasun *ab'uc* (?) 'side (direction)' (< IE *(*s*)*keu̯ḱs-*; cf. OIA *kukṣí-* 'belly, womb', Lith. *kūšỹs* 'female pubic hair'; Hegedüs 2012: 148–149; Pokorny IEW: 953; EWai I: 360–361);

T + s = N. ć:

Ashkun *mōc*̌, Kati. *maċi*, Tregani *məc̄*, Waigali *maċë, maċa* 'fish' (< IE *√*mad-si̯o-*; cf. OIA *mátsya-*; cf. Pokorny IEW: 694; Fussman 1972: 279–280; EWai II: 297–298; Lipp 2009a: 150, 169);

Waigali *ūċ* 'source' (< Indo-Iranian **ud-sa-*; cf. OIA *útsa-* 'source'; Fussman 1972: 345–346; Pokorny IEW: 78–79; EWai I: 213);

s + t = N. st/št:

Kati *mrestə* 'corpse', Waigali *mošta*, Ashkun *mərəsta* 'dead' (< Indo-Iranian **mr̥ta-sta-*< IE *√*mer-*; cf. Nelson 1986: 58; Pokorny IEW: 735; EWai II: 318–319; LIV[2]: 439–440; Cheung 2007: 264–265);

Kati *dušt*, Waigali *došt*, Ashkun *dōšt* 'hand' (< IE **ǵhest-to-*; cf. OIA *hastá-*, Av. *zasta*, OP. *dasta-*; cf. Pokorny IEW: 447; Nelson 1986: 58, 74; EWai II: 812);

š + t = N. ṣṭ/0ṭ:

Kat. *uṣṭ*, Waigali *ūṣṭ*, Ashkun *ōṣt* 'mouth' (< IE **Heu̯s-tH-*; cf. OIA *óṣṭha-*, YAv. *aošta,* 'mouth, lip'; cf. Pokorny: 785; Nelson 1986: 58; Pokorny IEW: 785; EWai I: 282–283);

but with the outcome *ṭ*:

Kati *pṭī* Waigali *yā-paṭī* (but Ashkun *piṣṭī*) 'back' (cf. OIA *pr̥ṣṭhá-*, YAv. *paršta-* 'back'; cf. Morgenstierne 1926: 63; Pokorny IEW: 735; EWai II: 165–166);

Kati *kāṭ* 'branch' (< IE **k*^(*u*)*olst*^h*o-* (?); OIA *kā́ṣṭha-*; cf. Morgenstierne 1926: 63; EWai I: 354–346);

š + d^h = N. (ž)d:

Kati *piždą̊*, *pidą̊* 'avalanche' (< IE **pi-sd-*; cf. OIA *pīḍā-* 'damage'; cf. Morgenstierne 1926: 61; Pokorny IEW: 887; EWai II: 136–137);

Bartholomae's Law was either not functional with the precursor of Nūristānī, or its results were leveled, as happened in Old Persian or in some cases in Avestan or Vedic (cf. Aṣhkun *batu* 'understood' but Kati *bədi* 'mind' above; both are traced to the root √**bud^h-* + *t-*).

An interesting feature of Nūristānī is the different outcomes of clusters *K + s* and of *Ḱ + s*: though both are realized as affricates, the results probably affected by later developments (cf. Morgenstierne 1926: 58–59; Nelson 1986: 84; Degener 2002: 105; Hegedüs 2012: 148–153). Indic has a single outcome for both clusters, Avestan has two outcomes; cf. above).

The outcomes of *s + t*, *š + t* and *Ḱ + t* seems to be reworked in the subsequent development, it seems that the *ruki*-rule was either never-functional or its result were leveled later (cf. Nelson 1986: 96–98; Degener 2002: 104), the second solution seems to be most probable, since similar process also affected Middle Indo-Aryan. The confusion of *št, st* could be probably a result of a secondary palatalizations (Nelson 1986: 94).

Hegedüs states that IE **ḱs* does not trigger the shift of **s* to **š* (Ashkun *da'cun*, Kati *datziẽ* 'right'; cf. OIA *dakṣina-*, Av. *dašinō* 'right'; cf. Hegedüs 2012: 148–149), in contrast with Indic and Iranian. The outcome of IE **ḱs* in Nūristānī is an affricate **c*, but the distribution of them is not clear even in the same dialect. However, this outcome is usually different from the outcome of IE **ks*, which results in Nūristānī **č* (see above). It seems very improbable the IE **ḱs* would not undergo the *ruki*-development, so the outcome has to be result of a some later secondary depalatalization.

Nūristānī seems to follow a similar trajectory in the development of clusters of two obstruents to that which Indo-Aryan does, since all two-plosive clusters are reduced to a single plosive, the single exception being *Ḱt* > N. *ṣṭ* (with *št* as a probably intermediate state). Indo-Aryan followed the trajectory of gemination of heterogenous clusters in Middle Indo-Aryan (T_1T_2 > T_2T_2; cf. OIA *bhuktá* - > Pāli *bhutta*), followed by later simplification of geminates. In this feature Nūristānī differs from the Iranian development, which followed (at least at its earliest stage) the trajectory of spirantization of the peripheral clusters *Pt, Kt* etc. (cf. Degener 2002: 104, 109)[27]. On the other hand, this 'Indic' development did not affect clusters with a sibilant (either an old one or resulting from an original palatovelar), which are preserved, contrary to the development in MIA, where OIA *ST* regularly gives MIA *TT^h^* (cf. OIA *asti* 'is', *aṣṭau* 'eight' vs. Pā. *atthi*, *aṭṭha*).

The attested Nūristānī outcomes could be summed in the following table:

IE	**Nūr.**	t-	d$^{(h)}$-	s-
-ḱ/ǵ	-ϑ/d	*ṣṭ*		*c*
-ǵ^{h}	-z			
-k$^{(u̯)}$/g$^{(u̯)}$	-k/c/g/j	*0t*		
-g$^{(u̯)h}$	-g/j	*0g*(?)		
-t/d	-t/d	*0t*		*ć*
-d^{h}	-d	*ṛ*		
-p/b	-p/b	*0t*		
-b^{h}	-b			
-s	-s	*st* *št*		
-š	-š	*ṣṭ* *0ṭ*	*žd* *0ḍ*	

2.6 The trajectories of the Indo-Iranian developments

To describe the trajectories of the development of two-obstruent clusters, we need to explain all changes and exceptions as fully as possible within the known Indo-Iranian and Indo-European contexts.[28]

We used the term 'trajectories' not only to express the proper multitude of the trajectories in their number (i.e the trajectory of velars, the trajectory of dentals, etc.), but to emphasize the possibilities of developments from the input, i.e., from the Indo-Iranian state of arts, given by the reconstruction, to the output, i.e., to the given states as attested in the Old Indo-Iranian languages.

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[27] The same trajectory is valid in Nūristānī as in Indic, for the dental cluster of *TT*.

[28] It should be remarked that traditional reconstruction generally followed the thesis of the innate archaism of Sanskrit, hence any difference from Sanskrit in any Indo-European language was primarily considered an aberration. With two centuries gone since the 'invention of Sanskrit" by the newly founded *Indogermanistik*, the psychological dominance of OIA is lesser and its archaic status could be rightly doubted, since the 'archaic" state of OIA could often be just a phantom, a result of a methodological prejudice based on the mental inertia, which could be demonstrated especially by the development of the *Tt* clusters, as we dare to demonstrate below.

2.6.1 Modelling the Indo-Iranian obstruent phonemes

We reconstruct the following inventory of Indo-Iranian obstruents:

	plosives			sibilants	
palatovelars[29]:	*ḱ	*ǵ	*ǵ^{h}		
(plain) velars[30]:	k	g	g^{h}		
palatals[31]:	c	j	j^{h}	š	(ž)
dentals:	t	d	d^{h}	s	(z)
labials:	p	b	b^{h}		

To our reconstruction model, we have to add that:

i. the question of the reconstruction of the palatovelars will be dealt with below in the section devoted to this: ‘palatovelars’. We use sibilants to mark given Indo-Iranian phonemes for simplicity, though today is more often to reconstruct them as affricates, at least for the first phase (the second being usually sibilants). For simplicity (and to avoid the debatable Indo-Iranian reconstruction) and the historical reasons the reconstructed palatovelars are present here as plosives;

ii. we have willingly omitted the question of voiceless aspirates in our reconstruction, though we assume their existence for the Common Indo-Iranian stage; this omission is purely due to lack of their development in the present paper. We suppose (in contrast with Lubotsky 2018: 1876, 1879, who directly rejects to accept the existence of the voiceless aspirates on the Indo-Iranian level) that at least three voiceless aspirates (k^h, t^h, p^h) could be securely reconstructed on the common Indo-Iranian level (though it is possible such phonemes were in fact spirants), but there is no secure reconstruction leading either towards *ś*^{h} nor c^h (OIA c^h is a result of an independent, specially Indic development of the IE cluster **sḱ*, paralleled by Iranian *s*; cf. OIA *gácchati* vs. YAv. *jasaiti*, both from Indo-Iranian *√*gam*- ‘go’ or OIA *pṛccháti* vs. OAv. *pərəsaētē,* YAv. *pərəsaitĕ* from Indo-Iranian √*praś*- ‘ask’).

However, we suppose that though the states of realization of our clusters differ in Old Indic and Old Iranian languages (and Nūristānī as well), they are the results of the regular developments in each branch, being the result of a development of the common Indo-Iranian state, i.e., that each difference (or preservation of an older state) between Indic and Iranian is a result of a further development of a given branch since Common Indo-Iranian, but never the result of a different development **before** the Common period.

[29] For simplicity, the term ‘palatovelar” will be used, though since we do not consider given set of phonemes to be ‘velar” in its phonetic form on the Common Indo-Iranian level at all, the term will be used purely as a convenient (and unmistakable) term, which helps to avoid a possible confusion resulting from the use of terms ‘older” and ‘younger” palatals.

[30] The result of merging of IE labiovelars and plain velars.

[31] Until the distinction between IE *e and *o (and *a) was preserved, velars and true palatals were just allophones of a singular series of velars, since complementary distributed according to a (non-)palatal context.

The **points of difference** between Old Indic and Old Iranian in the development of clusters of the type *obstruent +t/s/d*^{h}- could be summarized thus:

i. There is a spirantization of the left voiceless plosive before a voiceless obstruent for velar/ palatal and labial series in Iranian, but this feature is not known from Indic;
ii. There is a sibilantization of the left dental plosive before any plosive (either voiceless or voiced) in Iranian, but again this feature is not known from Indic, where dentals are either realized as a plosive, or as a null before voiced aspirates;
iii. Though the original IE palatovelars are realized as depalatalized sibilants in antevocalic positions in Iranian, the same palatovelars are realized in the same position either as palatalized sibilants (for **ḱ*) or affricates (for **ǵ*, **ǵ*^{h}) in Indic; palatovelars are realized as voiceless plosives before *t* and *s* or either as *ḍ* or 0 before the voiced plosive in Indic but as voiceless or voiced sibilants (according to the context) in Iranian;
iv. The original labial and velar (and palatal) plosives are realized as spirants before IE **s* (including Indo-Iranian **š*) in Iranian, though in Indic they are realized as plosives in the same environments;
v. The original palatalovelar and dental plosives are lost before *s* in Iranian, but are realized as plosives in Indic;
vi. Bartholomae's Law does not affect the clusters formed by a voiced aspirate and **s/š* in Indic, though it is fully functional for same clusters in Iranian (except in cases corrupted by the analogy: ppp. YAv. *anādruxta*- instead of the expected regular -*γža*-);
vii. The sibilants **s/š* are realized either as a voiced plosive or null before voiced plosives in Indic, but are uniformly realized as voiced sibilants in Iranian;
viii. Original sibilants **s/š* are realized before a sibilant as a plosive in Indic[32], but Iranian sibilants are lost before sibilants.
(ix. Indic has cerebral *ṣ* where Iranian has *š*; dental plosives following OIA *ṣ* are subsequently cerebralized.[33])

2.6.2 Towards the analysis of the Indo-Iranian clusters

Within the analysis of the Indo-Iranian languaes, we have to distinguish three contexts:

i. the context of *t*- (could be affected by Bartholomae's law, if the left phoneme is a voiced aspirate);
ii. the context of *d*^{h}- (the resulting cluster is usually the same as that of *D*^{h} + *t* affected by Bartholomae's Law);
iii. the context of *s*- (could be also affected by Bartholomae's law under the same circumstances, the sibilant could be **š* if in the context of Pedersen's Law);

Into this context enter the following blocks:

i. the **central/acute** block, including both dentals (including OIA 'cerebrals') and original IE palatovelars, which will be here dealt with as with plosives, according to their origin and function;

[32] Speaking about verbs, there are different outcomes for sibilants in the noun-declension of *s*-stems, see below.
[33] For the sake of continuity, we will stick to the traditional terms *cerebral* and *cerebralization* instead of *retroflex* and *reflexivization* or *cacuminal* and *cacuminalization*, and for the same reason we will use the traditional marking with the subscribed dot (*ṣ*, *ṭ*, *ḍ*$^{(h)}$, *ṇ*).

ii. The **peripheral/grave** block containing labials and velars (including old IE labiovelars and Indo-Iranian palatalized velars, since the latter are neutralized on plain velars in the examined contexts.);
iii. the **sibilant** block formed by the preserved IE sibilant **s* and **š*, arising from it due to Pedersen's law (the *ruki*-law).

The development of the central block differs from the development of the peripheral block. We can safely suppose that the development of both its series precedes the development of series of the peripheral block, since the developments of the central block are shared either with all IE branches (the development of dental series being the best example) or with all *satəm* languages (for the development of original palatovelar series). However, before we examine the trajectories of development of both blocks and the sibilant block, we have to mention the specifics related to the forming of clusters of two obstruents in Indo-Iranian languages[34].

Note: In the following lines, the inputs and outputs of diachronic processes will be marked bold; the intermediate states are without marking. The symbol > is used for regular (i.e., according to given sound laws) developments, the symbol → for analogical developments.

2.6.2 The cluster-forming and Bartholomae's Law

A typical feature of the development of the two-obstruent clusters is their equalization of the modal features, which is usually in its final value given by the value of the right obstruent, with the left one is assimilated to it.

The exception to this rule is well attested in the old Indo-Iranian languages but very doubtful outside of this language family. The scope of this exception affects clusters formed by the left voiced aspirate (D^h) and the right standing voiceless obstruent (*T*, *S*), in this case the output is DD^h for the input cluster D^hT and $D^{(h)}Z$ for the input D^hS. The model presented here is based on the generalization of the processes operational in Indic (where D^hT > DD^h but D^hS > *TS* without the operational Bartholomae's Law) and Iranian (where D^hT > *DD/ĐĐ* and D^hS > *DZ*), so the generalization is hence nothing more than a model, not a directly attested as such in any language.

The outcome of the cluster D^hT is shared with the outcomes of the clusters D^hD^h and TD^h both in Indic and Iranian, giving in Indic DD^h and *DD* in Iranian.

Note: From the above described full operational status of Bartholomae's Law on the two-plosive cluster, we can see pr. *dhattá*, derived from √*dhā*- 'put', as a sole exemption, having arisen probably due to analogy with *dattá* etc., from √*dā*- 'give'.
Note: A remarkable feature is that the Indic outcome has aspiration only on the right plosive, not on both (†D^hD^h), the nature of the Indic voiced aspirates clearly blocking the presence of the aspiration before the right standing

[34] There are no secure examples of Bartholomae's Law in Nūristānī.

plosive. This is not the case of the Greek voiceless aspirates, resulting from the IE voiced aspirates, since in Greek the clusters formed by two voiceless aspirates T^hT^h are possible and even a natural outcome of the clustering of *T/D* + T^h (see details in the chapter on Greek; cf. Gr. ἐτρέφθην vs. ἐτράπην).

Iranian, beside the assumed loss of aspiration is more close to the reconstructed Indo-Iranian state, since the law is fully operational on the *s*-clusters, unlike in Indic, where for this cluster we have to presume the secondary leveling (as it often happen in Iranian, too, as we saw above in examples). What is worth of reconsidering is if the original result in Indo-Iranian was not really DZ^h, analogical to DD^h; the final aspirated voiced sibilant is reconstructed by Burrow (1955: 94) or Lipp (2009a: 172). The outcome, i.e., the aspirated voiced sibilant, is not directly attested in any Indo-Iranian language (neither is a voiceless aspirated sibilant attested, nor any aspirated sibilant in other old IE languages) but such phonemes are not so uncommon: voiceless aspirated fricatives exist (often just as allophones of plain fricatives) in Korean and in Chodi (a member of the Tibeto-Burman languages, Gansu province, Central China), in Amerindian Ofo (a member of the wider Siouan family), in some Oto-Manguean languages (located in the Central America, especially southern Mexico) and in Hmu (located in Guizhou province, Southwest China), but voiced aspirated sibilants seems to be extremely rare. The aspirated voiced sibilant $*\check{z}^h$ is often reconstructed as the outcome of the IE palatovelar $*\acute{g}^h$. It has to be noted that a development of D^hS towards *DZ* (without any *translatio aspirationis* on a sibilant) is an appealing possibility.

Note: Bartholomae's Law is perpendicular for its orthogonality on location series, its applications crosses the series, i.e., it affects all of them without any regard for the location value of a given series.

Bartholomae was to first to describe the law (Bartholomae 1882; Bartholomae 1883: 48; Bartholomae 1885: 206; Bartholomae 1895–1901: 21–23; for further references see especially Collinge 1985: 7–11 and Mayrhofer 1986: 115–118; Szemerényi 1990: 106–109; Mayrhofer 2004: 46). Bartholomae simply stated that the result of the concatenation of any voiced aspirated obstruent and voiceless unaspirated obstruent would be a cluster of voiced and voiced aspirated plosives (schematically: $-D^h + T- = DD^h$, $-D^h + s- = -Dz-$)[35].

The development of two-plosive clusters was modelled by Anderson (1970: 388) as a two-stage development: in the first phase, a cluster of two voiced aspirated plosives is created ($-D^h + T- = D^hD^h$), the second phase is a deaspiration of the first plosive ($D^hD^h > DD^h$). Sag (1974: 593) states a paradox: Bartholomae's law (and subsequent deaspiration) should precede

[35] Note that Barthlomae's careful wording covers even clusters arising from $-T + D^h-$ and clusters with sibilants, since he does not state its limitation on plosives!

Grassmann's Law in case of *bhotsya-* but Grassman's Law should precede Bartholomae's Law in case of *buddha-*! Deaspiration as a second step of the whole process is accepted by Schindler (1976), though other authors assume that Indian aspirates are of biphonematic nature (Ejerhed 1981). Mey (1972) forms a complex of processes, where a deaspiration with a subsequent devoicing before an obstruent goes through a series of shifts of inter-exclusive operations. Schindler (1976) simply states that an obstruent becomes aspirated (and inherently voiced) after a voiced aspirate. D. G. Miller (1977) follows the influence of the root structure on the process, considering the voicing process as a primary trajectory, followed by the aspiration as a later process. Lombardi (1991: 140) tries to explain the the unexpected voicing of the right obstruent and the transfer of aspiration to it as 'spreading of the entire Laryngeal node', i.e., by aspiration of the whole cluster. Kobayashi (2004: 117–125) speaks about the 'aspiration throwback', using the instrumentality of Optimality theory and following the morphemic structure of clusters.

The origin of Bartholomae's Law is either assumed to be Indo-European[36] (as stated in e.g., Kuryłowicz 1935: 50–51; Lubotsky 2018: 1879) or specifically Indo-Iranian (e.g., Szemerényi 1990: 107; Hoffmann/Forsmann 1996: 95–96) but is outside the scope of this paper, since only its validity for Indo-Iranian is undoubted.

Note: There are no secure examples of Bartholomae's Law in Nūristānī; hence, the following model is applied solely to Old Indo-Iranian languages, though it could be applied even for Nūristānī.

Our proposed model for the development of D^hT clusters follows the trajectory of spirantization (Walde 1897: 466 assumes that the original value of the D^h was originally the voiced spirant $\varDelta$) and subsequent fortition with the following steps:

i. the left plosive (an originally voiced aspirate) becomes a voiced spirant and the right voiceless plosive also becomes a voiced spirant ($D^h + T \rightarrow \varDelta\varDelta$)[37];

ii. in the second phase both spirants became a subject of fortition to plosives, the left spirant became a voiced plosive, the right spirant changed into a voiced aspirate ($\varDelta\varDelta \rightarrow DD^h$). The result is preserved in Indic, but the second plosive lost its aspiration in Iranian (either directly due the same process or later; Walde 1897 assumes aspiration a later feature both of OIA and Gr. aspirates).

i. $\mathbf{D^h + T > \Delta\Delta > DD^h}$	(Indic)
ii. $\mathbf{D^h + T > \Delta\Delta >}$ **DD/ĐĐ**	(Iranian)

[36] The possible validity of the Bartholomae's Law for Germanic was examined in last years especially by Görtzen (1998: 444–448) and Hill (2003: 218–220, for older references see Collinge (1985: 5–11) and Szemerényi (1990: 115–117).

[37] We assume, similarly to D. G. Miller (1977) that voice was a primary quality, not aspiration.

As we have already mentioned above, the outcome of Bartholomae's Law for D^hT clusters is essentially the same as the outcome of the regular regressive development of the cluster of TD^h. Here we have to point out that this time the process is under the dominance of the right standing plosive, so the process could be sketched:

i. both plosives become voiced spirants;

ii. the cluster develops as described above, with a fortition of both plosives.

i. **T/D** + $\mathbf{D^h}$ > ΔΔ > $\mathbf{DD^h}$ (Indic)
ii. **T/D** + $\mathbf{D^h}$ > ΔΔ > **DD/ĐĐ** (Iranian)

Similarly, we also assume the spirantization and the subsequent fortition for D^hD^h clusters, which develop as follows:

i. $\mathbf{D^h}$ + $\mathbf{D^h}$ > ΔΔ > $\mathbf{DD^h}$ (Indic)
ii. $\mathbf{D^h}$ + $\mathbf{D^h}$ > ΔΔ > **DD/ĐĐ** (Iranian)

The development of D^hs clusters is in its trajectory and properties similar to the development of the D^hT clusters:

i. a voiced aspirate becomes a voiced spirant;
ii. a sibilant becomes voiced
iii. a *ΔZ* cluster is despirantized in the left part of it in Iranian; *Ts* replaces the expected †*DZ* due to analogy in Indic, the Iranian state is assumed to be archaic:

i. $\mathbf{D^h}$ + **S** > ΔZ (→ **TS)** (Indic)
ii. $\mathbf{D^h}$ + **S** > ΔZ > **DZ** (Iranian)

The spirantization model of Bartholomae's law has one prominent advantage concerning the development of D^hS clusters: within the spirantization model, there is no need to introduce the voiced aspirated sibilants at all.

2.6.3 The trajectories of clusters *labial + t/s/d^h^*

The development of both peripheral series differs in Indic and in Iranian since Iranian plosives are spirantized in the context of a right standing plosive or sibilant, but preserved as plosives in Indic.

The spirantization in Iranian is one of many spirantization processes we meet in the development of the Indo-European languages in different stages (Celtic, Sabellian, Pre-Slavic, Middle Greek etc., could serve as examples of this common, though necesarilly not mutually related development).

It seems sure that the Iranian spirantization of the peripheral/grave block is a later process than the development of the acute/central series, which could be demonstrated by the Iranian development of *Ks/Ps* > *xš/fs* on the one hand but *Ḱs/Ts* > *0s/0s* on the other hand. since being both parallel developments; we could expect similar outcomes, similarly *Kt/Pt* > *xt/ft*[38] on one hand but *Ḱt/Tt* > *št/st* of the central series has sibilants instead of spirants of the peripheral development.

We model the development of clusters formed by non-aspirated labial plosives with spirantization in Iranian, but without spirantization in Indic; the Nūristānī development mirrors that of the Indic, but see the note below:

i. **P** + **t** > **pt**	(Indic)
ii. **P** + **t** > φt > **ft**	(Iranian)
iii. **P** + **t** > pt > tt > **0t**	(Nūristānī)

Note: The outcome of IE **Pt* is **0t* in Nūristānī. Such an outcome could be reached at least by two trajectories: either 'Indic', attested in the development of MIA and NIA languages, i.e., through gemination and later simplification of geminates: *Pt* > *tt* > *0t*, or through the Iranian trajectory of lenition, with spirantization first, followed by debuccalization and elision: *Pt* > *φt* > *ht* > *0t*. At the moment we are not able to determine the one more probable.

We have already seen above that the regular Avestan[39] development is without spirantization (cf. Av. *hapta*- 'seven'; YAv. ppp. *vipta*- from √*vaēp*- 'engage in homosexual activities'; OAv. pr. *haptī* from √*hap*- 'keep'). However, the Middle and New Persian has an *ft* cluster (cf. Av. *hapta*- vs. Phl., NP *haft* 'seven'; YAv. ppp. *x^{v}apta*- from √*x^{v}ap*- 'sleep' vs. NP *xuftan*, Blažek 1999: 200; Cheung 2007: 145–146) and even in Avestan the parallel cluster of *Ps* is realized as *fs/fš*.

The question then naturally arises whether the attested *pt* cluster in Avestan is either an archaism or a later innovation (most probably due to the analogical leveling). We encounter in Avestan forms of *pitar*- 'father': N. sg. OAv. *ptā*, *tā*, YAv. *ptā, pita*, D. sg. OAv. *f$^\partial$δrōi*, *piϑrē*, YAv. *piϑre*, the form *tā* is easy to explain as the result of the development from **ftā*, which underwent lenition (debuccalization and subsequent elision) *ft* > *ht* > *0t*,[40] the form *ptā* being then the secondary fortition of aspirant back to a plosive. Reichelt (1909: 40) assumes spirantization and subsequent fortition, Kümmel (2007: 63–65, 147–148) assumes partial restitution of the spirants **f*, **θ*, **χ* in Later Iranian (cf. Lipp 2009a: 158–160 with further ref.).

[38] With different development in Avestan, where *Pt* > *ft*, see above and below.
[39] Unluckily, there are no secure Old Persian data.
[40] Hoffmann/Forssman (1996: 94) assume direct simplification of initial *pt*- > *t*-, which seems to be too complex a change if considered without at least one intermediate stage.

Beekes (1988: 73) and Hoffmann/Forssman (1996: 94) reckon with the preservation of the inherited *pt*.

Our model presumes fricativization and later fortition on plosive, especially concerning the development as mentioned earlier of Av. *pitar-*.

The development of clusters of voiced aspirates *b^h + *t-* shares its outcome with the development of clusters of any plosive (without regard to its aspiration or voice) + d^h-, since Bartholomae's Law afflicts it. For this development we state the following trajectory, based on spirantization, followed by the assimilation of voice and finally by the subsequent fortition of both plosives, according to either to Indic or Iranian peculiarities

i. $\mathbf{b^h}$ + **t** > βδ > $\mathbf{bd^h}$ (Indic)
ii. $\mathbf{b^h}$ + **t** > βδ > **bd/βð** (Iranian)

Note: Nūristānī has no secure data for this development.

The labial clusters *Pd^h* and *b^hd^h* are rarely attested (only the cluster of *Pd^h* is securely attested in Avestan), but we can surely assume that the mechanism was even simpler, in accord with the rule of the regressive assimilation triggered by the right member, and the result of the process is shared with the preceding development of clusters of *b^ht*. An asterisk marks the reconstructed patterns, Nūristānī trajectory is omitted for the lack of examples:

i. **P** + $\mathbf{d^h}$ > βδ > *$\mathbf{bd^h}$ (?) (Indic)
ii. **P** + $\mathbf{d^h}$ > βδ > **bd/βð** (Iranian)

i. $\mathbf{b^h}$ + $\mathbf{d^h}$ > βδ > *$\mathbf{bd^h}$ (?) (Indic)
ii. $\mathbf{b^h}$ + $\mathbf{d^h}$ > βδ > ***bd/βð** (?) (Iranian)

The clusters with non-aspirated plosives in the left position and a sibilant in the right position followed a simple trajectory of the spirantization. The variant cluster of *fš* in Iranian has probably arisen due to the analogy with the cluster of *kš* (see below), or as an example of a unique extension of Pedersen's Law/*ruki*-rule on any cluster of a peripheral plosive and sibilant, which seems improbable. As in the case of the peripheral clusters of *Pt-*, we do not assume a spirantization in Indic, but we assume an intermediate bilabial plosive in the Iranian trajectory:

i. **P** + **s** > **ps** (Indic)
ii. **P** + **s** > φs **> fš/fs** (Iranian)

Note: Nūristānī lacks secure examples of this development.

The development of clusters $b^h s$ is similar to the development of the clusters with *t*-, i.e., the result is affected by Bartholomae's Law (including the assumed spirantization), with later analogical leveling in Indic. Again, in Iranian labial clusters could be realized either as *βz* (unattested!) or *βž* as an analogy to clusters of *Ps/Pš*, as described above (and also analogical to the development of the clusters of K/g^h + $t/d^h/s$). Analogical leveling to voiceless clusters is attested in Iranian, similar to that in Indic, where it is, as we already know, a regular process:

i. $\mathbf{b^h}$ + **s** > βz (→ **ps**) (Indic)
ii. $\mathbf{b^h}$ + **s** > βz > **βž**/(βz ?) (Iranian)

Note: Again, Nūristānī has no secure data for this development.

The outcome of the clusters made of a labial aspirate plosive + sibilant as a spirant and a voiced sibilant do not require the intermediate cluster with an unusual combination of the type Dz^h (where *D* is any voiced plosive), appearing (for example) in Burrow (1955: 94, who reconstructs the intermediate cluster of $b\check{z}^h$ as a first outcome of the process of clustering of b^h +*s*). As we have noted above, the outcome *ps/bz* is limited to those clusters arising from original cluster of *labial* + *sḱ* (inchoatives), the outcome *pš/βž* on *labial* + *s*, clusters reflecting in this way the different origins of Avestan *s* (and the morphemic structure of suffixes).

2.6.4 The trajectories of clusters *velar* + *t/s/*d^h

The development of the velar (including the original labiovelar and later palatalized velars) is wholly parallel to that of the labial series in the same contexts: in Iranian, the plosive is spirantized, but it is preserved as a plosive in Indic.

The development of the clusters of non-aspirated velar (either voiceless or voiced) plosives + *t* could be then modelled simply as trajectories:

i. **K** + **t** > **kt** (Indic)
ii. **K** + **t** > **xt** (Iranian)
iii. **K** + **t** > kt > tt > 0t (Nūristānī)

Note: The Nūristānī development follows similar lines as that of the cluster of *Pt* mentioned above: we assume that it in general features followed the Middle Indo-Aryan trajectory of the geminate and its simplification. Again, it is even possible to accept an alternative trajectory of the spirantization and later debuccalization (*Kt* > *φt* > *ht* > *0t*). As in the preceding case, the solution is open at the moment, but the preferred solution is the 'Indian' one, since it explains even the development of clusters of **TT* > Nur. *0t* (see below).

Similarly to the development of the Iranian initial cluster of *#pt* in forms of Avestan *pitar-* 'father' (see above), we meet a special development with the cluster of *#kt-* both in OIA and Avestan, thus the development is securely already Indo-Iranian. It follows the trajectory: *#kt-*

> *#xt-* > *#ht-* > *#0t-*, attested in OIA *turī́ya-*,[41] Av. *tūiriia-* 'fourth'; the root is in the reduced grade (**ktur-*). We have to emphasize that Avestan has prefixed forms *ā-xtūirim* 'four times' (cf. *ā-ϑritīm* 'three times'; cf. Blažek 1999: 201) with original velar preserved in the form of a spirant. It seems that in the non-prefixed forms, spirantization was followed by a debuccalization and later elision, which is valid not only for Avestan but also for Vedic numeral *turīya-*. It seems that the spirantization already affected the grave anlaut clusters (but probably not the inlaut clusters) in the common Indo-Iranian period.

The development of clusters of voiced aspirates *$*g^h$* + **t-* shares its outcome with the development of clusters of any plosive (without regard to its aspiration or voice) + *$*d^h$-*, being again affected by Bartholomae's Law. For this development we state the following trajectory, based on spirantization, followed by the assimilation of voice and finally by the subsequent fortition of both plosives, according to either to Indic or Iranian peculiarities:

i. $\mathbf{g^h}$ + **t** > γδ > $\mathbf{gd^h}$	(Indic)
ii. $\mathbf{g^h}$ + **t** > γδ > **gd/γð**	(Iranian)

Note: Old Persian has a regular, analogy based, leveling of clusters of $g^h t$ to *kt*; cf. OP. *duruxta-* from √*druj-* 'lie', though Bartholomae's Law could be working in unattested examples. Nūristānī examples are not securely attested.

The same outcomes are shared by regularly formed clusters with a dominance of the right context of *$*d^h$-* with any quality of voice or aspiration of the left plosive preserved. The development of clusters of $g^h d^h$ either in Indic or Iranian is not attested; the outcome is based on the analogy:

i. **K** + $\mathbf{d^h}$ > γδ > $\mathbf{gd^h}$	(Indic)
ii. **K** + $\mathbf{d^h}$ > γδ > **gd/γð**	(Iranian)
i. $\mathbf{*g^h}$ + $\mathbf{d^h}$ > γδ > $\mathbf{gd^h}$ (?)	(Indic)
ii. $\mathbf{*g^h}$ + $\mathbf{d^h}$ > γδ > **gd/γð** (?)	(Iranian)

Note: Again, the Nūristānī development is not attested either for Kd^h or $g^h d^h$.

The clusters either of a voiceless non-aspirated plosive or a voiced non-aspirated plosive and *s-* are affected by Pedersen's Law (the *ruki*-rule), hence the outcome (if not leveled by the analogy) always has *š*, in Indic shifted to the cerebral *ṣ*, while the Iranian outcome is regularly spirantized (as is the analogical cluster of *Kt*) in the velar:

[41] If the meaning is 'fourth part, quarter", the accent shifts to the first syllable: *túrīya-* AV, cf. MacDonell 1910: 311. Blažek (1999: 200–201, 209) reconstructed *$*k^u$tur(ī)yo-*. In OIA, there is another term for 'fourth", which is *caturthá-*, regularly derived from the cardinal *catúr-* 'four".

i. **K** + **s** > kš > **kṣ** (Indic)
ii. **K** + **s** > **xš** (Iranian)
iii. **K** + **s** > kš > tš > **č** (Nūristānī)

The development of clusters of *g^h + *s is similar to the development of the clusters with **t*-, i.e., affected again by Bartholomae's Law (including the assumed intermediate spirantization), with later analogical leveling on *kṣ* in Indic. Similar leveling is also attested in Iranian (cf. YAv. ppp. *anādruxta*- 'undeceivable' vs. OAv. pr. *pa^{i}rii-aoγžā,* both being derived from the same root √*aoj*- 'say'). Again, in Iranian velar clusters could be realized either as *γž* according to analogy to clusters of *Kš*, as described above:

i. **g^h** + **s** > γž → kš > **kṣ** (Indic)
ii. **g^h** + **s** > γž > **γž** (Iranian)

Note: Nūristānī has no secure data for this development.

Again, as with labials above, the outcome of the development of the clusters of velar voiced aspirated plosive + sibilant do not require an intermediate cluster with a combination *gz^h* as proposed by Burrow (1955: 94).

2.6.5 The trajectories of clusters *palatovelar + t/s/d^h*

The development of the Indo-Iranian palatovelar obstruent clusters has parallels in other languages having original palatovelars (i.e., all *satəm*-languages, the process in clusters of our interest are well attested in Baltic and Slavic languages, rudimentarily also in Armenian and Albanian).

Before we sketch the possible trajectories of the development of the two plosive clusters of *Ḱt*, *$\acute{g}^h t$*, *$\acute{K}d^h$*, *$\acute{g}^h d^h$*, *Ḱs*, *$\acute{g}^h s$*, we have to turn our attention the development of the original palatovelar plosives in non-alternating contexts (which could be found in Indo-Iranian especially before vowels), since there are different outcomes not only for Indic and Iranian branches but also inside the Iranian branch, since the IE triad **ḱ*, **ǵ*, *$\acute{g}^h$* is realized in Vedic as a triad *ś*, j_1, h_1 but in Iranian as a dyad (resulting from the merge of both voiced plosives) either *s*, *z* (in Avestan) or *ϑ*, *d* in Old Persian.

Note: Nūristānī, as far as we can safely reconstruct, has a dyad of affricates **ċ*, **j* [= /*dz*/]. There are some cases with **š* instead of **ċ* for IE **ḱ*, generally considered to be attested in early loanwords (cf. Degener 2002: 104). Again, our analysis will be based on old Indo-Iranian languages, and Nūristānī will be dealt with in commentaries below.

The development of the original Indo-European palatovelars before vowels in the three old Indo-Iranian languages leads either to sibilants in Avestan, to a spirant and a plosive in Old Persian and to a sibilant affricates in Vedic.

The models of the reconstructed Indo-Iranian state could be classified into two groups: the **sibilant model** and the **affricate model**.

As for examples of sibilant-based models we should mention that of Bartholomae (1895: 12), who uses the symbols **ś, *ź, *ź^h*. Similarly the purely sibilant nature of the Indo-Iranian outcomes of original IE palatovelars was taken for granted at least by Leumann (1942: 2–3) and Kuiper (1967: 103–105; 117–120) or later by Erhart (1980: 21) or Kobayashi (2017: 334).

The affricate-based model is preferred since Morgenstierne (especially 1945).[42] Among others supporting this point of view we can name Burrow (1955: 73), who assumes the development from IE **ḱ, *ǵ,* ǵ^h* to earlier affricates **ć,* j́, *j́^{h}* and later to Common Indo-Iranian sibilants **ś, *ź, *ź^h* (i.e., to the sibilant phase), while Mayrhofer (1989: 6) reconstructs the outcomes of IE palatovelars as **ć, *j, *j^h*, as does Schmitt (1989: 27), who assumes for Iranian development another intermediate stage **ts, *dz* (for both voiced plosives), similarly Hoffmann/Forssman (1996: 93)[43], Kobayashi (2004: 52–54); Lipp (2009a: 131–189, especially 139–149) and Beekes (2018: 1880–1881) and others. The reconstruction of the reflexes of the original IE palatovelars as affricates was influenced by the discovery of Nūristānī, where the palatovelars are realized as non-palatal affricates **ċ* [*ts*], **j* [*dz*] (< **ǵ*$^{(h)}$), but alternatively reconstructed as **š* and **z* (< **ǵ*$^{(h)}$) (cf. Morgenstierne 1926: 23–53; Morgenstierne 1945: 225–238; Nelson 1986: 72–74; Degener 2002: 104, 110; Cardona/Jain 2003: 22–23; Lipp 2009a: 153–170; Werba 2016: 354–356; Cantera 2017: 492–493). It should be noted that Sihler (1997) criticizes the affricate trajectory with well-based arguments[44] and returns to the traditional sibilant-based model.

The **sibilant model** with a direct development of palatovelars to sibilants could be schematically reconstructed as follows (note that the sibilant model constructs voiced aspirated sibilants, otherwise constructed as outcomes of clusters of voiced aspirate + *s* according to Bartholomae's Law):

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[42] But it already was Bloomfield (1911) who doubted the traditional sibilant trajectory (assuming some occlusion present).

[43] The symbols used here are for simplicity, the same as those used by Bartholomae, Burrow, and Erhart.

[44] Sihler (1997: 190) argues that the development of affricates and spirants from original sibilants is an attested process in Burmese, Athapaskan, and Castilian, hence, according to his opinion, the Nūristānī affricate has arisen from original sibilant.

i. *$\acute{\mathbf{k}}$ > ś > **ś** (Old Indo-Aryan)
ii. *$\acute{\mathbf{k}}$ > ś > **s** (Avestan)
iii. *$\acute{\mathbf{k}}$ > ś > **ϑ** (Old Persian)

i. ***ǵ** > ź > **j** (Old Indo-Aryan)
ii. ***ǵ** > ź > **z** (Avestan)
iii. ***ǵ** > ź > **đ** (Old Persian)[45]

i. *$\acute{\mathbf{g}}^{\mathbf{h}}$ > $\acute{z}^h$ > $\mathbf{h_1}$ (Old Indo-Aryan)
ii. *$\acute{\mathbf{g}}^{\mathbf{h}}$ > $\acute{z}^h$ > ź > **z** (Avestan)
iii. *$\acute{\mathbf{g}}^{\mathbf{h}}$ > $\acute{z}^h$ > ź > **đ** (Old Persian)[46]

A possible trajectory for the Indic developments is done by:
i. the preservation of the voiceless sibilant;
ii. the occluvisation of both voiced palatovelars;
iii. the debuccalization of the aspirated palatovelar;

Note: The debuccalization of *$\acute{g}^h$ > h_1 is essentially similar to the development of the palatalized velars (g^h > j^h > h_2). It is interesting that there are some examples of the debuccalization of originally voiced aspirates in Vedic, especially for the original d^h: cf. 2nd imp. act. ending of athematic verbs *-dhi* vs. *-hi*; the 1st pl. primary med. ending *-mahe* (cf. Av. *-maide*), similarly the 1st pl. secondary med. ending *-mahi* (cf. Av. *maidī*). This tendency to debuccalization of d^h is attested with root phonemes too; cf. ppp. *hitá-* from √*dhā-* 'put'. There is even an example of the debuccalization of b^h to *h* in Vedic, attested with two variants of the single root √*grabh-/grah-* 'seize'. This debuccalization of the voiced aspirates is regular in the development of MIA languages; cf. Pāli *bhoti* vs. *hoti*: both parallel forms are from √*bhū-* 'be' (cf. Lubotsky 1995 for a detailed analysis of OIA *h* < d^h, b^h).

The sibilant trajectory for Iranian development is remarkable because of:

i. the depalatalization;
ii. the merging of voiced and aspirated members (as in all other series).

Note: Since the traditional sibilant model was developed before the discovery of Nūristānī, it does not solve the development of palatovelars in Nūristānī. Only Sihler (1997) tried to reconstruct a possible trajectory for Nūristānī according to the sibilant model, with the spirantization of the original palatovelars (a similar process is assumed for Old Persian) and later affricativization of such spirants (as is modelled for OIA voiced palatovelars anyway).

The **affricativization trajectory** could be modelled as follows (this reconstruction is based on that by Lipp 2009a, esp. 131–189; but cf. Lubotsky 2018: 1884–1885); note that with this model

[45] It seems that originally, the reflex of both voiced palatovelars was a voiced dental spirant, cf. Bartholomae (1895: 166), Reichelt (1927: 41), similarly Schmitt (1989: 68), but even by Mayrhofer (1989: 6), as it is by Erhart (1980: 24) and others, though Brandenstein/Mayrhofer (1964: 39) strictly reject the possibility that OP *d* < *$\acute{g}^{(h)}$ could be a spirant(synchronically). The intermediate spirant state is accepted by Lipp (2009a: 115, 144). Here the spirant symbol is used purely to distinguish the phoneme from the voiced dental plosive originating from original *$d^{(h)}$.

[46] The development in OP requires deaspiration before the merging of *ź* and *z*, otherwise it would be impossible to accept the transformation of *some* of zs to *d* and the preservation of others. The development in Avestan is hence analogous to that of Old Persian.

the voiced affricate (< **ǵ*) is preserved in Indic, but the Old Persian shifts from affricates to fricatives (plosives respectively[47]):

i. ***ḱ** > ć > **ś**	(Old Indo-Aryan)
ii. ***ḱ** > ć > c > **s**	(Avestan)
iii. ***ḱ** > ć > c > **ϑ**	(Old Persian)
iv. ***ḱ** > ć > **t**^{s}	(Nūristānī)
i. ***ǵ** > j > **j**	(Old Indo-Aryan)
ii. ***ǵ** > j > ź > **z**	(Avestan)
iii. ***ǵ** > j > ź > **đ**	(Old Persian)
iv. ***ǵ** > j > **d**^{z}	(Nūristānī)
i. ***ǵ**$^{\mathbf{h}}$ > j^{h} > ź^{h} > $\mathbf{h_1}$	(Old Indo-Aryan)
ii. ***ǵ**$^{\mathbf{h}}$ > j^{h} > ź^{h} > ź > **z**	(Avestan)
iii. ***ǵ**$^{\mathbf{h}}$ > j^{h} > ź^{h} > ź > **đ**	(Old Persian)
iv. ***ǵ** > j > **d**^{z}	(Nūristānī)

The affricativization trajectory could be considered a first phase of a wider, two-step model, sibilantization being the second phase, but it avoids the affricativization of voiced palatovelar in Indic, simply preserving the reconstructed affricate.

Note: Bloomfield (1911: 42–44) assumes that the development of palatovelars happened more 'rapidly' in Iranian than in Indic and this different 'speed of development' caused the merging of secondary voiced palatals (*j, j*^{h} < **g, *g*^{h} before *e/i*) in Indic, the Indic process being 'slow' enough to be 'caught up' by the secondary palatalization, which was not the case of **ś*. This developed, according to Bloomfield, rapidly, hence spirantized before its voiced counterparts. We assume that this merging was not due to the slowness of the development of voiced 'palatovelars', but due to the later fortition in Indic, which affected even true sibilants, especially those voiced (see below). There is no reason to assume (except for the development of clusters of *Ḱs*) that the development of original palatovelars did not follow the same trajectory in Common Indo-Iranian (cf. Lipp 2009a: 135).

The development of the left positioned original palatovelars in the contexts of **t-*, **d*^{h}*-*, **s-* is different from the development in the free context above in many aspects, given by the alternations occurring in such contexts.

Note: For simplicity, we will use the traditional symbols (i.e., **ḱ*, **ǵ*, **ǵ*^{h}) for palatovelars to avoid the use either of the affricate or the sibilant model. However, such 'palatovelar' symbols are used here purely as symbols, not as descriptions.

Here two possible trajectories for the description of the development of palatovelars will be used, the first using the **affricativization** model, the second using the **spirantization** model, which assumes the replacement of 'palatovelars' before obstruents by spirants.

[47] As above we preserve for simplicity the marking of OP reflexes of **ǵ*$^{(h)}$ as *d*.

The development before **t*-, according to the affricate model, could be modelled as follows. This model is based on the trajectory given by Lipp (2009a: 139–142), who assumes the development through affricates, later simplified by a loss of their plosive segment in all three sub-branches:

i. ***Ḱ** + **t** > ćt [i.e., t^{š}t] > št > **ṣṭ** (Indic)
ii. ***Ḱ** + **t** > ćt [i.e., t^{š}t] > **št** (Iranian)
iii. ***Ḱ** + **t** > ćt [i.e., t^{š}t] > **št** (Nūristānī)

For the clusters formed by the voiced aspirated palatovelar + *t*- we can model the development as follows (*i̯* is an approximand, causing either the lengthening of the preceding vowel or its diphthongization, according to the nature of the preceding vowel):

i. ***ǵ**$^{\mathbf{h}}$ + **t** > jd^{h} [i.e., d^{ž}d^{h}] > žd^{h} > ẓḍ^{h} > **i̯ḍ**$^{\mathbf{h}}$ (Indic)
ii. ***ǵ**$^{\mathbf{h}}$ + **t** > jd^{h} [i.e., d^{ž}d^{h}] > žd^{h} > **žd** (Iranian)

Note: Nūristānī has no secure data for this development.

The development of clusters of palatovelar + **s*- as a second member could be modelled, according to the 'affricate trajectory' as follows (cf. Lipp 2009a: 155; Lubotsky 2018: 1885), with sibilantization of the whole cluster in Iranian:

i. ***Ḱ** + **s** > čs [= t^{š}s] > tš > tṣ > **kṣ** (Indic)
ii. ***Ḱ** + **s** > čs [= t^{š}s] > šš > **0š** (Iranian)
iii. ***Ḱ** + **s** > čs [= t^{š}s] > tš > ts = **c** (Nūristānī)

Note: We will return below to the transformation of *ḱs* into *tš* and later into *kš* in Indic.

Analogously, the affricate trajectory for the voiced aspirated palatovelar **ǵ*^{h} + *s* could be modelled as follows (cf. Lipp 2009a: 172; Indian outcome is given by the analogy, the Nūristānī outcome is again not attested), again with a sibilantization of the whole cluster in Iranian:

i. ***ǵ**$^{\mathbf{h}}$ + **s** > jž^{h} [= d^{ž}ž^{h}] > dž^{h} > ḍẓ > (→ **kṣ**) (Indic)
ii. ***ǵ**$^{\mathbf{h}}$ + **s** > jž^{h} [= d^{ž}ž^{h}] > žž^{h} > žž >**0ž** (Iranian)

The confusing point of the affricate trajectory is that it is of the opposite vector than the assumed traditional (affricate) trajectory for the development of *T* + *t/d*^{h}*/s* dental clusters, since in Indic such dental clusters, according to the traditional theory, lose the internal sibilant (*t*^{s}*t* > *tt*, *d*^{z}*d*^{h} > *dd*^{h} etc., see below), but according to the affricate theory for the palatovelar series the left plosive would be lost but the sibilant preserved (*t*^{š}*t* > *št, d*^{ž}*d*^{h} >*žd*^{h}), though both processes should appear about the same time (this objection is not valid for Iranian, only for the Indian development). There is a question concering the affricate development both of dental and palatovelar series before a sibilant: why and how to lose a plosive before a sibilant, due to a process *tšš* > *0šš* > *0š* etc., or due to *tšš* > *tš* > *šš* > *0š*?[48]

For this reason, we dare to replace the affricativization model by the **spirantization model**,[49] which could solve some of the problems sketched above.

According to this model, the trajectory for the left standing non-aspirated plosive *Ḱ* (either originally voiceless or voiced) in the *t*-context produces a palatal spirant *ç* and is equal to the outcome of the sibilant resulting from the *ruki*-rule (i.e., Pedersen's Law) in the same context[50]. This spirant was later sibilantized, and in Indic it later underwent the typical Indo-Aryan shift to cerebrals[51] (secondarily affecting secondarily the following plosives), whereas in Iranian is the sibilant preserved:

i. ***Ḱ** + **t** > çt > št > **ṣṭ** (Indic)
ii. ***Ḱ** + **t** > çt > **št** (Iranian)[52]
iii. ***Ḱ** + **t** > çt > **št** (Nūristānī)[53]

Note: The minor development of **Ḱt* in Iranian *xšt*, mentioned by Kellens (1976) (attested widely for word-initials, internally there are only attested forms: Av. *paiti.fraxštar-* 'interrogator', *yaoxšti* 'branch', *spaxšti-* 'vision') is considered a proof that clusters from *Ḱ* + *t* and *š* + *t* did not merge fully even in the Proto-Iranian. Lubotsky (2018: 1884) explains this feature as a proof of a dialectal development in Eastern Iranian (similar reflexes are found in Sogdian and Bactrian), and the different outcomes in Avestan are then proof of the dialectally mixed origin of the attested Avestan texts, which is probably the most acceptable solution. However, the development of the cluster of *Ḱt* would require the split of the fricative *çt* to *xšt* in some of the dialects. A similar process, universal for all clusters of *št* in the word-initial (cf. YAv. *xštāṯ* 'stands, quoted by Bartholomae) as described by Bartholomae (1895–1901: 36) could be a prothesis, as Bartholomae stated, though Kellens (1976: 68) rejects the idea. However, the prosthesis explanation remains the most probable solution for the anlaut clusters. The development of the internal clusters would follow the trajectory of a 'split spirant': ***Ḱt*** > *çt* > *xšt* > ***št*** in all dialects except those Eastern Iranian, which is possible, but it requires a parallel later development both of Indic and Western Iranian. It would probably be easier to assume the dialectal split of the *çt* on *xšt* in Eastern Iranian as a later independent process.

Similarly modelled are all clusters, including the cluster of *$ǵ^h$t* are affected by the Bartholomae's Law: in our spirant model we assume first the transformation of both plosives into voiced spirants (*jδ*), second the sibilantization of the first spirant as *ž* and re-occlusivization

[48] It seems very improbable to chart a trajectory like: *tšš* > *ššš* > *šš* > *0š*.

[49] A simple model of this type was proposed by Morgenstierne)1942: 81), who assumes *ϑ´t* as an intermediate stage for Early Iranian, arising from the common Indo-Iranian *t´t* and this from the IE **ḱt*).

[50] About clusters *št* and *$žd^h$*, see more below.

[51] Which is considered a regional development, cerebrals are present even in Nūristānī.

[52] With a secondary depalatalization on *st* in some cases, attested in Old Persian (without clear trigger, cf. OP *ufrašta-* and *ufrasta-* both from √*fraϑ-* 'ask"). Since the depalatalization lacks a trigger, it could be either spontaneous, or another solution is simply analogical leveling with the cluster, either from original **s+t* or **Ḱ+t*.

[53] The same development as for Indic and Iranian is assumed for Nūristānī. Interestingly, Lipp (2009a: 335) proposes the development *ḱt* > *çt* > *št* for Nūristānī only, not for other Indo-Iranian languages.

of the second member on the voiced aspirated plosive in Indic, though the intermediate aspirated stage could be assumed even for the Iranian development. Avestan preserves this state (when not leveled to *št*), while Indic underwent a typical cerebralization to *ẓḍʰ*. The subsequent Indian development could contain the debuccalization phase of the sibilant to the voiced approximant and finally, the loss of this approximant. The mark of the lost approximant is the lengthening of the preceding high vowel (ppp. *gūḍhá-*, gd. *gūḍhvī́* from √*guh-* 'hide; ppp. *ūḍhá-* from √*vah-* 'carry'), sometimes even of an original short *a* (ppp. *sā̆ḍhá-* from √*sah-* 'prevail') but with context with *a* usually forming diphthongs (pr. *tṛṇédhi* from √*tṛh-* 'crush'[54]; inf. *vóḍhum* from √*vah-* 'carry'). Note that we can probably assume three allophones of the voiced approximant: *ɦ* for the pure lengthening, *i̯* for forming *e* and *u̯* for forming *o*, this allophone clearly before the syllable containing a labial vowel[55].

i. ***ǵʰ** + **t** > ɟ̊ð > žδ > ždʰ > **i̯ḍʰ** (Indic)
ii. ***ǵʰ** + **t** > ɟ̊ð > žδ > **žd/žð** (Iranian)

Note: The Nūristānī outcome is not attested, hence the trajectory is not reconstructed:

The developments of clusters of two aspirated plosives (i.e., the *dʰ*-context) are similar to that of **ǵʰt*. The cluster was later cerebralized in Indian again; the sibilant underwent lenition and elision with a compensatory lengthening of the same type (√*vah-* 'carry': *voḍhvám, voḷhám*). Again, since the Nūristānī data are not attested, the reconstruction of its trajectory is omitted:

i. ***ǵʰ** + **dʰ** > ɟð > žδ > žḍʰ > **i̯ḍʰ** (Indic)
ii. ***ǵʰ** + **dʰ** > ɟð > (**žδ/žd** ?) (Iranian)

Note: Since the Old Persian data are not fully attested, it seems that clusters of *T* + *Dʰ* do not follow Bartholomae's Law in Old Persian, probably secondarily, hence the result would be *št/st* as with **ḱ/ǵ* + *t*.

The development of clusters of *Ḱdʰ* generally mirrors both above-described processes. The trajectory leads again towards Indo-Iranian cluster of *ždʰ*, attested in Iranian. In Indic, the sibilant was re-occlusivized as *ḍḍʰ* (√*diś-* 'point': pr. *didiḍḍhí*), in contrast to the development of previous clusters leading towards lenition of the sibilant to an approximant and to subsequent elision and the compensatory lengthening. The reasons for this different outcome are not clear, though not within the range of trajectories described here (again, Nūristānī is omitted for the lack of secure data):

[54] From the root √*tṛh-* 'crush" there are even non-lengthened forms ppp. *tṛḷhá-*, *tṛḍhá-*, here the short syllabic resonant has probably arisen due to analogical leveling instead of the expected *ri* (< *r̥̄*).
[55] These different outcomes could be demonstrated with the both afore- and below-mentioned form of the root √*vah-* 'carry".

i. ***Ḱ** + **d**$^{\mathbf{h}}$ > jð > žδ > žḍ^h > **ḍḍ**$^{\mathbf{h}}$ (Indic)
ii. ***Ḱ** + **d**$^{\mathbf{h}}$ > > ǰð > **žd**/(**žδ** ?) (Iranian)

Note that outcomes of **Ḱd*^{h} in OIA (i.e., *ḍḍ*^{h}) are different from the outcomes of clusters of **ǵ*^{h}*t* and **ǵ*^{h}*d*^{h} (realized in OIA as *0ḍ*^{h}, which is regular of **ǵ*^{h}*t* and demonstrated by numerous examples, but attested by only a single secure example for **ǵ*^{h}*d*^{h}). We will meet a similar difference between Vedic clusters from **d*^{h}*t* on one side (resulting, according to Bartholomae's law, in regular *dd*^{h}) and clusters of **td*^{h} generally resulting not only in *dd*^{h}, but also in *i̯d*^{h} (Vedic *daddhí* vs. *dehí*) and *d*^{h}*d*^{h}, always resulting in *i̯d*^{h} (see below). The outcomes of both central series in this aspect strongly contrast with peripheral series, since the OIA clusters from **g*^{h}*t* and **Kd*^{h} (**g*^{h}*d*^{h} is not attested; cf. above) are both realized by *gd*^{h}; for OIA clusters from **b*^{h}*t* we meet *bd*^{h} (clusters from **b*^{h}*t* and **bd*^{h} are not attested; cf. above). Also note that in Avestan the outcomes of IE clusters of **ǵ*^{h}*t* and **Ḱd*^{h} (there are no data for the IE **ǵ*^{h}*d*^{h} in Avestan) are same, *žd*.[56]

The development of clusters in the **s*-context is, in many aspects, different from the development of clusters within the **t*-context. To the Indic development we have to emphasize again the lack of Bartholomae's Law for original clusters of *ǵ*^{h}*s*, to the Iranian development is needful to restate that not only clusters of *Ḱs* and *ǵ*^{h}*s*, but even clusters of *Ts* and *d*^{h}*s*, having arisen from *dental* + *sibilant*, underwent the elision of the left plosive to *0s*; hence we have to explain the loss of an acute plosive before a sibilant in Iranian in general.

Note: The Nūristānī development of the cluster of **Ḱs* is regular, with an assumed loss of palatalization (modelled as *Ḱs* > *tš* > *ts* > *c*) but again, we lack any solid proof of Bartholomae's Law functioning in cluster of *ǵ*^{h}*s*.

First, we will analyze the development of the clusters of *Ḱs*, leading in OIA to the cluster of *kš*; this development is regularly modelled as a trajectory *Ḱs* > *tš* > *kš* (> *kṣ*). The process *tš* > *kš* itself is generally considered to be a result of a leveling (cf. Kuryłowicz 1951/1973: 129–130; Burrow 1955: 91–92; Kuryłowicz 1956: 373–374; Schindler 1967: 1999–200; Gunnarsson 1971: 38–42; Lipp 2009a: 150–152; Lipp 2009b: 12–18).

The reasons for the reconstruction of the intermediate state **tš* is the twofold outcome of the original **Ḱs* (and **ǵ*^{h}*s* due to the absence of Bartholomae's Law in Indic) are:

[56] Old Persian and Nūristānī data are not satisfying enough to make any statements based on them, cf. given data above.

i. the difference between OIA *kṣ* and Iranian *0š* (and Nūristānī *ts*);
ii. the cerebral plosive as an allophone of a voiced palatovelar in left position before a plosive (a cluster of *ḍḍ^h^* is attested for **Ḱd^h^*, for clusters of **ǵ^h^t/ǵ^h^d^h^* the outcome is *0ḍ*, i.e., without the first plosive).

Note: There are examples of the alternation of original palatovelars from the nominal flexion in Old Indo-Aryan, namely the development of some nominal consonantal stems ending in an original palatovelar, though other stems (sometimes even same stems) end in a plain velar. The forms where cerebrals could appear are: nom. sg., dat.-abl. pl. and instr. pl., du. abl.-dat.-instr., in contrast to loc. pl., where only *kṣ* could appear, see following lines (note that *-j₂* and *-h₂* are regularly realized as *-k*, *-gbhyaḥ*, *-gbhiḥ*, *-gbhyam*, *-kṣu*):

The OIA forms from *-ś* realized as a cerebral:
nom. sg. *-ṭ*: *víṭ* (< √*viś-* 'settlement'); *spáṭ* (< √*spaś-* 'see') is derived from *-tš* (final *š* is an ending) In other cases the outcome is a plain velar: *-dṛ́k* (always present in a compound, < √*dṛś-* 'see'); *dík* (√*diś-* 'direction'); *-spṛ́k* (in compounds, < *spṛś-* 'touch');[57]
Similarly, the OIA forms from *-j₁* realized as a cerebral:
nom. sg. *-ṭ*: *rā́ṭ*[58](< √*rāj-* 'king'); *bhrā́ṭ*[59] (< √*bhrāj-* 'shining');
And the OIA forms from *-h₁* realized as a cerebral:
nom. sg. *-ṭ*: *sā́ṭ*[60] (< √*sah-* 'prevail'); *vā́ṭ*[61] (< √*vah-* 'carry'); *saráṭ* TS 'bee';

The voiced cerebral plosive for **ž* from original **ǵ* is attested before *b^h^*:
dat.-abl. pl. *-ḍbhyaḥ*: *viḍbhyáḥ* but a counterexample: *digbhyáḥ*;
inst. pl. *-ḍbhiḥ*: *viḍbhíḥ*; *padbhíḥ*, but a counterexample with a velar: *-dṛ́gbhiḥ*;
abl.-dat.-instr. du. *-ḍbhyam*: *viḍbhyás*

The voiced cerebral plosive for **ž* from original **ǵ^h^* before *b^h^*:
dat.-abl. pl. *-ḍbhyaḥ*: *saráḍbhyaḥ* (no attested counterexample of *-gbhyaḥ*);

Nevertheless, note that OIA loc. pl. is uniformly with *-kṣu*: *dikṣú* AV, VS, *vikṣú*; *srakṣú* (< √*sṛj-* 'emit').

According to the spirantization model, the development could be modelled slightly differently, since the Old Indo-Aryan data lead us toward **kš* uniformly for verbs and nouns, i.e., towards the original neutralization of palatovelars to a plain velar before original **s* (cf. Šefčík 2017, but already Bartholomae 1895: 12). On the contrary, the Iranian development has no traces of this, supposedly archaic, state, since the Iranian outcome is *0š/0s*. However, we can surely assume that the Iranian development of the palatovelar series mirrored in its main feature the development of the dental series (see below).

The development of the cluster of the aspirated voiced stop + *s* is even harder to describe since, in OIA, the presumed cluster according to Bartholomae's Law has been replaced by the analogous cluster of *kṣ* (the cluster of **ǵ^h^s* could not regularly be realized as *kš*). The Iranian development preserves the result according to Bartholomae's Law, but the plosive was lost as with the voiceless cluster.

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[57] Final *-s* is regularly dropped after a plosive in nom. sg.
[58] Including compounds and derivatives.
[59] Again, including compounds and derivatives.
[60] Including compounds and derivatives.
[61] Again, including compounds and derivatives.

If the Iranian clusters underwent a spirantization, it had to be earlier or different in its nature than that of clusters of **Ks/g^{h}s*, otherwise the results of both development would merge.[62] From Iranian development, we can be sure that there was a phase when there was a plain velar present (due to the palatalization of the sibilant according to the *ruki*-rule). We dare to propose that in Iranian there was a later replacement of the original cluster of **Ḱs* by a newly created analogously *çš* (due to the development of the original palatovelars in other positions), this process appearing after the *ruki*-rule. Similarly, the cluster **ǵ^{h}s* was replaced by a newly created *ǰž*. Both fricative clusters were assimilated later as fully sibilant clusters, and finally, the first member was elided. The Iranian state is then innovative, and the Indic state is archaic.

Note: The Nūristānī development is hard to trace back, but we assume the spirantization of the palatovelars and their later depatalization.

i. ***Ḱ** + **s** > kš > **kṣ**	(Indic)
ii. ***Ḱ** + **s** → çš > šš > **0š/0s**	(Iranian)[63]
iii. ***Ḱ** + **s** → çs > ϑš > tš > ts = **c**	(Nūristānī)
i. ***ǵ^h** + **s** > γz > γž → **kṣ**	(Indic)
ii. ***ǵ^h** + **s** > γz > γž→ ǰž > žž > **0ž**	(Iranian)

Note: OIA *anaḍ-vah-* 'ox' has irregular forms nom. sg. *anaḍvā́n*, dat. pl. *anadúdbhyaḥ* AV loc. pl. *anaḍútsu* without cerebralization. The word is a compound from √*vah-* 'carry' (cf. EWAi I: 69). Wackernagel (1896 I: 180) assumes the dissimilation of a cerebral after a preceding cerebral (*ḍuḍh* > *ḍudh*; *ḍuṭs* > *ḍuts*), but another trajectory could be modelled *çš* > *ϑs* > *ts* and similarly *ǰb^h* (or *ǰβ* with two spirants?) > *δb^h* > *db^h* as with regular development of **Ts* and **dd^h* (see below for details).

2.6.6 The trajectories of clusters *dental + t/s/d^h*

We can surely assume that the processes, attested in the development of clusters of dentals *T/d^h + t/d^h/s*, are of a very ancient origin, at least in their oldest stage of development, since we meet similar processes in other Indo-European branches outside the Indo-Iranian family. Such a wide geographical distribution is a mark of an old process, originating, at least in its first phase, from the Common Indo-European era.

To demonstrate the antiquity of the development of dental clusters, we will turn our attention to the best-attested cluster of *Tt*, since this cluster is very well covered in source languages.

The development of the cluster of *Tt* in IE languages generally has three different outcomes[64] in given branches of the Indo-European languages:

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[62] **Ks* gives *xš* in Iranian, *g^{h}s* gives *gž*, see the section on the development of velars.

[63] The form *0s* is a result of the analogical leveling, seems to be limited on inchoatives.

[64] For simplicity other outcomes such as Arm. *u̯t*, Alb. *0s* and Hittite and Tocharian *t^{s}t$^{(s)}$* are omitted here, cf. given chapters for details.

i. the cluster is preserved as *tt* (OIA being the sole example);
ii. the left dental is sibilantized, the right *t* is preserved: *st* (e.g., in Iranian, Slavic, Baltic, Greek);
iii. the whole cluster is sibilantized to *ss* (e.g., in Italic languages, Celtic languages, Germanic languages).

The model trajectory of this development was first proposed by Kräuter (1877: 88) and accepted especially by the most influential authority of the era, Brugmann (1880: 140–142; 1886: 347; Brugmann 1896 Ib: 624) and it has been generally accepted since (cf. Kent 1932a; Burrow 1955: 90; Hill 2003: esp. 3–7; Kobayashi 2004: 37–38 etc.).

For the cluster of *Tt* we can arrange this trajectory of development, where three outcomes are equated to stages of such a development:

		i.		ii.		iii.
Tt	>	tt	>	st	>	ss

Within this model trajectory, OIA would represent the oldest phase, equal to the assumed early IE state; Iranian, etc., the second phase; Italic, etc., the third phase of a single development.

Note: Since the development _*tt_ > _*ss_ does not appear in Indo-Iranian languages, we will pay no attention to this development here, though we accept fully the fact that this outcome is related to the development of _*tt_ > _*st_, making its final stage.

The confusing fact is that though the Iranian development fits perfectly into the frame of a rightfully old process, the Indian development seems to be an exception to this antiquity, since cluster of *Tt* is in OIA always realized as *tt*, not as *st* as in Iranian (cf. OIA *sattá-* vs. Av. *hasta-* < _*satta-_). This unique feature of Old Indo-Aryan, its confusing and apparent exception from the process otherwise affecting otherwise all Indo-European languages, is a puzzle with at least two possible solutions: either the Indic state is an archaism (i.e., OIA was never affected by the sibilantization of the left dental plosive or any possible preceding process) or the Indic state is an innovation, in fact, a re-archaization of the same process we meet in Iranian and elsewhere.

Accepting the model assuming the archaicity of the Indic state, we would face a problem: the current models generally accept the original unity of Indic and Iranian proto-languages in a Common Indo-Iranian and for good reasons, and since both branches so strictly differ in the preserving/innovation of such old feature as is (non)sibilatization of left dentals, it is hard to accept the existence of the Common Indo-Iranian, though this common stage could be safely reconstructed in many counter-examples. The single solution could be accepting that Iranian development appeared after the split of both branches (the details of the Nūristānī development are covered by too many eons to build any theory on it), but since all other IE branches are subjected to the same development, it is hard to imagine that the sibilantization of dentals affected all IE languages after the split of the whole Indo-Iranian branch off the IE continuum. That the Indo-Aryan state is a 're-archaization' is for these reasons the prevailing opinion (cf. Brugmann 1880: 140–142; Brugmann 1886: 347, etc.; Wackernagel 1978: 177–178; MacDonell 1910: 35; Leumann 1942: 13; Burrow 1955: 90 etc.).

However, if accepting that the fricativization of dentals already was, at least in its early stage, a regular process in the IE stage, before the split of the Indo-Iranian branch, we have to explain:

i. how the seemingly archaic state in Indo-Aryan has arisen from the more progressive state;
ii. whether we can trace this assumed older progressive stage in OIA, i.e., an internal proof of the older fricativization phase;
iii. whether we can harmonize it with existing sibilantization preserved in Iranian[65].

The authors assuming the 'archaization' of OIA who are trying to find an internal proof of the older 'fricative' stage in OIA are primarily focused on the developments of clusters of dental plosive + d^h in OIA, since they result either regularly in dd^h (cf. √*ad-* 'eat': *addhí*; √*vid-* 'find': *viddhí*) or exceptionally in $i̯d^h$[66] (cf. √*budh-* 'wake': *bodhí*; √*yudh-* 'fight': *yódhi*; √*dhā-* 'put': *dhehí*). It is noteworthy is that from the root √*dā-* 'give' we have both forms: *dehí* and *daddhí*,[67] and also remarkable that all 'problematic' outcomes are results of the clustering with -d^h, but clusters of d^h+t (according to Bartholomae's law) result in regular dd^h (cf. √*yudh-* 'fight': *yuddhá-*, *yuddhvī́*; √*idh-* 'kindle': *inddhé, iddhá-*; √*budh-* 'wake': *buddhá-*). This feature is striking, especially since √*yudh-* and √*budh-* have in that way clearly distinguished outcomes of two different clusters. This is in accord with the distinction between clusters of $ǵ^ht$ and $Ḱd^h$ in OIA, the first resulting in $0ḍ^h$, the second in $ḍḍ^h$ (cf. above, it is interesting that the cluster of $ǵ^hd^h$ realizes in accordance with $ǵ^ht$, as far as we can judge from a single example). In contrast, the OIA clusters of g^ht and Kd^h are both realized by gd^h, for OIA clusters of b^ht and Pd^h we have bd^h attested only for b^ht (cf. above). Also note that in Avestan, the outcomes of clusters of d^ht, td^h and d^hd^h are always *zd*.[68]

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[65] The Nūristānī, having the outcome *0t* is left aside for a moment once again.
[66] The *i̯* marks the approximant, causing the lengthening or the diphtongization of the preceding vowel.
[67] Note that roots with an infix have forms -nd^h-: √*ud-* 'wet": *undhí*; √*idh-* 'kindle": *indhvám,* but here we can assume either the simplification of -ndd^h- on -nd^h- or the simplification -ndd^h- > -nzd^h- > -nd^h-, the former process is more straightforward and in the accordance to the Ockham's razor.
[68] Old Persian and Nūristānī data are not numerous enough for any persuasive statements based on them.

Note: Jasanoff (2002) does not connect *yódhi* and *bódhi* to original -*dd*^{h}- at all, but assumes them the analogical formations based on the form *jóṣi*; hence both forms would be a product of the morphological reanalysis, not of any regular phonemic development. This would leave *yuddhá*- and *buddhá*- a single and regular **phonemic** outcome of the development of *dd*^{h}.

Wackernagel (1896: 178) considers *dehí* and *daddhí* both from **az* and compares to Av. *dazdi*: he assumes a similar process for *dhehí* (though **d*^{h}*add*^{h}*í* is not attested). Wackernagel's opinion is generally accepted (cf. Meillet 1922: 59; Burrow 1955: 89–90; Renou 1996: 21–22; Görtzen 1998: 313–315). Marsh (1941: 45–46) has considered both forms to be rather *sigmatic aorists* (i.e., forms †*d*^{h}*asd*^{h}*i*, †*dasd*^{h}*i*), not presents. Hoffmann (1956: 21) explained the forms *dehí* and *dhéhi* as results of the dissimilation of original **dadd*^{h}*i*/*d*^{h}*add*^{h}*i* (cf. Lubotsky 1995: 10, who presumes further dissimilations to attested forms). Insler (1972: 551–565) discusses some irregular imperatives ending on -*d*^{h}*i* (for us *yódhi*, *bodhí, randhí* are relevant); he explains *yódhi* and *bódhi* as secondarily formed based on subjunctives, *randhí* as a result of the analogy of the assumed original **randha* to the *d*^{h}*i*-imperatives. Tedesco (1968: 1–24) considers *dehí* and *dhehí* to be 'redactional substitutions for older Ved. **dād*^{h}*í,* **d*^{h}*ād*^{h}*í*', taken from Middle Indo-Aryan[69], as a regular counterpart of YAv. *dazdi* he accepts just *daddhí*, the mechanism he assumes is the 'regularization' derived from the reduced grades **did*^{h}*í,* **d*^{h}*id*^{h}*í*. Insler (1975: 4–5) takes Tedesco's opinion as highly probable, but he presumes that the *e*-vocalization has come due to the analogy to the MIA optatives *deyā*- and *dheyā*-. Pisani (1976: 166) connects these forms with Gr. δός and θές, i.e., as **das* and **d*^{h}*as* + *hi*, forming the original cluster of *sd*^{h}, not *dd*^{h}, which is, as Hill (2003: 65) states, phonemically impossible, since both *o* and *ε* are from original vocalized laryngeals. Kobayashi (2004: 90) takes *dehí* and *dhehí* as just examples of a broader process of deocclusion of *d*^{h} after a front vowel. Hill (2003: 65–69) brings a new hypothesis, assuming that *e* is here a result of a regular process of the monophthongization of **ai̯*, he follows Jamison's (1997: 78–79) observation that only exceptionally is this imperative accented and equates OIA *dhehí* vs. YAv. *dazdi* to OIA *neśa*- vs. Av. *nąsa*-. Hill accepts the change of *dd*^{h} to *i̯d*^{h}, without changes *dd*^{h} > *d*^{z}*d*^{h} > *zd*^{h}, i.e., he assumes the lenition of the original root-initial.

[69] The Pāli forms like *demi, desi, deti, dema, detha, denti* (Fahs 1989: 285) are results of a different process than the process leaning towards OIA *dehi* since aforementioned Pāli forms arose from the stem *dā-y(a)-*, contracted in MIA. The resulting single paradigm is the result of a later merging of stems of different origins. Similarly Pāli *-dheti*, etc., have arisen (Fahs 1989: 136, 291); the original *y*-suffix is preserved in Pāli *dhāyati* without contraction. The *ya*-suffix is preserved for √*dā*- in *dajjati* (= *da-d-ya*-). That these forms have nothing common with the reduplicated stems could demonstrate the root √*ṭhā*- 'stand" (cf. OIA √*sthā*-), which has the reduplicated form *tiṭṭhasi*, athematic root form -*ṭhāti* and *ya*-form -*ṭheti* (besides -*ṭhāyāmi*). Fahs (1989: 137) considers *deti* as a result of analogy to *dehi*, but his solution seems to be too complicated.

Any proposed trajectory for the development of the Indo-Iranian clusters of *T/*d^h + *t/*d^h*/s* has especially to set forth:

i. both the ‘preservation’ (or ‘restitution’) of the left dental in Indic and its transformation to a sibilant in Iranian (as in all other IE branches);
ii. the variation *d ~ 0* (*i̯, u̯* in given cases) before d^h- in Indian;
iii. the loss of a dental plosive in Iranian before *s*- and the preservation of the plosive in the same context in Indic.

Generally speaking, there could be more than one possible trajectory; at the moment, there are two of them, though both have the same incomes and the same outcomes.

The first trajectory we can term the trajectory of ***affricativization*** since it assumes the affricativization of the left plosive in its first phase and the subsequent fricativization of the first member, generally due to the loss of the plosive segment of the affricate. The trajectory was expressed first by Kräuter (1877: 88)[70] and popularized by Brugmann (firstly 1880: 140–142, used since), for Indo-Aryan we have to mention especially seminal works by Johansson (1903 and 1906). The disadvantage of this theory was expressed by Hill (2003: 4), who points out the supposed and very problematic long lifespan of the t^st stage (he expressly mentions the forming of the Germanic weak preterite). The approach by Hammerich (1955: 127–128), who assumes a later development of the dental clusters in the later phases of given branches/languages is too overstated and without solid proofs. The existence of the affricate stage in Indo-European is supported by Anatolian data, since Hitt. 3rd sg. preterite <*e-iz-ta*> and 3rd sg. imperative <*e-iz-du*> from √H_1ed- ‘eat’ shows the affricate form (probably first already noted by Götze 1928: 126; but put in the spotlight first by Sturtevant 1933a: 6–7 and Sturtevant 1933b: 129; later especially cf. Oettinger 1979: 530–532 and Melchert 1994: 113, 151, 249).

The development in Iranian according to the *affricativization trajectory for the original cluster resulting from T + t is regular like that of Balto-Slavic or Greek:* ***Tt*** > t^st > ***st***. The Indic development could be described in two possible trajectories: either we can assume the ‘archaic’ development without any change at all (***Tt*** > ***tt***) or we can presume a more complicated model, where the outcome *tt* is the result of a further process, following the common trajectory: ***Tt*** > t^st > *st* > ***tt***. Schematically expressed both trajectories would be:

i. T + t > t^st > st > **tt** (Indic)
ii. T + t > t^st > **st** (Iranian)

[70] It is interesting that Kräuter speaks about affricativization, but his *description* of the feature is that of a *spirantization*! Verner (1878: 341–342) has a critical evaluation of the idea.

Note: The Nūristānī outcome is *0t,* which could be probably traced to the same trajectory as in Indian, but with a further simplification of the geminate: *tt* > *0t*, similarly to the simplification of geminates in Indic (Late Middle Indo-Aryan). A similar process is assumed for clusters of **Pt* and **Kt* in Nūristānī (cf. above). A variant trajectory ('Iranian') following *st* > *ht* > *0t* seems not to be probably since clusters of sibilant + plosive are preserved in Nūristānī.

Note: Though the trajectory for the above mentioned third group of languages with the sibilantization of the whole cluster (Italic, Celtic, Germanic) is of no direct relationship to the development of Indo-Iranian languages, we can model the trajectory of the development, according to the affricativization theory as: $Tt > t^st > ts > ss$ just to present the whole context of the development (cf. especially Hammerich 1955: 127–128, but already Schwyzer 1934: 234–335).

Clusters from original $d^h + t$ are subjected to Bartholomae's Law, their outcome in Indic being dd^h and *zd* in Iranian. According to the traditional affricativization model, the trajectory should be modelled as:

i. $d^h + t > d^zd^h > zd^h >$ $\mathbf{dd^h}$ (Indic)
ii. $d^h + t > d^zd^h >$ **zd** (Iranian)

Note: There is no secure example of the development of the cluster of d^ht in Nūristānī.

Note: Old Persian has a regular, analogy based, leveling of clusters of d^ht to *st*, i.e., there is no Bartholomae's Law working with this cluster; cf. OP. *basta-* from √*band-* 'bind'.

As noted above, the outcomes of clusters of *Td^h and *d^hd^h are both $\underset{^}{i}d^h$ in Indic, but *zd* in Iranian. The Iranian outcome is same as for the development of clusters of *d^ht, in contrast to the Indic development (probably requiring the change $zd^h > \underset{^}{i}d^h$ in the Indic development for clusters resulting $\underset{^}{i}d^h$; cf. Götzen 331–315):

i. $T + d^h > d^zd^h > zd^h >$ $\mathbf{dd^h}$ (major) (Indic)
$zd^h >$ $\mathbf{\underset{^}{i}d^h}$ (minor)
ii. $d^h + d^h > d^zd^h >$ **zd** (Iranian)

i. $d^h + d^h > d^zd^h >$ $\mathbf{\underset{^}{i}d^h}$ (Indic)
ii. $d^h + d^h > d^zd^h >$ **zd** (Iranian)

Note: As far as we can state from a single attested example, Old Persian has the same development as Avestan for the cluster a regular outcome *zd* for the cluster of td^h (resulting from the dominance of the right plosive). There are no reliable data for this development attested in Nūristānī.

Now we have to turn our attention to clusters with a sibilant in the right position, either *T* + *s* or $d^h + s$.

According to the affricativization trajectory, the trajectory for the cluster of *Ts* requires the affricativization of a left plosive[71], followed by a simplification to a diphthong and with a subsequent elision of one sibilant in Indic (or a simple preservation of a plosive is more

[71] The clusters *affricate* + *s* are typologically possible (cf. Old Czech *čsti* 'of honour", later simplified on *cti*).

probable?), but a sibilantization and subsequent elimination of sibilants to a single one in Iranian.

i. **T** + **s** > t^ss > **ts** (Indic)
ii. **T** + **s** > t^ss > ss > **0s** (Iranian)

Note: The affricate is preserved in Nūristānī, with the sibilant segment of the affricate merged with the original sibilant, forming a final affricate (cf. Lipp 2009a: 169). For Nūristānī we could reconstruct a trajectory: T + s > t^ss > ts > ċ, but based on a single example of Kati *macī* 'fish' (OIA *matsya-*, YAv. *masiia-*; cf. Lipp 2009a: 169), we cannot rule out a secondary palatalization due to the following palatal approximant; cf. Pāli, Pkt. *maccha-* (Turner 1966: 560).

Similarly, the affricativization trajectory could be modelled for the cluster of D^hs. The Indic state has no traces of Bartholomae's law, being replaced by the same analogical forms as for *Ts*. Nūristānī and Old Persian have no useful data, hence our reconstruction relies heavy on Avestan, again with the affricativization of the plosive, sibilantization of the affricate and simplifying of the whole cluster as *0z* (cf. Lipp 2009a: 169):

i. $\mathbf{d^h}$ + **s** > d^zz → **ts** (Indic)
ii. $\mathbf{d^h}$ + **s** > d^zz > zz > **0z** (Iranian)

The typical feature of the development of clusters dental plosive + *s* in Indo-Iranian is then a simplification of the sibilant segment of the affricate with a following sibilant in Indic, but sibilantization (and following simplification) of the cluster in Iranian.

The affricativization model requires, to explain the Indic development, a loss on the sibilant segment between two plosives; cf. t^st > OIA *tt*, d^zd^h > OIA dd^h.[72] Such a process is well attested for Indic development, but it is not a proof of the validity of the affricativization model, since such a loss is attested for all clusters formed by the sequence: plosive–sibilant–plosive, since such sequences have two full stops of the airflow, interrupted by a momentous opening (which causes a change of sonority), which could be expressed schematically by a letter **M**. Such a cluster is articulatory complicated and the elision of the sibilant forms much simpler clusters of two plosives, schematically: **II**. We meet such alternation in examples like those of the sigmatic aorist: *patthās* AV (< *-d-s-*t^h, √*pad-* 'fly'); *ácchānta* (< *d-s-t*, √*chand-* 'seem'); *ábhakta* (< *-j-s-t*, √*bhaj-* 'eat'), *ápṛkta* (< *c-s-t*, √*pṛc-* 'mix'), *árabdha* (< d^h*-s-t*, √*rabh-* 'grasp' etc., It is known from other formations with *s* between two plosives; cf. ppp. *-gdha* TS. < gsd^h < g^h*s-t-*[73] (√*ghas-* 'eat'). Cf. Brugmann 1880: 140–142; Wackernagel 1896 I: 76, 131, 269;

[72] Besides, if we assume the trajectoryt^ss > OIA *ts*, but it is hard to be sure that the middle obstruent is lost and not the last one.
[73] Note Bartholomae's law working over the sibilant.

Johansson 1903; Johansson 1009; Meillet 1922: 59; Kent 1932a: 24; Kent 1936: 241; Görtzen 1998: 308, 312–313, 317; Hill 2003: 4).

Another possible trajectory we propose is not based on the affricativization of the left dental plosive, but on its spirantization, assuming that the original spirantization had already appeared in Late Indo-European and that further developments (sibilantization in Iranian and re-occluvisation in Indic) appeared independently later in further stages.

The **spirantization trajectory** was already first proposed for Indo-Iranian by Bartholomae (1895: 16), who assumed $*Tt > \vartheta t$ and $*Td^h/*d^ht > \delta d^{(h)}$. The process is taken as a possibility by Leumann (1942: 13). It is worth noting that Brugmann in one of the early versions of his affricativization model (1886: 347) states that 'Wir schreiben $t^st(h)$ und $d^zd(h)$ und geben gerne zu, dass vielleicht richtiger $t^þt(h)$ und $d^đd(h)$ gesetzt würde.' Morgenstierne (1942: 80) proposes $*\vartheta t$ as an intermediate stage for Early Iranian (t^st being reconstructed for the common Indo-Iranian period, but *tt* for the common Indo-European).

To sum up the outcomes, we assume that *T* was first spirantized as *ϑ* before *t*- or *s*- but as *δ* before original d^h (also which turned δ), according to the Bartholomae's Law. The clusters of $*Td^h$ and $*d^hd^h$ were also realized as *δδ*. The cluster of $*d^hs$ would realize as *δz*.

Note: Alternatively, there appeared, in all cases, just the spirantization of the first plosive, and d^h- is preserved in the right position (d^h-context). However, the model would be too complicated, especially since we assume that *δ* was always just an allophone to d^h; hence we will use cluster of *δδ*, though readers can substitute it with δd^h, if it is more convenient for them.

Summing up the whole development of the early Indo-Iranian clusters, the model of spirantization could be represented as follows:

	t-	d^h-	s-
-T	ϑt	δδ	ϑs
$-d^h$	δδ	δδ	δz

In the following development in later stages, the Iranian spirants generally underwent a sibilantization, and the sibilants were preserved before plosives. The Indic development was more complicated: the voiceless spirants were fortitied into plosives in the left position, the voiced spirant was fortified on *d* in the left position in clusters of d^ht, but on d^h in the right position, since *δ* was always only a positional allophone of d^h (*addhí*, *viddhí*, *daddhí*, *yuddhvī́*, *inddhé*[74], *buddhá*-). In some cases, the *δδ* cluster underwent a lenition to *i̯δ/i̯d^h^* (cf. Hill 2003: 68 and more below). In this case the sonant approximant formed a diphthong with a preceding vowel (*dehí, dhehí*), or was lost (*bodhí, yodhí*, *indhvám*), as we have already stated above, though the causes of the split could only be expressed by means of a sound law with difficulty, it is noteworthy that Td^h could be both realized as dd^h (a major trajectory; cf. *daddhí*) or as $0d^h$ (a minor trajectory; cf. *dehí*), all clusters of d^hd^h are realized as $0d^h$. However, both the minor and the major trajectories can be modelled on similar grounds, without the sibilant grade in the Indo-Iranian stage as an intermediate state.

The trajectories of development according to the spirantization model for given Indo-Iranian branches could be modelled for the original clusters resulting from *T* + *t* the trajectories in both branches as:

i. **T + t** > ϑt > **tt**	(Indic)
ii. **T + t** > ϑt > **st**	(Iranian)
iii. **T + t** > ϑt > tt > **0t**	(Nūristānī)

Note: As has been already stated above, the Nūristānī development is similar in its outcome to that of **Kt*, **Pt*, with the outcome being simple *0t*. It has to be noted that original cluster of **st* is preserved with a sibilant in Nūristānī, as are *št* clusters both from **št* or **ḱt*, hence the outcome is not a product of a later elision of a sibilant in such clusters (for original **st* cf. Kati *dušt*, Waigali *došt*, Ashkun *dōšt* 'hand' vs. OIA *hastá*-, Av. *zasta*, OP. *dasta*-; for original **št*: Kat. *uṣṭ*, Waigali *ūṣṭ*, Ashkun *ōṣt* 'mouth' vs. OIA *óṣṭha*-, Av. *aošta,* 'mouth'; for original **Ḱt* cf. Kati. *uṣṭ*, Waigali *oṣṭ*, Ashkun *ōṣt* 'eight' vs. OIA *aṣṭáu*, Av. *ašta,* 'eight). The simplest solution seems to accept the Old, Middle and Early New Indic development of the same clusters: spirantization of the first *T*, re-plosivation as *tt* followed by a later simplification of geminates (cf. MIA *satta* > Hindi, Marathi *sāt*; cf. Bloch 1965: 93–96; Masica 1991: 187–188). In contrast with NIA, there are no signs of the compensatory lengthening in Nūristānī.

For clusters resulting from $d^h + t$, according to Bartholomae's Law, the trajectories will be:

i. $\mathbf{d^h + t}$ > δδ > $\mathbf{dd^h}$	(Indic)
ii. $\mathbf{d^h + t}$ > δδ > **zd**	(Iranian)

Note: There are no data on which the Nūristānī development could be based, as we also lack them for clusters of d^ht and d^hd^h.

The development of the clusters from original $T + d^h$ is similar to the preceding, but with a variation in the Indic development. The major development is the same for clusters of d^ht, the minor as for clusters of d^hd^h, Iranian sibilantization being a regular development:

i. $\mathbf{T + d^h}$ > δδ > $\mathbf{dd^h}$	(major)	(Indic)
> $\mathbf{i̯d^h}$	(minor)	
ii. $\mathbf{T + d^h}$ > δδ > **zd**		(Iranian)

[74] But some forms of imperatives from this root have a single plosive: *indhvám*, *indhā́m* (cf. MacDonell 1916: 371).

Moreover, the development for clusters from d^h + d^h could be modelled, with an approximant arising from the left spirant in Indic, the Iranian sibilantization being also a regular development:

i. **d^h + d^h** > δδ > **i̯d^h** (Indic)
ii. **d^h + d^h** > δδ > **zd** (Iranian)

Data seems to lead us towards a projection that clusters of *d^ht* in Indic always realized as first as *δδ* and preserved as such till the re-plosivation as *dd^h*, in contrast with clusters of *d^hd^h*, realized first as *i̯δ* and later as *i̯d^h*, the distinction probably based on morphemic reasons, not phonemic. The 'mixed' realization of *Td^h* is probably a result of analogy, the original state being hard to determinate.

We assume spirantization even for clusters of dental plosive + *s* in similar lines.

The cluster of *Ts* is preserved in Indic, or better, the initial spirant was later re-occlusivised;
in Iranian, the spirant was first assimilated to a sibilant, and the subsequent geminate was later simplified to a simple *0s*.

Note: In Nūristānī, the cluster is preserved as an affricate, but this development is not principally different from the Indic development:

i. **T** + **s** > ϑs > **ts** (Indic)
ii. **T** + **s** > ϑs > ss > **0s** (Iranian)
iii. **T** + **s** > ϑs > ts > **c** (Nūristānī)

The cluster of *d^hs* underwent an analogical leveling in Indic. The Iranian clusters developed similarly to *Ts* clusters, i.e., through a spirantization, a sibilantization and finally simplification

i. **d^h** + **s** > δz (→ **ts)** (Indic)
ii. **d^h** + **s** > δz > zz > **0z** (Iranian)

Note: There are no secure examples for the Nūristānī development of clusters *Ts* and *d^hs*.

The Iranian process of elision (or simplification of the geminate) for both clusters of *Ts* and *d^hs* has to be a late process, since otherwise, a newly intervocalic *VsV* would have to regularly become *VhV* in Iranian: at least clusters of *VssV* had to exist before the debuccalization of Iranian intervocalic *s* into *h* (cf. OIA *sapta-* vs Av. *hapta-* < Indo-Iranian **sapta-* 'seven'; OIA *sácate* vs. YAv. *hacaitē̆* < Indo-Iranian *√*sac-* 'accompany, follow'; OIA *siñcáti* vs. YAv. *hiṇcaiti* < Indo-Iranian *√*sai̯c-* 'pour'). From the logic of the development, it is clear that the debuccalization of Iranian *VsV* to *VhV* had to appear before the transformation of *VśV* to *VsV* (otherwise the debuccalization would affect even the sibilants from the original palatovelars).

Generally speaking, since Iranian clusters of *st/zd* are not affected by the *ruki*-rule, this proves that the final transition either from the first phase to the sibilant phase had to appear after the application of Pedersen's Law. Even the Indic clusters from *dd^h* resulting in *i̯d^h* were not transformed due to the *ruki*-rule (in contrast to those arising from *ǵd^h*; cf. above and ff. Brugmann 1987: 637; Meillet 1922: 60).

Note: The singular Nūristānī example of *ṛ* from **d^ht* (Ashkun *būṛə* 'mind, spirit', Waigali *buṛā́*, *buṛṓk* 'meaning, intent' (< **būḍhi* < **būṣḍhi* < **b^hudᶻdhi* < **b^hud^h-ti*; cf. Turner 1964; Turner 1966: 525; Hill 2003: 44–45) is probably a result of an analogy based leveling, not a counter-argument (cf. Budruss 1977: 24; Görtzen 1998: 310–312).

2.6.7 The trajectories of clusters *sibilant + t/s/d^h*

Historically there are only two sibilants (*S*)[75] in Indo-Iranian, each with two positional allophones:

i. the primary sibilant, the old Indo-European **s* (with its positional variant **z* before voiced plosives);
ii. the secondary sibilant **š* (with its positional variant **ž* before voiced plosives), arising from the primary sibilant due to Pedersen's Law (*ruki*-rule).

The development of clusters of *S + t* is simple; all clusters are preserved, except for the subsequent cerebralization in Indic and Nūristānī of the clusters of *št*, which is a regular process:

i. **s** + **t** > **st**	(Indic)
ii. **s** + **t** > **st**	(Iranian)
iii. **s** + **t** > **st**	(Nūristānī)
i. **š** + **t** > št > **ṣṭ**	(Indic)
ii. **š** + **t** > **št**	(Iranian)
iii. **š** + **t** > **ṣṭ/0ṭ**	(Nūristānī)

Note: The twofold outcome of the cluster of **št* in Nūristānī could be a result of original dialectal Nūristānī developments and probably of the later dialect mixing. While Nūristānī *ṣṭ* would be a direct descendant of **št*, Nūristānī *0ṭ* could be a result of the gemination *št* > *ṣṭ* > *ṭṭ*, similar to the Middle Indo-Aryan development, with a later simplification of the geminate to *0ṭ*. The presence of both outcomes in Kati, Waigali could be a result of a secondary mixing of dialects originally differing either by *ṣṭ* or *0ṭ* during the history of the Nūristānī language area.

The trajectory of clusters of *S + d^h* is far more interesting and less trivial in its development than the previous development of the clusters of *St*, since the sibilant voiced allophones were

[75] The sibilants which arose from original palatovelars we treat as plosives, especially since their sibilant form is probably an outcome of later developments, as we demonstrated above.

later regularly lost in Indic, though preserved in Iranian (the Nūristānī data are scarce and data unreliable and doubtful).

Generally, the model assumes the voicing of the original sibilants before *d^h-, which is fully proportional to the development of the clusters of *T* + d^h, as described above, with the dominance of the right element. The Iranian developments fully follow these lines, but the dental plosive was later deaspirated, as is a general rule of Iranian development. For the development in Indic, we have to assume a far more complex trajectory, according to known outcomes. The outcomes are two: the first is a *moraic lengthening* of the preceding vowel, either by newly created vowel length (cf. OIA *tāḍhí* < √*takṣ*- + d^hi; the process is 'invisible' on roots with the inherent length of a root: OIA *ā́dhvam* < √*ās*- 'sit' + d^hvam; *śādhí* < √*śās*- 'order' + d^hi) or by its diphthongization (cf. OIA *edhí* < √*as*- 'be' + d^hi); cf. a similar process with the development of clusters with palatovelars above. Both variants of the development could be traced through a lost approximant since both the lengthening and the diphthongization could be explained through this approximant. The second outcome is a *fortition* of a sibilant to a plosive, either dental (for an original dental sibilant) or cerebral (for an original palatal, later cerebral, sibilant); cf. OIA *vaddhvam* S. < √*vas*- 'dwell', *vidiḍḍhi* < √*viṣ*- 'be active' + d^hi. However, these processes are parallel to the development of original palatovelars in the same context; cf. above. The transition of palatal clusters to cerebral is essentially the same. The trajectories we reconstruct as follows:

i. **s** + **d**$^{\mathbf{h}}$ > zδ > **i̯d**$^{\mathbf{h}}$	(major)	(Indic)
> **dd**$^{\mathbf{h}}$	(minor)	
ii. **s** + **d**$^{\mathbf{h}}$ > zδ > **zd**		(Iranian)

Note: There is no attested example for the cluster of *sd^h in Nūristānī.

i. **š** + **d**$^{\mathbf{h}}$ > žδ > žd^h > ẓḍ^h > **i̯ḍ**$^{\mathbf{h}}$	(major)	(Indic)
> ḍḍ$^{\mathbf{h}}$	(minor)	
ii. **š** + **d**$^{\mathbf{h}}$ > žδ > **žd**		(Iranian)
iii. **š** + **d**$^{\mathbf{h}}$ > žδ > **žd**$^{\mathbf{(h)}}$ > **ẓḍ/0ḍ/0ṛ**		(Nūristānī)

Note: The data for the Nūristānī development are scarce (cf. Morgenstierne 1926: 61), but it seems that they also, in general features, follow a similar development as Indic did, both in the older and younger development. The 'mixed' outcomes could be a consequence for the dialect confusion in the later history of Nūristānī.

Alternatively, we can model a spirant intermediate stage, either dental or cerebral, between both sibilant and plosive stages for Indic development. The spirant inter-stage would easily explain the transformation of a sibilant to a plosive (a two-step process instead of a single step), but alternatively, the spirant could be a subject of a further lenition and turned into an approximant, which, when elided, would either cause a relict lengthening or be preserved as a part of an unetymological diphthong. The trajectory would then be, in both variants for both sibilants:

LENITION		RE-PLOSIVATION
s + $\mathbf{d^h}$ > zδ > δδ > **i̯**$\mathbf{d^h}$	~	***s** + $\mathbf{d^h}$ > zδ > δδ > **d**$\mathbf{d^h}$
š + $\mathbf{d^h}$ > žδ > δ̣δ̣ > **i̯ḍ**$\mathbf{^h}$	~	***š** + $\mathbf{d^h}$ > žδ > δ̣δ̣ > **ḍḍ**$\mathbf{^h}$

Extremely intricate developments are met with clusters of *s* + *s* and *š* + *s*, which in Indic result in plosive + sibilant (*ts*, *kṣ*) clusters, but in Iranian as *0s/0š* (no secure data are known for Nūristānī).

The Iranian development is easy to model. We can only assume that the geminate was later simplified to a single sibilant, or alternatively the first sibilant underwent lenition to *h* and then it underwent an elision. However, we should keep in mind that the palatal sibilant in *0š* is a result of an earlier assimilation of **šs* to **šš* and that the simplification had to appear relatively later, since intervocalic *-s-* underwent the change to *-h-*, but this process did not affect the dental sibilant from the original geminate.

The Indic development was more complicated than that of Iranian and Lipp (2009a: 213–214) correctly relates it to the development of *Ḱs* clusters. The trajectory he reconstructs for the cluster of **šš* in Indic is: *šs* > *šš* > *ṭṣ* (Lipp 2009a: 213) and for the cluster of **ss* as: *ss* > *ts* (Lipp 2009a: 214).

Note: A special attention could be paid to clusters of **ss* and **šš* of *s*-stems:

i. The OIA *as*-stems end in nom. sg. with *-as#*, realized primarily as *ḥ* for an original **-s* (one sibilant is lost; cf. *-māḥ* 'moon', *ájňāḥ*, *ápaḥ* 'water' etc.,), Av. *ah*-stems are realized as *-ā̊0#* < Ir. **-ah#* < IIr. **-s(s)#* in nom. sg. (cf. OAv. *ušā̊* 'dawn' etc.,) and OP. *ah-* stems are realized as *-ā* in nom. sg. (cf. OP *tauviyah-* 'stronger').
ii. The clusters of loc. pl. of *as*-stems are realized in Vedic as *-ss-* or *-s-*: OIA *mássu* (but *másu* TS), *apsarássu, áṃhassu* AV (but *áṃhasu* in mss.), *rájassu*, *vákṣassu* etc., but *ápasu* (cf. MacDonell 1910: 221, 223; Wackernagel I: 111); the geminate is probably a restoration due to analogy with other stems. Avestan has -*ahu*(*ua*), with a single phoneme: YAv. *ą̇zahu*, *rauōhu*, *raucōhuua*, *ušahuua* (Hoffmann/Forsman 1996: 154, 156).
iii. Similarly, clusters of **šš#* (arising due to the *ruki*-rule) are realized in Vedic as *-ṭ* if from a radical stem (cf. *dvíṭ* 'hatred') but as *-ḥ#* representing the original **-š* (again, one sibilant was lost; cf. OIA *áhaviḥ* 'not offering oblations', *-jyotiḥ* 'shining' etc.,). In Av. and OP such clusters are not attested for masculine and feminine.
iv. The clusters of loc. pl. of *uṣ*/*iṣ*-stems are realized in Vedic as *-ṣṣ-* (cf. *havíṣṣu*). The forms of locative pl. are not attested in Vedic, as they are not attested in both Old Iranian languages.

We assume the following trajectory, similar to that of Lipp, but with an intermediate spirantization: the cluster of *ss* merged in Indic with a cluster of *ϑs* (resulting from *Ts* according to the spirantization trajectory) and the cluster *šs* (assimilated later to *šš*) similarly merged with a cluster of *xš* (otherwise arising from the original cluster of *Ḱs*). In both cases, resulting clusters underwent the same later fortition to *ts* for the original cluster of *ss*, and to *kš* (> *kṣ*) for the original cluster of *šs* (see above).

i. **s** + **s** > ϑs > **ts** (Indic)
ii. **s** + **s** > hs > **0s** (Iranian)

i. **š** + **s** > šš > xš > kš > **kṣ** (Indic)
ii. **š** + **s** > šš > γš > **0š/0s** (Iranian)

In some cases, the original state with two sibilants is restored due to analogy (*śāssi*). The development of the *ss* clusters in the second sg. from the root √*as-* 'be' in Indo-Iranian is different. In Old Indo-Aryan, we meet *ási*, in Avestan *ahi* (< **asi*); both forms require an older simplification of a geminate *ss* to *0s*. This process is probably already Indo-European, since we meet Gr. εἶ (< **esi*), OLith. *esi*, OCS *jesi* also without a geminate, and forms with geminates such as Gr. Hom./Dor. ἐσσί and L. *ess* (Plautus) are probably not archaisms, but results of the later morphemic leveling (cf. Mayrhofer 1986: 120–121). This is the reason why this morphologically affected *ss* cluster has developed differently from other such clusters.

The transition of the original dental plosive to a sibilant had to be younger than the effect of Pedersen's Law (the *ruki*-rule) on a sibilant since Iranian *st*/*zd* from original *tt/dd*^{h} was not affected by the *ruki*-rule (cf. Hill 2003: 45–46).

2.7 Conclusions and final remarks

The development of clusters formed by any left-standing obstruent in the contexts of the right standing *t/d*^{h}*/s-* could be split into minor blocks based either on the context of the right obstruent, but also into blocks according to the centrality or peripherality of the given series. The block of sibilants stands independently then, since its existence is based not on location but on its sonority (sibilants vs. plosives of other blocks). The blocks we have recognized are:

i. the **central** (or **acute**) block formed by the dental and by the palatovelar series;
ii. the **peripheral** (**grave**) block, formed by the labial and velar/palatal series;
iii. the **sibilant** block, containing both sibilants, the old dental one, and the palatal one, a result of the *ruki*-rule.

The perpendicular process affecting all three blocks in the Indo-Iranian languages is Bartholomae's Law, which causes the transition of cluster of voiced aspirated plosives (D^h) + *t* to DD^h (usually merging in this way the outcome of the process with outcomes of processes D^h+d^h and T+d^h) and of voiced aspirated plosives + *s* to $D^{(h)}z$.

The proposed solution presumes the spirantization of both segments in a cluster (D^h+*t* > *ΔΔ*), and later re-plosivation of both voiced spirants of the cluster on DD^h in Indic, dialectally in Avestan. The spirantization could explain both voicings of the right segment, and the later re-plosivation explains why only the right segment is aspirated in Indian. The voiced spirant is considered an allophone of the given corresponding voiced aspirated plosive D^h, not a phoneme of its own (the voiced spirant in Iranian has also the same value). The development of cluster of D^h+*s* could be modelled, according to the spirantization model, as the spirantization of the plosive, accompanied by the voicing of the sibilant, with later re-plosivation of the left spirant (the sibilant is not affected): D^h+*s* > *ΔZ* > *DZ*. Within this model, there is no need to introduce an intermediate stage †$D^{(h)}z^h$, especially since the existence of the aspirated sibilant it is not attested (though still typologically possible, albeit extremely rare).

The oldest development affected the clusters formed by a dental in the left position. This process is usually modelled as affricativization of the left dental (**the affricativization trajectory**). The opinion can be traced back to Kräuter (1877: 88) and especially to Brugmann (1880 and passim), who established it as a leading model. An alternative trajectory, which we prefer, at least for Indo-Iranian, leads us to spirantization of the left dental; this trajectory can be traced back to Bartholomae (1880) (**the spirantization trajectory**).[76]

The affricativization model assumes the transition of the dental to an affricate and later loss of the sibilant segment of the affricate in Indic, but the loss of the dental segment of the affricate in Iranian (e.g., T^st > In. *Tt*, Ir. *st*; d^zd^h > In. dd^h, Ir. *zd*;). It should be noted that for some Indic clusters resulting from *dd^h we can safely reconstruct the outcome $\underset{\frown}{i}d^h$.

The spirantization explains the (not only) Iranian transition to *st/zd* as a further lenition on the trajectories *t* > *ϑ* > *s* and d^h> *Δ* > *z* , but fits as well into the frame of later Indic developments, since it assumes the fortition of the spirant to plosives, but it even could explain the transition of **δδ* to *$\underset{\frown}{i}d^h$ as a minor process, but still within the frame of a lenition.

The assumed existence of dental spirants in clusters of *ϑs* could explain the otherwise difficult to explain the fortition of **ss* to *ts* in Indic: we assume that the left sibilant in the cluster merged with clusters of **ϑs* (from **ts*) and the resulting *ϑs* was fortified in Indic to *ts* without regard to its origin. In Iranian, the trajectory would be: **ϑs* > *ss* > *0s*/**δz* > *zz* > *0z*.

However, the process of final sibilantization of dentals before a dental plosives + sibilant in Iranian was finished after the operationality of the *ruki*-rule, since such sibilants were not affected by it and the existence of *ϑt* (< **Tt*) and *δδ* (< *$d^ht/d^hd^h/Td^h$) could easily explain why the first segment of such a cluster was never affected by Pedersen's Law: there was no sibilant yet to be subdued by the process, though otherwise the very old one.

76 De Saussure (1877), Cocchia (1883) and Bartholomae himself (1887) assumed this trajectory for Italic development, modelling it as: *Tt* > *ϑt* > *ϑϑ* > *ss*, we will return to this model below.

Note: For the development of the Nūristānī dental series we have to assume the 'Indic' model, which, according to the spirantization model, would be: *Tt > ϑt > tt > 0t*; *Ts > ϑs > ts* (?)[77].

The second oldest development is that of the original palatovelar series. The clusters of *palatovela*r + plosive in the *satəm*-languages result in clusters of sibilant + plosive, Albanian being a single exception (see below).

Though the rise of palatovelars is highly probably a dialectal feature (the *centum* languages were not affected by this process), the process is still ancient.

The rise of palatovelars and their transition to (generally) sibilants was modelled with two different trajectories (similar to those of the development of the analogous clusters with dentals), first being the **affricativization trajectory**, the second the **spirantization trajectory**. According to the affricate trajectory, palatovelars turned to affricates in general and later lost the plosive segment before $t/d^h/s$ both in Indic and Iranian ($Ḱt > t^{š}t > št$; $ǵ^ht > d^{ž}d^h > žd^h$, etc.)

The problematic point of the **affricativization model** is hidden in the Indic development: if the interstage for both of dental and palatovelar series was an affricate (and we have to reconstruct the same state for both branches before the split), why in Indic was it the intermediate sibilant segment with dental clusters but the initial plosive segment with palatovelar clusters that was lost? The Indic development hence has an innate contradiction: the affricate clusters of $t^{s}t$ and $d^{z}d^h$ both lose the sibilant segment of an affricate, but the affricate clusters of $t^{š}t$ and $d^{ž}d^h$ lose the plosive segment of a plosive.

For this reason we prefer the **spirantization model** for the development of both series, hence Indo-Iranian clusters of *ϑt* and *δδ* for dentals and *çt* and *i̯δ* for original palatovelars: the Iranian process would lead towards the sibilantization of both series due to the general lenition of the acute plosives to fricatives; Indian towards the re-plosivation of the dentals (in some cases with a minor lenition to *i̯δ*) and sibilantization for voiceless palatovelars and similarly re-plosivation or lenition for voiced clusters. The Indian development of palatovelars was affected (as was Iranian) by the already existing clusters of *št* and $žd^h$, resulting from original clusters of *st* and zd^h according to Pedersen's Law (*ruki*-rule).

According to the **affricativization model**, the palatovelar clusters with a right-standing sibilant would be realized as $t^{š}s$ and $d^{ž}z$ in Common Indo-Iranian. The Iranian development would first simplify the clusters to *tš/dž* and later *šš/žž*, to finally be degeminated to *0š/0ž*

[77] Since based on single example *macī* 'fish' (OIA *matsya-*, YAv. *masiia-*), we cannot rule out a secondary palatalization due to following palatal, cf. Pāli, Pkt. *maccha-* (Turner 1966: 560).

(analogously to the development of clusters of *Ts* and *d^hs*). The Indic development would be: *$t^š$s/ $d^ž$z > tš/dž > kṣ* (the outcome for *dž* leveled on *tš* due to analogy).

The **spirantization model** assumes the transformations the patalatovelar clusters as: *Ḱs > kš* in Indic (with neutralization of a palatal marker in the neutralization position), but in Iranian with leveling to *çš*, followed by a later sibilantization and simplification to *šš > 0š*, with the development of the original *$ǵ^h$s* as: *ǰž > žž > 0ž*.

Note: For the development of the Nūristānī palatovelar series we model with the spirantization and the sibilantization of the palatovelars, which, according to the spirantization model, would be: *Ḱt > çt > št*; *Ḱs > çš > ϑs > ts* (= *c*).

The development of both series of the peripheral block (i.e., velars and labials) is simpler than that of the central block: the left plosives underwent spirantization in all contexts in Iranian, but plosives are preserved as such in Indic in all contexts. Clusters with originally voiced plosives contained voiced spirants, later re-plosived, according to our model of Bartholomae's Law.

Note: For the development of the Nūristānī clusters, we assume the gemination and later simplification (as with the *Tt*); the model is similar to the development of the Middle Indo-Aryan languages: *Kt/Pt > tt > 0t*.

Note: The existence of clusters of *pt* in Avestan seems to be a result of a later re-archaization specific for Avestan; cf. above.

Both phonemes of the sibilant block are voiceless, and they are not subjected to any alternation before *t*-; the clusters are preserved. Clusters of *Sd^h* have a more complicated development, which are realized as *Zd^h* in Iranian (the simple assimilation of voice), but the sibilant is lost in Indic, being replaced either by a plosive (analogically to clusters of *dentals* or *palatovelars* + *d^h*) or by an approximant (changing a preceding vowel either to a diphthong or lengthening it). Clusters of *sibilant + s* underwent an occlusion to *ts* (with the dental sibilant) and *kṣ* (with the palatal sibilant) in Indian, probably through a spirant intermediate stage; cf. similar development of given series, but in Iranian such clusters were simplified to *0s/0š*, as were clusters with secondary sibilants (from original dentals or palatovelars) + *s*. Again, this process was later than the debuccalization on the intervocalic *s* to *h* in Iranian.

Speaking about general tendencies, the development followed in its earliest phase the **lenition** of both central series in all contexts. If we accept the spirantization model of Bartholomae's Law, the lenition affected even clusters of voiced aspirates + *$t/d^h/s$*, or any plosive + *d^h* of all series. However, this statement is valid both for for the affricate and the spirantization strategy, since both lead from plosives towards sibilants, though even for the late Common Indo-Iranian phase we cannot assume the sibilantization yet (otherwise we would hardly explain the lack of *ruki*-affection on sibilants from dentals and the different outcomes of dentals in Indic and Iranian). The sibilantization (at least of original dentals) is a matter of later dialectal development in Iranian, though the sibilantization of original palatovelars could be already Indo-Iranian since it affected all branches.

The Iranian development followed the **lenition trajectory** even with both peripheral series: the spirantization of velars (of different origin, including palatals) and labials mechanically mirrors the original development of the central series.

The Indian development later abandoned lenition to such extent that even original lenited dentals were re-occlusivized (**the fortition trajectory**). This re-plosivation affected even spirants, which had arisen from original sibilants before sibilants (SS) since even such fricatives turned into being newly created plosives (*ss* > *ϑs* > *ts*, *šs* > *çš* > *kš*). Both grave series, according to the new trajectory, were hence not affected by a spirantization but preserved as plosives.

However, even opposite trajectories share the same feature: the tendency to leveling: Iranian lenited all clusters of our interest, Indic undid most of the lenited clusters, and turned towards fortition. However, in both branches, the structure of clusters was finally more uniform than that in the transition stage of Late Common Indo-Iranian. The leveling in Indic was finished in Middle Indo-Aryan, since all clusters of plosive + *s* or *s* + plosive are leveled on two plosive clusters; cf. Pāli √*sak*- 'can' + *si* = ao. *asakkhi* and √*as*- 'be' + *ti* = pr. *atthi*.

3 The development of the two-obstruent clusters from Indo-European into Baltic

3.0 Baltic languages

Though relatively late attested, the Baltic languages, due to their relatively archaicity, play a relative role in the reconstruction of Indo-European phonology.

Lithuanian, beside older glosses, is attested since 1547 by (Mažvydas' *Catechismvsa*), Latvian securely since 1585 (Casinius' *Catechismus Catholicorum*,[78] Prussian is attested since 14th century (if we accept this age of the *Elbing vocabulary*) until 16th century (three catechisms) (cf. Larson/Bukelskytė-Čepelė 2018).

Note: We will use the term *Prussian* for the same language otherwise named *Old Prussian* since there is no chance to confuse it with German dialects (Low Prussian and High Prussian) in the context we use since we exclusively speak about Baltic languages, not Germanic.

3.1 On the reconstruction of the trajectory of Baltic development

The development of the IE clusters of *plosive + t*, *plosive + d^h*, *plosive + s*, *sibilant + t* and *sibilant + sibilant* in Baltic languages is in its many aspects highly conservative, as the whole phonemic system of Baltic languages often is (cf. Smoczyński 2001: 167–178 for examples of archaicity of Baltic phonemic systems).

Note: This tendency to be phonemically conservative is not shared with the morphemic system, especially that of verbs.

The innovative features of the consonantal phonemes of the Baltic languages are often shared with other *satəm*-languages, and we can list especially:

i. Baltic languages, as all *satəm*-languages, merged original IE labiovelars with plain velars (IE *K*, $K^{u̯}$ > Balt. *K*);
ii. similarly to other *satəm*-languages, again, the reconstructed palatovelars were sibilantized, the new sibilants are preserved as palatal sibilants in Lithuanian, but secondarily depalatalized in other Baltic languages (as they were in Slavic or Iranian);
iii. the original IE **s* changed to **š* according to Pedersen's Law (*ruki*-law), though the contexts and extension of this process are debatable[79]; again this process is well attested in Slavic and Indo-Iranian languages;
iv. the reconstructed IE voiced non-aspirates and voiced aspirates merged into voiced plosives (IE *D*, D^h > Balt. *D*); the process is shared with Iranian and Slavic[80];

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[78] A paradox is that the oldest Lithuanian text is Lutheran and the oldest Latvian Catholic catechisms, contrary to prevailing Christian denominations of the given countries.

[79] See below for clusters *$K^{(u̯)}s$, **Ḱs*, **št*, **šs* and their assumed development in Baltic languages.

[80] Since a similar process also appeared in Celtic, it is probably not a dialectal feature of the *satəm*- or Balto-Slavic languages but a universal phenomenon of a common drift (especially since the loss of aspiration affected even Sinhalese, though Indo-Aryan languages usually preserve this feature). The original distinction between both modal classes could be traced due to Winter's Law, which causes the lengthening of vowels before original IE voiced non-aspirated plosives (Winter 1976; Kortlandt 1978c; Kortlandt 1978d; Kortlandt 1985a; Korlandt 1985b; Kortlandt assumes the original glottal nature of IE voiced non-aspirates; cf. also Sukač 2013, here an especially detailed overview of the given literature; note that Winter 1979 and Winter 2011 reject any glottalic explanations). For similar processes in Latin (Lachmann's Law), Slavic and Tocharian see given chapters.

As a primary source, we use Lithuanian, as a language both well attested (in contrast to Prussian) and phonemically more conservative than Latvian (and Prussian). Latvian and Prussian data will be used below to illustrate the wider state of Baltic languages in the way of commentary on the Lithuanian developments.

3.2 The development of two-obstruent clusters in Lithuanian

In the formation of clusters in Baltic, following tendencies are observed:

i. the final voicedness/voicelessness of the cluster is given by the quality of the right obstruent, there are no signs of Bartholomae's Law;
ii. the two sibilant clusters, either original *Ss* or formed by a palatovelar or dental plosive + *s*, are simplified to *0s/0š*, according to the original left sibilant.

While using Lithuanian, we focused primarily on synchronic alternation (especially those of the verbal system), the ʽliving flesh' of synchronic alternations. The most used forms are: infinitive or supine for *C* + *t* (that Baltic infinitive is of old IE instrumentality is beyond doubt: cf. Slavic infinitive on -*ti*, OIA -*taye*; both old datives of *ti*-stem; similarly Baltic supine[81] has the related supine forms in Slavic -*tъ* and L. -*tum*, OIA infinitive -*tum*, being old accusatives of *tu*-stem (cf. Erhart 1980: 181–182; Erhart 1984: 147–148); both related to verbal abstracta on *ti/tu*- (cf. Stang 1966: 394–397), if possible, the old athematic present 3rd sg. ending *-*ti* is used. For sigmatic forms, the future (derived from the infinitive stem) is used (related in its instrumentality to the *sya*-future of OIA and sigmatic future of Greek; these sigmatic forms are related to the sigmatic desideratives and sigmatic aorists; cf. Stang 1966: 397–399; Erhart 1980: 173; Erhart 1984: 142), on *sta*-iteratives (Stang 1966: 338–349). Additionally, if possible, the old athematic present 2nd sg. ending *-*si* is used.

Note: The old suffix on *d^h- is used to form Baltic imperfect (-*davau*); this form could be related to reconstructed d^h-presents (LIV 20, 717). However, the relationship of *davau*-imperfect to IE forms is debatable.

When needed, the synchronic data are supported by those ʽetymological' data, i.e., from unproductive clusters with clear and sure etymology, usually from numerals, if possible, since they usually have a reliable etymology.

Note: We need to keep in mind that the alternation of voice is not reflected in Lithuanian orthography.

[81] Which is later a base for Baltic conditional.

3.2.1 The development of clusters *labial + t/d*^{h}*/s*

The labial series has no specific features besides the (de)voicing of the left plosive according to its right context; its development shares the same general features with the development of the velar series:

P + t = Lith. pt:

- inf. *kir̃pti* (cf. pr. *kerpù* ʽcut, shear’; < IE *√(*s*)*kerp*-; cf. L. *carpō* ‘grab, grasp’; cf. Pokorny IEW: 944–945; Fraenkel LEW: 257–258; LIV^2: 559; Smoczyński 2007: 289; Derksen 2015: 246–247);
- inf. *lìpti* (cf. pr. *limpù* ʽglue’; < IE *√*lei̯p*-; cf. OIA *limpáti* ‘smear’, OCS -*lěpiti* ‘stick’; cf. Pokorny IEW: 670–671; Fraenkel LEW: 375–376; LIV^2: 408–409; Smoczyński 2007: 357–358; NIL 453–454; Derksen 2015: 288);
- Lith. *neptė̃* ʽgranddaughter’ (< IE **neptī*; cf. OIA *naptī*, L. *neptis*, OHG *nift*; cf. Pokorny IEW: 764; Fraenkel LEW: 494; Smoczyński 2001: 172, 183, 240; Smoczyński 2007: 420; NIL 520–524; Derksen 2015: 332);
- Lith. *septynì*, Latv. *septiņi* ʽseven’, Pruss. *septmas* ʽseventh’ (< IE **septm̥*; cf. OIA *saptá*-, L. *septem*; cf. Pokorny IEW: 909; Fraenkel LEW: 776; Stang 1966: 279, 283; Comrie 1992: 756–759; Blažek 1999: 246–250; Smoczyński 2007: 543; Derksen 2015: 393–394);
- inf. *dìrbti* (cf. pr. *dìrbu* ʽwork’; < IE *√*derb*^{h}-; cf. OIA pr. part. *dr̥bhánti*- ‘forming tufts’; cf. Pokorny IEW: 211–212, 257; Fraenkel LEW: 82; LIV^2: 121; Smoczyński 2007: 114–115; Derksen 2015: 131);
- inf. *del̃bti* (cf. pr. *delbiù* ʽput lower’; < IE *√*d*^{h}*elb*^{h}-; cf. OE *delfan* ‘dig’; cf. Pokorny IEW: 246; Fraenkel LEW: 81; LIV^2: 143; Smoczyński 2007: 112–113; Derksen 2015: 120–129–130);
- inf. *grė́bti* (cf. pr. *grė́biu* ʽrake’; < IE *√*greb*^{h}-; cf. Gr. γράφω ‘scratch, graze’; cf. Pokorny IEW: 392; Fraenkel LEW: 165–166; LIV^2: 187; Smoczyński 2007: 196–197; Derksen 2015: 186);

P + s = Lith. ps:

- fut. *kir̃psiu* (cf. pr. *kerpù* ʽcut, shear’; < IE *√(*s*)*kerp*-; cf. L. *carpō* ‘grab, grasp’; cf. Pokorny IEW: 944–945; Fraenkel LEW: 257–258; LIV^2: 559; Smoczyński 2007: 289; Derksen 2015: 246–247);
- fut. *lìpsiu* (cf. pr. *limpù* ʽglue’; < IE *√*lei̯p*-; cf. OIA *limpáti* ‘smear’, OCS -*lěpiti* ‘stick’; cf. Pokorny IEW: 670–671; Fraenkel LEW: 375–376; LIV^2: 408–409; Smoczyński 2007: 357–358; NIL 453–454; Derksen 2015: 288);
- fut. *dìrbsiu* (cf. pr. *dìrbu* ʽwork’; < IE *√*derb*^{h}-; cf. OIA pr. part. *dr̥bhánti*- ‘forming tufts’; cf. Pokorny IEW: 211–212, 257; Fraenkel LEW: 82; LIV^2: 121; Smoczyński 2007: 114–115; Derksen 2015: 131);
- fut. *del̃bsiu* fut. *dìrbsiu* (cf. pr. *dìrbu* ʽwork’; < IE *√*derb*^{h}-; cf. OIA pr. part. *dr̥bhánti*- ‘forming tufts’; cf. Pokorny IEW: 211–212, 257; Fraenkel LEW: 82; LIV^2: 121; Smoczyński 2007: 114–115; Derksen 2015: 131);
- fut. *grė́bsiu grė́bti* (cf. pr. *grė́biu* ʽrake’; < IE *√*greb*^{h}-; cf. Gr. γράφω ‘scratch, graze’; cf. Pokorny IEW: 392; Fraenkel LEW: 165–166; LIV^2: 187; Smoczyński 2007: 196–197; Derksen 2015: 186);

P + d^h = Lith. bd:

impf. *kir̃pdavau* (cf. pr. *kerpù* 'cut, shear'; < IE *√(*s*)*kerp*-; cf. L. *carpō* 'grab, grasp'; cf. Pokorny IEW: 944–945; Fraenkel LEW: 257–258; LIV²: 559; Smoczyński 2007: 289; Derksen 2015: 246–247);

impf. *lìpdavau* (cf. pr. *limpù* 'glue'; < IE *√*leịp*-; cf. OIA *limpáti* 'smear', OCS *-lěpiti* 'stick'; cf. Pokorny IEW: 670–671; Fraenkel LEW: 375–376; LIV²: 408–409; Smoczyński 2007: 357–358; NIL 453–454; Derksen 2015: 288);

impf. *dìrbdavau* (cf. pr. *dìrbu* 'work'; < IE *√*derbʰ*-; cf. OIA pr. part. *dr̥bhánti*- 'forming tufts'; cf. Pokorny IEW: 211–212, 257; Fraenkel LEW: 82; LIV²: 121; Smoczyński 2007: x; Derksen 2015: 131);

impf. *del̃bdavau* (cf. pr. *delbiù* 'put lower'; < IE *√*dʰelbʰ*-; cf. OE *delfan* 'dig'; cf. Pokorny IEW: 246; Fraenkel LEW: 81; LIV²: 143; Smoczyński 2007: 112–113; Derksen 2015: 120; Smoczyński 2007: x; Derksen 2015: 120);

impf. *grė́bdavau grė́bti* (cf. pr. *grė́biu* 'rake'; < IE *√*grebʰ*-; cf. Gr. γράφω 'scratch, graze'; cf. Pokorny IEW: 392; Fraenkel LEW: 165–166; LIV²: 187; Smoczyński 2007: 196–197; Derksen 2015: 186);

3.2.2 The development of clusters (*labio*)*velar* + *t/dʰ/s*

The plain velars and labiovelars merged in plain velars; as in all *satəm*-languages; voiced phonemes merged in all positions.

The development could be expressed by formulae (where *K* = IE. **k/g/gʰ/ kᵘ/gᵘ/gᵘʰ*):

K⁽ᵘ̯⁾ + t = Lith. kt:

inf. *lẽkti* (cf. pr. *lekiù* 'fly'; < IE *√*lek*-; cf. MHG *lecken* 'knock out with feet', OCS *letěti* 'fly'; cf. Pokorny IEW: 673; Fraenkel LEW: 353–354; LIV²: 411; Smoczyński 2007: 343–344; Derksen 2015: 278);

inf. *sèkti* (cf. pr. *senkù* diminish, fall, sink'; < IE *√*sek*-; cf. OIA *ásaścant*- 'dry up'; OCS *i-sęčetъ* 'dry out' ; cf. Pokorny IEW: 894–895; Fraenkel LEW: 772–773; LIV²: 523–524; Smoczyński 2007: 541; Derksen 2015: 392);

inf. *jùngti* (cf. pr. *jùngiu* 'yoke up'; cf. OIA *yunákti* 'harness', L. *iungō* 'join'; < IE *√*i̯ung*-; cf. Pokorny IEW: 508–510; Fraenkel LEW: 196–197; LIV²: 316; Smoczyński 2007: 237–238; NIL 397–404; Derksen 2015: 214);

inf. *dérgti*, *drégti* (cf. pr. *dérgia* ', moist, rain'; < IE *√*dʰreH₂gʰ*-; cf. Gr. θράσσω, Att. θράττω 'trouble, disturb', OCS *raz-dražǫ* 'provoke anger'; cf. Pokorny IEW: 251, 273; Fraenkel LEW: 103; LIV²: 154–155; Smoczyński 2007: x; Derksen 2015: 123[82]);

inf. *sir̃gti* (cf. pr. *sergù*, OLith. *sérgmi* 'be ill'; < IE *√*su̯ergʰ*-; cf. OIA *sūrkṣata* 'care' (?), OHG *sorgēn* 'care'; cf. Pokorny IEW: 1051; Fraenkel LEW: 776–777; LIV²: 613–614; Smoczyński 2007: 550; Derksen 2015: 399);[83]

OLith. pr. *liekti*, inf. *lìkti* (cf. pr. *liekù* 'hold, keep'; < IE *√*lei̯kᵘ*-; cf. OIA *rikthās* 'protrude beyond', L. *līquī* 'leave'; cf. Pokorny IEW: 669–670; Fraenkel LEW: 372; LIV²: 406–407; Smoczyński 2007: 355–356; Derksen 2015: 287);

inf. *sèkti* (cf. pr. *sekù* 'follow'; < IE *√*sekᵘ*-; cf. OIA *sáścati* 'accompany', L. *sequor* 'follow'; cf. Pokorny IEW: 896–897; Fraenkel LEW: 773; LIV²: 525–526; Smoczyński 2007: 540–541; Derksen 2015: 392);

Lith. *peñktas*, Latv. *pìektais*, Pruss. *penckts* 'fifth' (< IE **penkᵘ-to*-; cf. OIA *pakthá̄ḥ*, Gr. πέμπτος; Stang 1966: 283; Comrie 1992: 752–754; Blažek 1999: 221, 224; Pokorny IEW: 808; Fraenkel LEW: 570; Smoczyński 2007: 450; Derksen 2015: 351);

inf. *bė́gti* (cf. pr. *bė́gu*, OLith. *bė́gmi* 'run'; < IE *√*bʰegᵘ*-; cf. Gr. φέβομαι 'put to glight, flee', OCS *-běgnǫti* 'run'; cf. Pokorny IEW: 116; Fraenkel LEW: 38; LIV²: 67; Smoczyński 2007: 52–53; Derksen 2015: 85–86);

[82] Derksen reconstructs IE *√*dʰerg*- and considers the relationship between Lith. and Gr. verbs problematic (l.c.).
[83] Fraenkel reconstructs IE *√*sergʰ*- (l.c.).

inf. _dègti_ (cf. pr. _degù_ ʽburn'; < IE *√_d^{h}eg^{uh}_-; cf. OIA _dáhati_ 'burn', Alb. _djeg_ 'burnt'; cf. Pokorny IEW: 240–241; Fraenkel LEW: 85–86; LIV^2: 133–134) ; Smoczyński 2007: 97–98; Derksen 2015: 119);

inf. _snìgti_ (cf. pr. _sniẽga_ ʽsnow'; < IE *√_snei̯g^{uh}_-; cf. Gr. νείφω, L. _ningit_ 'snow'; cf. Pokorny IEW: 974; Fraenkel LEW: 853; LIV^2: 573; Smoczyński 2007: 591; NIL 622–625; Derksen 2015: 416);

K$^{(u̯)}$ + s = Lith. ks:

fut. _lẽksiu_ (cf. pr. _lekiù_ ʽfly'; < IE *√_lek_-; cf. MHG _lecken_ 'knock out with feet', OCS _letěti_ 'fly'; cf. Pokorny IEW: 673; Fraenkel LEW: 353–354; LIV^2: 411; Smoczyński 2007: 343–344; Derksen 2015: 278);

fut. _sèksiu_ (cf. pr. _senkù_ diminish, fall, sink'; < IE *√_sek_-; cf. OIA _ásaścant_- 'dry up'; OCS _i-sęčetъ_ 'dry out' ; cf. Pokorny IEW: 894–895; Fraenkel LEW: 772–773; LIV^2: 523–524; Smoczyński 2007: 541; Derksen 2015: 392);

fut. _jùngsiu_ (cf. pr. _jùngiu_ ʽyoke up'; cf. OIA _yunákti_ 'harness', L. _iungō_ 'join'; < IE *√_i̯ung_-; cf. Pokorny IEW: 508–510; Fraenkel LEW: 196–197; LIV^2: 316; Smoczyński 2007: 237–238; NIL 397–404; Derksen 2015: 214);

fut. _dérgs_ (cf. pr. _dérgia_ ʽ, moist, rain'; < IE *√_d^{h}reH$_2$g^h_-; cf. Gr. θράσσω, Att. θράττω 'trouble, disturb', OCS _raz-dražǫ_ 'provoke anger'; cf. Pokorny IEW: 251, 273; Fraenkel LEW: 103; LIV^2: 154–155; Smoczyński 2007: x; Derksen 2015: 123[84]);

fut. _sir̃gsiu_ (cf. pr. _sergù_, OLith. _sérgmi_ ʽbe ill'; < IE *√_su̯erg^h_-; cf. OIA _sūrkṣata_ 'care' (?), OHG _sorgēn_ 'care'; cf. Pokorny IEW: 1051; Fraenkel LEW: 776–777; LIV^2: 613–614; Smoczyński 2007: 550; Derksen 2015: 399);

fut. _lìksiu_ (cf. pr. _liekù_ ʽhold, keep'; < IE *√_lei̯k^u_-; cf. OIA _rikthās_ 'protrude beyond', L. _līquī_ 'leave'; cf. Pokorny IEW: 669–670; Fraenkel LEW: 372; LIV^2: 406–407; Smoczyński 2007: 355–356; Derksen 2015: 287);

fut. _sèksiu_ (cf. pr. _sekù_ ʽfollow'; < IE *√_sek^u_-; cf. OIA _sáścati_ 'accompany', L. _sequor_ 'follow'; cf. Pokorny IEW: 896–897; Fraenkel LEW: 773; LIV^2: 525–526; Smoczyński 2007: 540–541; Derksen 2015: 392);

fut. _bė́gsiu_ (cf. pr. _bė́gu_, OLith. _bė́gmi_ ʽrun'; < IE *√_b^{h}eg^u_-; cf. Gr. φέβομαι 'put to glight, flee', OCS -_běgnǫti_ 'run'; cf. Pokorny IEW: 116; Fraenkel LEW: 38; LIV^2: 67; Smoczyński 2007: 52–53; Derksen 2015: 85–86);

fut. _dègsiu_ (cf. pr. _degù_ ʽburn'; < IE *√_d^{h}eg^{uh}_-; cf. OIA _dáhati_ 'burn', Alb. _djeg_ 'burnt'; cf. Pokorny IEW: 240–241; Fraenkel LEW: 85–86; LIV^2: 133–134) ; Smoczyński 2007: 97–98; Derksen 2015: 119);

fut. _snìgs_ (cf. pr. _sniẽga_ ʽsnow'; < IE *√_snei̯g^{uh}_-; cf. Gr. νείφω, L. _ningit_ 'snow'; cf. Pokorny IEW: 974; Fraenkel LEW: 853; LIV^2: 573; Smoczyński 2007: 591; NIL 622–625; Derksen 2015: 416);

K$^{(u̯)}$ + d^h = Lith. gd:

impf. (cf. pr. _lekiù_ ʽfly'; < IE *√_lek_-; cf. MHG _lecken_ 'knock out with feet', OCS _letěti_ 'fly'; cf. Pokorny IEW: 673; Fraenkel LEW: 353–354; LIV^2: 411; Smoczyński 2007: 343–344; Derksen 2015: 278);

impf. _sèkdavau_ (cf. pr. _senkù_ diminish, fall, sink'; < IE *√_sek_-; cf. OIA _ásaścant_- 'dry up'; OCS _i-sęčetъ_ 'dry out' ; cf. Pokorny IEW: 894–895; Fraenkel LEW: 772–773; LIV^2: 523–524; Smoczyński 2007: 541; Derksen 2015: 392);

impf. _jùngdavau_ (cf. pr. _jùngiu_ ʽyoke up'; cf. OIA _yunákti_ 'harness', L. _iungō_ 'join'; < IE *√_i̯ung_-; cf. Pokorny IEW: 508–510; Fraenkel LEW: 196–197; LIV^2: 316; Smoczyński 2007: 237–238; NIL 397–404; Derksen 2015: 214);

[84] Derksen reconstructs IE *√_d^{h}erg_- and considers the relationship between Lith. and Gr. verbs problematic (l.c.).

impf. *dérgdavo* (cf. pr. *dérgia* ‛, moist, rain’; < IE *√*d^{h}reH$_{2}$g^{h}*-; cf. Gr. θράσσω, Att. θράττω ‘trouble, disturb’, OCS *raz-dražǫ* ‘provoke anger’; cf. Pokorny IEW: 251, 273; Fraenkel LEW: 103; LIV^{2}: 154–155; Smoczyński 2007: x; Derksen 2015: 123);

impf. *sir̃gdavau* (cf. pr. *sergù*, OLith. *sérgmi* ‛be ill’; < IE *√*su̯erg^{h}*-; cf. OIA *sūrkṣata* ‘care’ (?), OHG *sorgēn* ‘care’; cf. Pokorny IEW: 1051; Fraenkel LEW: 776–777; LIV^{2}: 613–614; Smoczyński 2007: 550; Derksen 2015: 399);

impf. *lìkdavau* (cf. pr. *liekù* ‛hold, keep’; < IE *√*lei̯k^{u}*-; cf. OIA *rikthās* ‘protrude beyond’, L. *līquī* ‘leave’; cf. Pokorny IEW: 669–670; Fraenkel LEW: 372; LIV^{2}: 406–407; Smoczyński 2007: 355–356; Derksen 2015: 287);

impf. *sèkdavau* (cf. pr. *sekù* ‛follow’; < IE *√*sek^{u}*-; cf. OIA *sáścati* ‘accompany’, L. *sequor* ‘follow’; cf. Pokorny IEW: 896–897; Fraenkel LEW: 773; LIV^{2}: 525–526; Smoczyński 2007: 540–541; Derksen 2015: 392);

impf. *bė́gdavau* (cf. pr. *bė́gu*, OLith. *bė́gmi* ‛run’; < IE *√*b^{h}eg^{u}*-; cf. Gr. φέβομαι ‘put to glight, flee’, OCS -*běgnǫti* ‘run’; cf. Pokorny IEW: 116; Fraenkel LEW: 38; LIV^{2}: 67; Smoczyński 2007: 52–53; Derksen 2015: 85–86);

impf. *dègdavau* (cf. pr. *degù* ‛burn’; < IE *√*d^{h}eg^{uh}*-; cf. OIA *dáhati* ‘burn’, Alb. *djeg* ‘burnt’; cf. Pokorny IEW: 240–241; Fraenkel LEW: 85–86; LIV^{2}: 133–134) ; Smoczyński 2007: 97–98; Derksen 2015: 119);

impf. *snìgdavo* (cf. pr. *sniẽga* ‛snow’; < IE *√*snei̯g^{uh}*-; cf. Gr. νείφω, L. *nīuit* ‘snow’; cf. Pokorny IEW: 974; Fraenkel LEW: 853; LIV^{2}: 573; Smoczyński 2007: 591; NIL 622–625; Derksen 2015: 416);

3.2.3 The development of clusters *palatovelar + t/d^{h}/s*

The original palatovelars are realized as palatal sibilants in Lithuanian, both voiced phonemes merged. Before **t*- both sibilants are realized as -*š* (i.e., devoiced), before **s*- the palatovelars are lost, and an original sibilant has become palatalized (i.e., *Ḱ+s > 0š*).

The development could be expressed by formulae (where Ḱ = IE. **ḱ/ǵ/ǵ^{h}*):

Ḱ + t = Lith. št:

inf. *nèšti* (cf. pr. *nešù* ‛carry’; < IE *√*Hneḱ*-; cf. Toch. B *eṅtär* ‘grasp’, OCS *nošǫ* ‘carry’; cf. Pokorny IEW: 316–318; Fraenkel LEW: 497–498; LIV^{2}: 250–251; Smoczyński 2007: 423; Derksen 2015: 334);[85]

inf. *pèšti* (cf. pr. *pešù* ‛pluck, pick’; < IE *√*peḱ*-; cf. Gr. πέκω ‘comb’, L. *pectō* ‘comb, shear’; cf. Pokorny IEW: 797; Fraenkel LEW: 580–581; LIV^{2}: 467; Smoczyński 2007: 453; Derksen 2015: 353);

Lith. *aštuonì*, Latv. *astoņi* ‛eight’ (< IE **oḱtō-ni-*; cf. OIA *aṣṭau*, L. *octō*; cf. Fraenkel LEW: 19–20; Stang 1966: 279, 283–284; Comrie 1992: 758–760; Blažek 1999: 267; Pokorny IEW: 775; Smoczyński 2007: 27; Derksen 2015: 64–65);

inf. *réižti* (cf. pr. *reižiù* ‛stretch’; < IE *√*rei̯ǵ*-; cf. OIr. *rigid* ‘stretch out, rule’; cf. Pokorny IEW: 862; Fraenkel LEW: 715; LIV^{2}: 503; Smoczyński 2007: 512–513; Derksen 2015: 380–381);[86]

inf. *mìlžti*, *mélžti* (cf. pr. *mélžu* ‛milk’; < IE *√*H$_{2}$melǵ*-; cf. Gr. ἀμέλγω, L. *mulgeō* ‘milk’; cf. Pokorny IEW: 722–723; Fraenkel LEW: 434–435; LIV^{2}: 279; Smoczyński 2007: 387–388; Derksen 2015: 310–311);

inf. *liẽžti* (cf. pr. *liežiù* ‛lick’; < IE *√*lei̯ǵ^{h}*-; cf. OIA *rḗḍhi*, Gr. λείχω ‘lick’; cf. Pokorny IEW: 668; Fraenkel LEW: 369; LIV^{2}: 404; Smoczyński 2007: 353; Derksen 2015: 285);

[85] LIV reconstructs either **H$_{1}$neḱ*- or **H$_{2}$neḱ*-, Derksen *H$_{1}$neḱ*- (l.c.), since this question does not concert the final plosive, we use a neutral symbol.

[86] Derksen reconstructs IE *√*H$_{3}$reǵ*- (l.c.).

inf. *mỹžti* (cf. pr. *mężù*, OLith. *minžu* 'urinate'; < IE *√H$_3$mei̯ǵ^h-; cf. OIA *méhati*, L. *mingō* 'urinate'; cf. Pokorny IEW: 713; Fraenkel LEW: 461–462; LIV^2: 301–302; NIL 384–385; Smoczyński 2007: 407; Derksen 2015: 322);

Ḱ + s = Lith. 0š:

fut. *nèšiu* (cf. pr. *nešù* 'carry'; < IE *√Hneḱ-; cf. Toch. B *eṅtär* 'grasp', OCS *nošǫ* 'carry'; cf. Pokorny IEW: 316–318; Fraenkel LEW: 497–498; LIV^2: 250–251; Smoczyński 2007: 423; Derksen 2015: 334);

fut. *pèšiu* (cf. pr. *pešù* 'pluck, pick'; < IE *√peḱ-; cf. Gr. πέκω 'comb', L. *pectō* 'comb, shear'; cf. Pokorny IEW: 797; Fraenkel LEW: 580–581; LIV^2: 467; Smoczyński 2007: 453; Derksen 2015: 353);

ašìs 'axle, axis' (< IE *H$_2$eḱs-i-; cf. OIA *ákṣa-*, L. *axis*; cf. Pokorny IEW: 6; Fraenkel LEW: 19; Smoczyński 2007: 26; NIL 259–262; Derksen 2015: 63);

fut. *réišiu* (cf. pr. *reižiù* 'stretch'; < IE *√rei̯ǵ-; cf. OIr. *rigid* 'stretch out, rule'; cf. Pokorny IEW: 862; Fraenkel LEW: 715; LIV^2: 503; Smoczyński 2007: 512–513; Derksen 2015: 380–381);

fut. *mìlšiu* (cf. pr. *mélžu* 'milk'; < IE *√H$_2$melǵ-; cf. Gr. ἀμέλγω, L. *mulgeō* 'milk'; cf. Pokorny IEW: 722–723; Fraenkel LEW: 434–435; LIV^2: 279; Smoczyński 2007: 387–388; Derksen 2015: 310–311);

fut. *liẽšiu* (cf. pr. *liežiù* 'lick'; < IE *√lei̯ǵ^h-; cf. OIA *réḍhi*, Gr. λείχω 'lick'; cf. Pokorny IEW: 668; Fraenkel LEW: 369; LIV^2: 404; Smoczyński 2007: 353; Derksen 2015: 285);

fut. *mỹšiu* (cf. pr. *mężù*, OLith. *minžu* 'urinate'; < IE *√H$_3$mei̯ǵ^h-; cf. OIA *méhati*, L. *mingō* 'urinate'; cf. Pokorny IEW: 713; Fraenkel LEW: 461–462; LIV^2: 301–302; Smoczyński 2007: 407; NIL 384–385; Derksen 2015: 322);

Ḱ + d^h = Lith. žd:

impf. *nèšdavau* (cf. pr. *nešù* 'carry'; < IE *√Hneḱ-; cf. Toch. B *eṅtär* 'grasp', OCS *nošǫ* 'carry'; cf. Pokorny IEW: 316–318; Fraenkel LEW: 497–498; LIV^2: 250–251; Smoczyński 2007: 423; Derksen 2015: 334);

impf. *pèšdavau* (cf. pr. *pešù* 'pluck, pick'; < IE *√peḱ-; cf. Gr. πέκω 'comb', L. *pectō* 'comb, shear'; cf. Pokorny IEW: 797; Fraenkel LEW: 580–581; LIV^2: 467; Smoczyński 2007: 453; Derksen 2015: 353);

impf. *réiždavau* (cf. pr. *reižiù* 'stretch'; < IE *√rei̯ǵ-; cf. OIr. *rigid* 'stretch out, rule'; cf. Pokorny IEW: 862; Fraenkel LEW: 715; LIV^2: 503; Smoczyński 2007: 512–513; Derksen 2015: 380–381);

impf. *mìlždavau* (cf. pr. *mélžu* 'milk'; < IE *√H$_2$melǵ-; cf. Gr. ἀμέλγω, L. *mulgeō* 'milk'; cf. Pokorny IEW: 722–723; Fraenkel LEW: 434–435; LIV^2: 279; Smoczyński 2007: 387–388; Derksen 2015: 310–311);

impf. *liẽždavau* (cf. pr. *liežiù* 'lick'; < IE *√lei̯ǵ^h-; cf. OIA *réḍhi*, Gr. λείχω 'lick'; cf. Pokorny IEW: 668; Fraenkel LEW: 369; LIV^2: 404; Smoczyński 2007: 353; Derksen 2015: 285);

impf. *mỹždavau* (cf. pr. *mężù*, OLith. *minžu* 'urinate'; < IE *√H$_3$mei̯ǵ^h-; cf. OIA *méhati*, L. *mingō* 'urinate'; cf. Pokorny IEW: 713; Fraenkel LEW: 461–462; LIV^2: 301–302; Smoczyński 2007: 407; NIL 384–385; Derksen 2015: 322);

3.2.4 The development of clusters *dental + t/d^h/s*

The development of the dental series has a typical (and not specifically Baltic) development of *Tt* > *st*. The clusters of *Ts* developed into *0s*; i.e., the plosive was probably first sibilantized and lost after due to degemination, similarly to the development of palatovelars.

The development could be expressed by formulae (where T = IE. *t/d/d^h):

T + t = Lith. st:

- inf. *kir̃sti* (cf. pr. *kertù* ʽhew, string, hit, strike'; < IE *√(*s*)*kert-*; cf. OIA *kṛntáti* 'cut'; cf. Pokorny IEW: 941–942; Fraenkel LEW: 258; LIV^2: 559–560; Smoczyński 2007: 289–290; Derksen 2015: 247–248);
- inf. *ver̃sti* (cf. pr. *verčiù* ʽfell, turn over'; < IE *√*u̯ert-*; cf. OIA *vártate*, OCS *vraštǫ*, L. *uertor* 'turn'; cf. Pokorny IEW: 1156–1158; Fraenkel LEW: 1228; LIV^2: 691–962; Smoczyński 2007: 739–740; Derksen 2015: 498);
- inf. *ésti* (cf. pr. *ėdù* ʽeat'; < IE *√*H_1ed-*; cf. Hitt. *ēdmi*, OIA *átti*, L. *edō* 'eat'; cf. Pokorny IEW: 287–289; Fraenkel LEW: 124–125; LIV^2: 230–231; Smoczyński 2007: 149; NIL 208–220; Derksen 2015: 157–158);
- pr. OLith. *duostí* (cf. pr. *dúodu* ʽgive'; < IE *√*deH_3-*; cf. OIA *ádāt*, OCS *dati* 'give'; cf. Pokorny IEW: 223–225; Fraenkel LEW: 111–112; LIV^2: 105–106; Smoczyński 2007: 134–135; Derksen 2015: 146–147);
- inf. *sė́sti* (cf. pr. *sė̀dù* ʽsit'; < IE *√*sed-*; cf. OIA *sī́dati*, L. *sīdō* 'sit'; cf. Pokorny IEW: 884–887; Fraenkel LEW: 777; LIV^2: 513–515; Smoczyński 2007: 538–539; NIL 590–600; Derksen 2015: 395);
- inf. *bùsti* (cf. pr. *bundù* ʽwake up'; < IE *√*b^heu̯d^h-*; cf. OIA *bódhati* 'notice', Gr. πεύθομαι 'give notice'; cf. Pokorny IEW: 150–152; Fraenkel LEW: 62; LIV^2: 82–83; Smoczyński 2007: 78–79; NIL 36–37; Derksen 2015: 83, 107);

T + s = Lith. 0s:

- fut. *kir̃siu* (cf. pr. *kertù* ʽhew, string, hit, strike'; < IE *√(*s*)*kert-*; cf. OIA *kṛntáti* 'cut'; cf. Pokorny IEW: 941–942; Fraenkel LEW: 258; LIV^2: 559–560; Smoczyński 2007: 289–290; Derksen 2015: 247–248);
- fut. *ver̃siu* (cf. pr. *verčiù* ʽfell, turn over'; < IE *√*u̯ert-*; cf. OIA *vártate*, OCS *vraštǫ*, L. *uertor* 'turn'; cf. Pokorny IEW: 1156–1158; Fraenkel LEW: 1228; LIV^2: 691–962; Smoczyński 2007: 739–740; Derksen 2015: 498);etymological development: Lith. *giesmė̃*, Lat. *dziêsma* but Lith. *giedóti*, Latv. *dziêdat*, Pruss. *waisei* but *waidimai* (Stang 1966: 107);
- fut. *ésiu* (cf. pr. *ėdù* ʽeat'; < IE *√*H_1ed-*; cf. Hitt. *ēdmi*, OIA *átti*, L. *edō* 'eat'; cf. Pokorny IEW: 287–289; Fraenkel LEW: 124–125; LIV^2: 230–231; Smoczyński 2007: 149; NIL 208–220; Derksen 2015: 157–158);fut. *sė́siu* (cf. pr. *sė̀dù* ʽsit'; < IE *√*sed-*);
- fut. *bùsiu* (cf. pr. *bundù* ʽwake up'; < IE *√*b^heu̯d^h-*; cf. OIA *bódhati* 'notice', Gr. πεύθομαι 'give notice'; cf. Pokorny IEW: 150–152; Fraenkel LEW: 62; LIV^2: 82–83; Smoczyński 2007: 78–79; NIL 36–37; Derksen 2015: 83, 107);

T + d^h = Lith. zd:

- impf. *kir̃sdavau* (cf. pr. *kertù* ʽhew, string, hit, strike'; < IE *√(*s*)*kert-*; cf. OIA *kṛntáti* 'cut'; cf. Pokorny IEW: 941–942; Fraenkel LEW: 258; LIV^2: 559–560; Smoczyński 2007: 289–290; Derksen 2015: 247–248);
- impf. *ver̃sdavau* (cf. pr. *verčiù* ʽfell, turn over'; < IE *√*u̯ert-*; cf. OIA *vártate*, OCS *vraštǫ*, L. *uertor* 'turn'; cf. Pokorny IEW: 1156–1158; Fraenkel LEW: 1228; LIV^2: 691–962; Smoczyński 2007: 739–740; Derksen 2015: 498);-);
- impf. *ésdavau* (cf. pr. *ėdù* ʽeat'; < IE *√*H_1ed-*; cf. Hitt. *ēdmi*, OIA *átti*, L. *edō* 'eat'; cf. Pokorny IEW: 287–289; Fraenkel LEW: 124–125; LIV^2: 230–231; Smoczyński 2007: 149; NIL 208–220; Derksen 2015: 157–158);
- impf. *sė́sdavau*(cf. pr. *sė̀dù* ʽsit'; < IE *√*sed-*; cf. OIA *sī́dati*, L. *sīdō* 'sit'; cf. Pokorny IEW: 884–887; Fraenkel LEW: 777; LIV^2: 513–515; Smoczyński 2007: 538–539; NIL 590–600; Derksen 2015: 395);
- impf. *bùsdavau* (cf. pr. *bundù* ʽwake up'; < IE *√*b^heu̯d^h-*; cf. OIA *bódhati* 'notice', Gr. πεύθομαι 'give notice'; cf. Pokorny IEW: 150–152; Fraenkel LEW: 62; LIV^2: 82–83; Smoczyński 2007: 78–79; NIL 36–37; Derksen 2015: 83, 107);

3.2.5 The development of clusters *sibilant* + *t/dʰ/s*

Both original Baltic sibilants (**s* and **š*, the second developed from IE **s* due to Pedersen's Law/*ruki*-rule) are preserved in Lithuanian before *t*- and lost before *s*-, the outcome of the *š*+*s* cluster is *0š*.

The development could be expressed by formulae:

s + t = Lith. st:

pr. *ẽsti* (cf. pr. OLith *esmì* 'be'; < IE *√*H₁es*-; cf. OIA *ásti*, L. *est* 'be'; cf. Pokorny IEW: 340–341; Fraenkel LEW: 124; LIV²: 241–242; Smoczyński 2007: 148; NIL 235–238; Derksen 2015: 157);

inf. *júosti* (cf. pr. *júosiu* 'gird'; < IE *√*i̯eH₃s*-; cf. Gr. ζῴννῡμι 'gird', OCS *po-jašǫ* 'gird up'; cf. Pokorny IEW: 513; Fraenkel LEW: 198; LIV²: 311; Smoczyński 2007: 239; Derksen 2015: 214–215);

inf. *kláusti* (cf. pr. *kláusiu* 'ask'; < IE *√*ḱleu̯s*-; cf. cf. OIA *śróṣan* 'obey', Toch. A *klyoṣäs*, B *klyauṣäm*' listen'; cf. Pokorny IEW: 606–607; Fraenkel LEW: 265–267; LIV²: 336–337; NIL 432–434; Smoczyński 2007: 294–295; Derksen 2015: 249);

Note: The palatal sibilant *š*, which has arisen due to Pedersen's Law, is well attested after *r* (Stang 1966: 95), but scarcely after other original triggers, cf. *sunsù*, *sùsti*; *kláusiu, kláusti* without palatalization.
Note: The forms from √*klaus*- 'ask' we would expect to be under Pedersen's law.

š + t = Lith. št:

inf. *kar̃šti* (cf. pr. *koršiù* 'comb, card'; < IE *√(*s*)*kers*-; cf. L. *carrō* 'card' cf. Pokorny IEW: 552–553; Fraenkel LEW: 224; LIV²: 559; Smoczyński 2007: 258–259; Derksen 2015: 228);

inf. *pur̃kšti* (cf. pr. *purškiù* 'splash'; < IE *√*pres*-[87]; cf. OIA *pŕ̥ṣant*- 'sprinkled', Toch. B *prantsäṃ* 'sprinkle'; cf. Pokorny IEW: 823; Fraenkel LEW: 673; LIV²: 492–493 Smoczyński 2007: 490);

Lith. *pir̃štas* (cf. Latv. *pìrst*, Pruss. *pirsten* 'finger'; < IE **prstH₂o*-; cf. Pokorny IEW: 813; Fraenkel LEW: 598; Smoczyński 2007: 464; NIL 637–659; Derksen 2015: 358);

inf. *aũšti* 'dawn, break day' (< IE **H₂u̯es*-; cf. Lith. *aušrà* 'dawn', OIA *ucchati* 'shine'; cf. Pokorny IEW: 86–87; Fraenkel LEW: 27; LIV²: 292–293; Smoczyński 2007: 35–36; Derksen 2015: 72);

s + s = Lith. 0s:

pr. *esì* (cf. pr. OLith *esmì* 'be'; < IE *√*H₁es*-; cf. OIA *ásti*, L. *est* 'be'; cf. Pokorny IEW: 340–341; Fraenkel LEW: 124; LIV²: 241–242; Smoczyński 2007: 148; NIL 235–238; Derksen 2015: 157);

fut. *júosiu* (cf. pr. *júosiu* 'gird'; < IE *√*i̯eH₃s*-; cf. Gr. ζῴννῡμι 'gird', OCS *po-jašǫ* 'gird up'; cf. Pokorny IEW: 513; Fraenkel LEW: 198; LIV²: 311; Smoczyński 2007: 239; NIL 391–392; Derksen 2015: 214–215);

fut. *kláusiu* (cf. pr. *kláusiu* 'ask'; < IE *√*ḱleu̯s*-; cf. cf. OIA *śróṣan* 'obey', Toch. A *klyoṣäs*, B *klyauṣäm*' listen'; cf. Pokorny IEW: 606–607; Fraenkel LEW: 265–267; LIV²: 336–337; Smoczyński 2007: 294–295; NIL 432–434; Derksen 2015: 249);

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[87] The plosive *k* is inserted, cf. Lith. *ankštas* 'close' but OIA *aṁhú*-, OCS *ǫzъkъ*, L. *angustus*; Lith. *áuksas* 'gold' but. Pruss. *ausis*, L. *aurum*, cf. Stang (1966: 108–109)

š + s = Lith. 0š:

fut. *kar̃šiu* (cf. pr. *karšiù* ʽcomb, cardʼ; < IE *√(*s*)*kers*-; cf. L. *carrō* ‘cardʼ cf. Pokorny IEW: 552–553; Fraenkel LEW: 224; LIV²: 559; Smoczyński 2007: 258–259; Derksen 2015: 228);

fut. *pur̃kšiu* (cf. pr. *purškiù* ʽsplashʼ; < IE *√*pres*-[88]; cf. OIA *pŕ̥ṣant*- ‘sprinkled’, Toch. B *prantsäṃ* ‘sprinkleʼ; cf. Pokorny IEW: 823; Fraenkel LEW: 673; LIV²: 492–493 Smoczyński 2007: 490);

s + dʰ = Lith. zd:

impf. *júosdavau* (cf. pr. *júosiu* ʽgirdʼ; < IE *√*i̯eH₃s*-; cf. Gr. ζώννῡμι ʽgirdʼ, OCS *po-jašǫ* ʽgird upʼ; cf. Pokorny IEW: 513; Fraenkel LEW: 198; LIV²: 311; Smoczyński 2007: 239; NIL 391–392; Derksen 2015: 214–215);

impf. *kláusdavau* (cf. pr. *kláusiu* ʽaskʼ; < IE *√*ḱleu̯s*-; cf. cf. OIA *śróṣan* ʽobeyʼ, Toch. A *klyoṣäs*, B *klyauṣäm*ʼlistenʼ; cf. Pokorny IEW: 606–607; Fraenkel LEW: 265–267; LIV²: 336–337; NIL 432–434; Smoczyński 2007: 294–295; Derksen 2015: 249);

š + dʰ = žd:

impf. *kar̃šdavau* (cf. pr. *karšiù* ʽcomb, cardʼ; < IE *√(*s*)*kers*-; cf. L. *carrō* ‘cardʼ cf. Pokorny IEW: 552–553; Fraenkel LEW: 224; LIV²: 559; Smoczyński 2007: 258–259; Derksen 2015: 228);

impf. *pur̃kšdavau* (cf. pr. *purškiù* ʽsplashʼ; < IE *√*pres*-[89]; cf. OIA *pŕ̥ṣant*- ‘sprinkled’, Toch. B *prantsäṃ* ‘sprinkleʼ; cf. Pokorny IEW: 823; Fraenkel LEW: 673; LIV²: 492–493 Smoczyński 2007: 490);

3.2.6 The overview of the Lithuanian alternations

Summing up the developments in Lithuanian, we should remark that clusters of *K* + *s* are realized as *ks*, surprisingly not as *kš*, according to the *ruki*-rule, though the cluster of *Ḱs* is realized as *0š*, hence reflecting **kš* with the *ruki*-rule operating. A plausible solution is the levelling of paradigms: the original palatovelars were considered sibilants (phonetically being sibilants!), even having the same outcome as clusters on -*š*, the velar paradigm was levelled on *s*, as were many other outcomes of the original *š*: cf. Lith. *ausìs* ʽear’ (but OCS *uxo*), *teisùs* ʽsilence’ (but OCS *tixъ*).

IE	**Lith.**	t-	d⁽ʰ⁾-	s-
-K⁽ᵘ̯⁾	-k	*kt*	*gd*	*ks*
-Ḱ	-š	*šṭ*	*žd*	*0š*
-T	-t	*st*	*zd*	*0s*
-P	-p	*pt*	*bd*	*ps*
-s	-s	*st*	*zd*	*0s*
-š	-š	*št*	*žd*	*0š*

[88] The plosive *k* is inserted, cf. Lith. *ankštas* ʽcloseʼ but. OIA *aṁhú*-, OCS *ǫzъkъ*, L. *angustus*; Lith. *áuksas* ʽgoldʼ but. Pruss. *ausis*, L. *aurum*, cf. Stang (1966: 108–109)

[89] The plosive *k* is inserted, cf. Lith. *ankštas* ʽcloseʼ but. OIA *aṁhú*-, OCS *ǫzъkъ*, L. *angustus*; Lith. *áuksas* ʽgoldʼ but. Pruss. *ausis*, L. *aurum*, cf. Stang (1966: 108–109)

3.3 Main features of development in Latvian

Latvian development of clusters with *t-* follows in its main features known from Lithuanian. The development leads to non-palatal clusters, resulting from the depalatalization of the original palatal clusters (preserved otherwise in Lithuanian).

We have to add to clusters of *plosive + s* in Latvian that future stems formed from the peripheral plosives (labial and velar) regularly, the future stems from the central plosives (dental and palatovelar) are always with the anaptyctic vowel *ī*, which prohibits any alternation; in contrast, the (present) *sta*-stems (diachronically iteratives) are directly attached to the sibilant (either original or from a palatal or a dental) – but for such stems we cannot exclude analogical forms[90].

The examples are selective, and only illustrative of the main features of the development; the etymologies are based on Karulis (1992a; 1992b) and Derksen (2015), while the Indo-European reconstruction is based on LIV.

3.3.1 The development of clusters *obstruent + t/s*

The old IE peripheral clusters are fully preserved, the palatovelars are realized as *s* before *t-*, lost before *s-*; old IE dentals have the same outcomes in the same contexts:

P + t = Latv. pt:

inf. *dir̂tb* ʽwalk fast' (< IE *√d^hr̥b^h-< IE *√*derb^h*-; cf. OIA pr. part. *dṛbhánti-* 'forming tufts'; cf. Pokorny IEW: 211–212, 257; Karulis 1992a: 199–200; LIV^2: 121; Derksen 2015: 131);

num. *septiņi* ʽseven' (< IE **septm̥*; cf. OIA *saptá-*, Pruss. *septmas* ʽseventh', L. *septem* 'seven'; cf. Pokorny IEW: 909; Stang 1966: 279, 283; Karulis 1992b: 171; Comrie 1992: 756–759; Blažek 1999: 246, 249; Derksen 2015: 393–394);

P + s = Latv. ps:

fut. *teps* 'smear' (cf. pr. *tepju*; < IE *√*tep-*; cf. OCS *teti* 'flog, beat'; cf. Karulis 1992b: 392; LIV^2: 630; Derksen 2015: 464);

sta-pr. *kvēpstu* ʽsmoke, smell' (cf. pr. *kvēpu*; < IE *√*ku̯ep-*; cf. OIA *kúpyati* 'get angry', Goth. *afƕapjan* 'smother, wipe'; cf. Pokorny IEW: 596; Karulis 1992a: 453; LIV^2: 376; Derksen 2015: 268);

apse, epse ʽaspen' (< IE **aps-*; cf. Lith. *āpušė*, *ẽpušė*, OHG *aspa* 'aspen'; cf. Pokorny IEW: 55; Karulis 1992a: 73–74; Derksen 2015: 154);

lapsa ʽfox' (< IE **H_2lōp-s*; cf. Lith. *lãpė*, Gr. ἀλώπηξ 'fox'; cf. Pokorny IEW: 1179; Karulis 1992a: 501; Derksen 2015: 274);

$K^{(u̯)}$ + t = Latv. kt:

[90] For details on *sta*-stems in general see Endzelin (1923: 580-588), Stang (1966: 338–349), Forssman (2001: 178–181), Holst (2001: 175–177).

inf. *lèkt* (cf. pr. *lęcu* 'jump, fly'; < IE *√*lek*-; cf. MHG *lecken* 'knock out with feet', OCS *letěti* 'fly'; cf. Pokorny IEW: 673; Karulis 1992a: 513; LIV²: 411; Derksen 2015: 278);

inf. *júgt* (cf. pr. *júdzu* 'joke'; (cf. pr. *jùngiu* 'yoke up'; < IE *√*i̯ung*-; cf. OIA *yunákti* 'harness', L. *iungō* 'join'; cf. Pokorny IEW: 508–510; Karulis 1992a: 360; LIV²: 316; NIL: 397–404; Derksen 2015: 214);

num. *pìektais* 'fifth' (< IE **penku̯-to-*;[91] cf. OIA *pakthá́ḥ*, Gr. πέμπτος; cf. Stang 1966: 283; Karulis 1992b: 42–43; Comrie 1992: 752–754; Blažek 1999: 221, 224; Pokorny IEW: 808; Smoczyński 2007: 450; Derksen 2015: 351);

inf. *diêgt* 'thread, beat, sew, stick' (cf. pr. *diêdziu*; < IE *√*dʰei̯(H)gᵘ*-; cf. L. *fīgere* 'insert, pierce, fix, attach'; cf. Pokorny IEW: 243–244; Karulis 1992a: 214–215; LIV²: 142; Derksen 2015: 127);

K⁽ᵘ̯⁾ + s = Latv. ks:

fut. *liks* (cf. pr. *liekt* 'leave, lay, put'; < IE *√*lei̯kᵘ*-; cf. OIA *rikthās* 'protrude beyond', L. *līquī* 'leave'; cf. Pokorny IEW: 669–670; Karulis 1992a: 535–536; LIV²: 406–407; Derksen 2015: 287);

sta-pr. *dī̃gstu* 'thread, beat, sew, stick' (cf. pr. *diêdziu*; < IE *√*dʰei̯(H)gᵘ*-; cf. L. *fīgere* 'insert, pierce, fix, attach'; cf. Pokorny IEW: 243–244; Karulis 1992a: 214; LIV²: 142; Derksen 2015: 127);

Ḱ + t = Latv. st:

inf. *nest* 'carry, bring' (cf. pr. *nęsu*; < IE *√*Hneḱ*-; cf. Toch. B *eṅtär* 'grasp', OCS *nošǫ* 'carry'; cf. Pokorny IEW: 316–318; Karulis 1992a: 624–625; LIV²: 250–251; Derksen 2015: 334);

inf. *riêzt* 'stick out, become warped' (cf. pr. *riêžu* < IE *√*rei̯ǵ*-; cf. OIr. *rigid* 'stretch out, rule'; cf. Pokorny IEW: 862; Karulis 1992b: 101–102; LIV²: 503; Derksen 2015: 380);

astuôņi 'eight' (< IE **oḱtō-ni-*; cf. OIA *aṣṭau*, L. *octō*; cf. Stang 1966: 279, 283–284; Karulis 1992a: 81; Comrie 1992: 758–760; Blažek 1999: 267; Pokorny IEW: 775; Derksen 2015: 64–65);

Ḱ + s = Latv. 0s:

sta-pr. *lūstu* 'break' (inf. *laûzt* 'break'; < IE *√*leu̯ǵ*-; cf. OIA *rujáti* 'break', OE *tōlūcan* 'destroy'; cf. Pokorny IEW: 686; Karulis 1992a: 510–511; LIV²: 415–416; Derksen 2015: 276);[92]

ass[93] 'axle, axis' (< IE **H₂eḱs-i*-; cf. OIA *ákṣa*-, L. *axis*; cf. Pokorny IEW: 6; Karulis 1992a: 79–80; NIL 259–262; Derksen 2015: 63);

lasis[94] 'salmon' (< IE **loḱsi*; cf. Tocharian B *laks* 'fish'; OHG *lahs*, Lith. *lãšiš* 'salmon'; cf. Pokorny IEW: 653; Karulis 1992a: 503; Derksen 2015: 274);

Note: Latvian future is regularly formed with an anaptyctic vowel from roots ending on an original palatovelar, cf. fut. *nesīs* (cf. pr. *nęsu* 'carry, bring'; < IE *√*Hneḱ*-) and fut. *lauzīs* (cf. pr. *laũžu* 'break'; < IE *√*louǵ*-).

Note: Latv. *seši* 'six' (cf. Lith. *šešì*) has *š* is from **si̯*, cf. Stang 1966: 277; Karulis 1992b: 174; Derksen 2015: 446). If IE was formed by a palatovelar + *s* **(K)seḱs/(K)su̯eḱs* (cf. Blažek 1999: 234–245 for details), the Baltic form could be traced to **seks-i*; Lith. *šẽstas*, Latv. *sęstaĩs*, Pruss. *wuschts* 'sixth' are derived directly from the stem by *to*-.

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[91] Latvian has lost the root nasal.

[92] LIV reconstruct *√*leu̯g*-.

[93] The assumed development is: *aḱšis* > *ašis* > *asis* > *ass* after a syncope (Karulis 2001: 79).

[94] The assumed development is: *-ḱs-* > *-ḱš-* > *šš* > *0š* > *0s*.

T + t = Latv. st:

inf. *mest* (cf. pr. *mętu* 'throw'; < IE *√*met-* ; cf. OCS *metǫ, mesti* 'throw'; cf. Pokorny IEW: 703–704; Karulis 1992a: 584–585; LIV²: 442; Derksen 2015: 313–314);[95]

inf. *êst* (pret. *êdu* 'eat'; < IE *√*H₁ed-*; cf. Hitt. *ēdmi*, OIA *átti*, L. *edō* 'eat'; cf. Pokorny IEW: 287–289; Karulis 1992a: 273–274; LIV²: 230–231; NIL 208–220; Derksen 2015: 157–158);

inf. *bust* 'awake, wake up' (cf. pr. *bùdu*; < IE *√*bʰeu̯dʰ-*; cf. OIA *bódhati* 'notice', Gr. πεύθομαι 'give notice'; cf. Pokorny IEW: 150–152; Karulis 1992a: 112–114; LIV²: 82–83; NIL 36–37; Derksen 2015: 83, 107);

inf. *brìst* (cf. pr. *brìedu* 'wade'; < IE *√*bʰredʰ*; cf. OCS *bredǫ* 'wade'; cf. Pokorny IEW: 164; Karulis 1992a: 146; LIV²: 91; Derksen 2015: 101);

T + s = Latv. 0s:

sta-pr. *bilstu* 'say' (pret. *bil̃da,* < IE *√*bʰel-t-st-*; cf. OE *bellan* 'roar';cf. Pokorny IEW: 123–124; Karulis 1992a: 127; LIV²: 74; Derksen 2015: 90);

Note: Similarly to stems ending on a palatovelar (see above), Latvian future is regularly formed with an anaptyctic vowel from roots ending on an original dental, cf. fut. [fut. *metīs* (cf. pr. *mętu* 'throw'; < IE *√*met-*) or fut. *vedīs* (inf. *vest* 'lead'; < IE *√*u̯edʰ-*) or fut. *edīs* (inf. *ēst* 'eat'; < IE *√*H₁edʰ-*).

s + t = Latv. st:

juôsta 'girdle' (< IE *√*i̯eH₃s-*; cf. Gr. ζώννῡμι 'gird', OCS *po-jašǫ* 'gird up'; cf. Pokorny IEW: 513; Karulis 1992a: 358–359; LIV²: 311; NIL 391–392; Derksen 2015: 214–215);

s + s = Latv. 0s:

sta-pr. *dzièstu* 'extinguish, put out' (pr. *dzešu*; < IE *√*gᵘ̯es-*; cf. Lith. *gèsti*, pret. *gẽso*, OIA *jásate* 'be exhausted', Gr. σβέννῡμι 'quench', OCS *-gasiti* 'extinguish'; cf. Pokorny IEW: 479–480; Karulis 1992a: 250; LIV²: 541543; Derksen 2015: 173);

š + t = Latv. st:

inf. *klàust* (pret. *klàusu* 'ask'; < IE *√*ḱleu̯s-*; < IE *√*ḱleu̯s-*; cf. cf. OIA *śróṣan* 'obey', Toch. A *klyoṣäs*, B *klyauṣäm* 'listen'; cf. Pokorny IEW: 606–607; Karulis 1992a: 401; LIV²: 336–337; NIL 432–434; Derksen 2015: 249);

inf. *kā̃rst* (prêt. *kā̃rsu* 'card, comb'; < IE *√(*s*)*kers-*; cf. L. *carrō* 'card' cf. Pokorny IEW: 532–533; Karulis 1992a: 385; LIV²: 559; Derksen 2015: 228);

pìr(*k*)*sts* 'finger' (< IE **prstH₂o-*; cf. Lith. *pir̃štas*; cf. Pokorny IEW: 813; Karulis 1992b: 54; NIL 637–659; Derksen 2015: 358);

inf. *àust* 'dawn, break day' (< IE *√*H₂u̯es-*; cf. Lith. *aušrà* 'dawn', OIA *uccháti* 'shine'; cf. Pokorny IEW: 86–87; Karulis 1992a: 91; LIV²: 292–293; Derksen 2015: 72);

inf. *aízmìrst* 'forget' (< IE *√*mers-*; cf. Lith. *mir̃šti*, OIA *mṛ́ṣyate* 'forget'; cf. Pokorny IEW: 737–738; Karulis 1992a: 61; LIV²: 440–441; Derksen 2015: 320);

š + s = Latv. 0s:

sta-pr. *àustu* 'dawn, break' (< IE *√*H₂u̯es-*; cf. Lith. *aušrà* 'dawn', OIA *uccháti* 'shine'; cf. Pokorny IEW: 86–87; Karulis 1992a: 91; LIV²: 292–293; Derksen 2015: 72);

sta-pr. *aizmirstu* 'forget' (< IE *√*mers-*; cf. Lith. *mir̃šti*, OIA *mṛ́ṣyate* 'forget'; cf. Pokorny IEW: 737–738; Karulis 1992a: 61; LIV²: 440–441; Derksen 2015: 320);

[95] Not securely attested outside Balto-Slavic. Derksen (l.c.) proposes as cognates L. *metere* "mow, harvest" and W. *medi* "reap". LIV² (l.c.) proposes as a cognate Gr. μέτρον "measure".

Note: Endzelin (1923: 178) brings several dialectal examples of the Latvian future with geminate sibilants – we consider these forms analogous, not preserving the older stage of development.

3.3.2 Overview of the Latvian alternations

The development of clusters of our interest in Latvian is similar in its main features with that of Prussian, and remotely to Lithuanian. The peripheral series clusters are preserved, as are clusters of a sibilant + *t/s*, but both *ruki*-clusters and old palatovelars are depalatalized. A remarkable feature is the loss of a plosive (from the synchronic point of view a total elision) before *s*-affixes of both central series.

IE	Latvian	t-	s-
-K$^{(\text{u̯})}$	-k	*kt*	*ks*
-Ḱ	-s	*sț*	*0s*
-T	-t	*st*	*0s*
-P	-p	*pt*	*ps*
-s	-s	*st*	*0s*
-š	-s	*st*	*0s*

Note: The palatal phonemes *š, ž* in Latvian are results of secondary, specifically Latvian developments of clusters.

3.4 Main features of development in Prussian

Prussian is a dead language, in contrast to Lithuanian and Latvian, documented by a very limited corpus of texts, hence we are forced to use few attested examples instead of the wider possibilities while dealing with Lithuanian or Latvian.

Note: Prussian data were written by German-speaking (and writing) authors and the orthography of Prussian is that of locally used German, hence we see <*ckt*> or <*ct*> for */kt/*, <*x*> for */ks/*, geminates could mark the length of the preceding syllable, etc. The problem of the phonetic reality of Prussian is important, especially in cases of clusters of *sibilant* + *t*, since attested <*st*> could be a realization of */št/* as well as */st/* (cf. Gerullis 1922: 221). Similarly, the phonetic value of <*s*> could as well be either /*š*/ or /*s*/ or /*z*/.

Regarding our clusters of interest, the general features of clustering follow the general Baltic course (clusters of peripheral plosives + *t/s* are preserved; *Tt* realizes as *st*, clusters formed by a sibilant of any origin + *s* are realized by a single sibilant), in fact in many features are more similar to Latvian than Prussians geographical neighbour Lithuanian.

3.4.1 The development of clusters *obstruent + t/s*

The development of clusters of our interest is generally well attested, though the literary sources we have at our disposal are not numerous. The data are written with a Low German orthography and by writers without a native knowledge of the language, hence with varying orthography, which negatively affects the outcomes.

P + t = Pruss. pt:

inf. *trapt* ʽstep’ (< IE *√*trep*-; cf. cf. cf. Gr. τρᾰπέω ʽtread grapes’, OS *thrabōn* ʽtrot’; cf. Pokorny IEW: 1094; LIV^2: 650; Smoczyński 2005: 370; Mažiulis 2013: 915; Derksen 2015: 469–470);

septmas ʽseventh’ (< IE **septm̥*; cf. OIA *saptá-*, L. *septem*; cf. Pokorny IEW: 909; Comrie 1992: 756–759; Blažek 1999: 246, 249; Mažiulis 2013: 843; Derksen 2015: 393–394);

dalptan ʽchisel’ (< IE *√*d^helb^h*-; cf. Lith. *dálba* ʽlever’, OS *delfan* ‘dig’; cf. Mažiulis 2013: 103; cf. ; cf. Pokorny IEW: 246; LIV^2: 143; Mažiulis 2013: 103; Derksen 2015: 113, 120);

P + s = Pruss. ps:

abse ʽaspen’ (< IE **aps*-; cf. Lith. *āpušė, ẽpušė*, OHG *aspa* ‘aspen’ ; cf. Pokorny IEW: 55; Mažiulis 2013: 4-5; Derksen 2015: 154);

wobse ‘wasp’ (< *(H_1)*u̯ob^h-s*-; cf. Lith. *vapsvà*, Latv. *vapsene*, *vapsine,* L. *vespa*, OHG *wafsa* ‘wasp’; cf. Pokorny IEW: 1179; Mažiulis 2013: 963; Derksen 2015: 488);

K$^{(u̯)}$ + t = Pruss. kt:

deickton, deicktan ʽplace, something’ (< IE *√*d^hei̯Hg^u*-; cf. Lith. *dáiktas* ʽthing, object’, Latv. *daîkts* ʽobject, thing, tool’; cf. Pokorny IEW: 243–244; LIV^2: 142; Mažiulis 2013: 111; Derksen 2015: 111);

penckts, *pyiencksts*, *piēncts* ʽfifth’ (< IE **penk^u-to*-; cf. Lith. *peñktas*, OIA *pakthā́ḥ* ‘fifth’; Comrie 1992: 752–754; Blažek 1999: 224; cf. Pokorny IEW: 808; Mažiulis 2013: 690; Derksen 2015: 351);

duckti ʽdaughter’ (< PBalt.**duktē* < IE **d^hugH^2-ter*-[96]; cf. Litv. *duktė̃,* OIA *duhitár*- ‘daughter’; cf. Pokorny IEW: 277; NIL 126–130; Mažiulis 2013: 146; Derksen 2015: 145);

nacktin ʽnight’ (< IE **nek^u-t*-; cf. Lith. *naktìs*, Latv. *nakts,* Hitt. *nekuz* gen sg. ʽin the evening’; etc.; cf. Pokorny IEW: 762–763; NIL 504–513; Mažiulis 2013: 626; Derksen 2015: 327–328);

K$^{(u̯)}$ + s = Pruss. ks:

various personal names: *Paxis* (Lith. *Pakšys*); *Lixa* (Lith. *Likšas*); *Kixe* (Lat. *Kiksis*) (cf. Trautmann 1974: 178–179);

Note: Other examples on *Ks*-clusters than proper names are hard to identify.

Ḱ + t = Pruss. st:

instixs ʽthumb’ (< IE *H_1enḱ-t-/H_2neḱ-t-* (?);[97] cf. Lith. *nykštỹs*[98], Latv. *îkstis*; cf. LIV^2: 282–283; Mažiulis 2013: 304; Derksen 2015: 335);

[96] Alternatively < IE **d^huǵH^2-ter*-, then belonging to *Ḱt*-clusters.
[97] But Fraenkel (LEW: 188) proposes IE *√*H_2id*- “swell”.
[98] Lith. *n*- is regarded as secondary, cf. Derksen 2015: 335. The etymology is not clear, but the internal cluster is reconstructed always with *ḱt*.

pistwis ʽdogs flies (= 4th of Plagues of Egypt)'[99] (< IE *√*peḱ*-; cf. OCS *рьсъ* ʽdog'; cf. Pokorny IEW: 795; Mažiulis 2013: 716; Derksen 2015: 431);

Ḱ + s = Pruss. 0s/ss (?):[100]

assis[101] ʽaxle' (< IE **H_2eḱs-i*-; cf. OIA *ákṣa*-, L. *axis*; cf. Pokorny IEW: 6; NIL 259–262; Mažiulis 2013: 49–50; Derksen 2015: 63);

lalasso ʽsalmon' (< IE **loḱsi*; cf. Toch. B *laks* 'fish'; OHG *lahs*, Lith. *lãšiš* 'salmon'; cf. Pokorny IEW: 653; Derksen 2015: 274);

wuschts, usts, uschts etc. ʽsixths' (< IE **(s)uḱs-tH_2*-[102]; cf. Lith. *šẽstas*, OIA. *ṣaṣṭhá*-; cf. ; cf. Pokorny IEW: 1044; Comrie 1992: 754–755; Blažek 1999: 238; Mažiulis 2013: 924–925; Derksen 2015: 446);

T + t = Pruss. st:

inf. *istwei, īst ist* ʽeat' (< IE *√*H_1ed*-; cf. Pruss. *īdis* ʽfood', Hitt. *ēdmi*, OIA *átti*, L. *edō* 'eat'; cf. Pokorny IEW: 287–289; LIV^2: 230–231; Smoczyński 2005: 184; NIL 208–220; Mažiulis 2013: 316–317; Derksen 2015: 157–158);

ppp. *pomests* ʽsubject' (< IE *√*met*-; cf. Latv. pr. *mętu*, OCS *metǫ, mesti* ʽthrow'; cf. Pokorny IEW: 703–704; LIV^2: 442; Smoczyński 2005: 279–280; Mažiulis 2013: 741–743; Derksen 2015: 313–314);[103]

inf. *dāst, dast*, pr. 3rd sg. athem. *dāst* ʽgive' (inf. *dātwei, datwei*; < IE **de-dH_3-ti*; cf. Lith. *dúoti*, OCS *dastъ*, OIA *dádāti*; cf. Pokorny IEW: 223–225; LIV^2: 105–106; Smoczyński 2005: 72–80; Mažiulis 2013: 106–107; Derksen 2015: 146–147);

inf. *waist* ʽknow' (cf. pr. 1st pl. *waidimai*; < IE *√*u̯ei̯d*-; cf. OIA *véda*, Gr. (ϝ)οῖδα 'know'; cf. Pokorny IEW: 1125–1127; LIV^2: 665–667; Smoczyński 2005: 382–388; Mažiulis 2013: 928–929; Derksen 2015: 566);

T + s = Pruss. 0s:

pr. 2nd sg. athem. *waisei, waisse* 'know'[104] (cf. pr. 1st pl. *waidimai*; < IE *√*u̯ei̯d*-; cf. OIA *véda*, Gr. (ϝ)οῖδα 'know'; cf. Pokorny IEW: 1125–1127; LIV^2: 665–667; Smoczyński 2005: 382–388; Mažiulis 2013: 928–929; Derksen 2015: 566);

sta-pr. *poprestemmai* ʽfeel' (cf. inf. *issprestun*; < IE *√*pret*-; cf. Goth. *fraþjan* 'understand'; cf. Pokorny IEW: 845; LIV^2: 493; Smoczyński 2005: 281–282; Mažiulis 2013: 315–316, 746–747; Derksen 2015: 369);

sta-pr. *wīrst* ʽbecome' (< IE *√*u̯ert*-; cf. Lith. *vir̃sta*, OIA *vártate* ʽturn' OCS *vraštǫ*, L. *uertor* 'turn'; cf. Pokorny IEW: 1156–1158; LIV^2: 691–962; Smoczyński 2005: 409–411; Mažiulis 2013: 953–954; Derksen 2015: 498);

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[99] Since the word is a translation of German *huntfliege* of the same meaning, there is no doubt of its relationship to CS *рьсъ* ́dog'.

[100] The forms of *wuschts, uschts, uschtai, uschtan* ʽsixths' offer only a solution with the *št*-cluster (cf. Mažiulis 2013: 924–925), but this is probably an outcome of the cluster *Ḱst* only.

[101] The ʽgeminate' <*ss*> marks the shortness of the preceding vowel (as in German, cf. Endzelin 1944: 23–24).

[102] The Prussian form we reconstruct: *šukš-to-* > (*š*)*ušta-* (Stang 1966: 279, 283, Blažek 1999: 238, Derksen 2015: 446)

[103] Not securely attested outside Balto-Slavic. Derksen (l.c.) proposes as cognates L. *metere* "mow, harvest" and W. *medi* "reap". LIV^2 (l.c.) proposes as a cognate Gr. μέτρον "measure".

[104] The assumed development here is: *-d-s-* > *-ss-* > *-0s-*.

s + t = Pruss. st:

pr. 3rd sg. athem. *ast, æst, est* 'be' (< IE *√H_1*es*-; cf. OIA *ásti*, L. *est*, OLith. *ẽsti* 'be'; cf. Endzelin 1944: 161; Pokorny IEW: 340–341; LIV²: 241–242; Smoczyński 2005: 24–28; Mažiulis 2013: 47–48; Derksen 2015: 157);

inf. *tiēnstwei* 'provoke' (imp. *tenseiti*; < IE *√*tens*-; cf. OIA *taṁsayethe* 'tug', Goth. -*þinsan* 'pull', Lith. *tę̃sti* 'continue, proceed'; cf. Pokorny IEW: 1068–1069; LIV²: 629; Smoczyński 2005: 366–367; Mažiulis 2013: 910; Derksen 2015: 464);

inxcze 'kidney' (< IE *H_2*id-st*-; cf. Lith. *ìnkstas*, Latv. *îkstis*, OCS *istesa* 'kidney', ON *eista* 'testicle'; cf. Pokorny IEW: 774; LIV²: 258; Mažiulis 2013: 304; Derksen 2015: 202);[105]

š + t = Pruss. st:

pirsten 'finger' (< IE *$prstH_2o$-; Lith. *pir̃štas*, Latv. *pìrst*; cf. Pokorny IEW: 813; NIL 637–659; Mažiulis 2013: 715–716; Derksen 2015: 358);

austo, *āustin* 'mouth' (< IE **Heu̯s-t*-; cf. Lith. *úostas*, Latv. *uōsta* 'port, harbor, mouth of a river', OCS *usta* 'mouth', OIA *óṣṭha*- '(upper) lip'; cf. Pokorny IEW: 784–785; Mažiulis 2013: 64; Derksen 2015: 481–482);

s + s = Pruss. 0s:

pr. 2nd sg. athem. *assei, essei, assai, asse, esse* 'be' (< IE *√H_1*es*-; cf. Lith. *esi*, OIA *ási* 'be'; cf. Endzelin 1944: 161; Pokorny IEW: 340–341; LIV²: 241–242; Smoczyński 2005: 24–28; Mažiulis 2013: 47–48; Derksen 2015: 157);

fut. *postāsei* 'become' (√*steH*$_2$*-s-sei*, cf. Endzelin 1944: 176; Stang 1966: 397; Pokorny IEW: 1004–1108; LIV²: 590–592; Smoczyński 2005: 284–287, 468; NIL 637–659; Mažiulis 2013: 749–750; Derksen 2015: 430);

š + s = Pruss. [0s]:

not attested (?). The reconstructed form is based on analogous *Ḱs*, assuming that both clusters could have a common outcome, as in other *satəm*-languages.

3.4.2 The overview of the Prussian alternations

The development of clusters of our interest in Prussian is similar to that of Latvian. The peripheral series clusters are preserved, as are clusters of a sibilant + *t/s*, but note that the *ruki*-clusters are depalatalized, and what is more, even clusters of old palatovelars + *t* are depalatalized too. A remarkable feature is the loss of a plosive (from the synchronic point of view a total elision) before *s*-affixes.

IE	**Prussian**	t-	s-
-K(u̯)	-k	*kt*	*ks*
-Ḱ	-s	*st*	*0s*
-T	-t	*st*	*0s*
-P	-p	*pt*	*ps*
-s	-s	*st*	*0s*
-š	-s	*st*	(*0s*)

[105] In our opinion, it is possible to assume the connection of Baltic **i*(*n*)*st*- (reconstructed in the accord to Derksen l.c.) with IE *√*H*$_2$*ei̯d*- (cf. Gr. οἰδέω, Arm. *yatnowm* "swell", ON *eitr* "pus", OCS *jadъ*).

3.5 Trajectories of the Baltic developments

The development of clusters of obstruent + *t/s*(/d^h) can be split into three blocks: the first block is that of acute/central plosives (i.e., dentals and original palatovelars); the second block is that of the grave/peripheral plosives (i.e., original plain velars/labiovelars and labials); the third block is that of sibilants. The distinction between blocks can be listed as:

i. based on the opposition between plosives (the first and second block) and sibilants (the third block);

ii. based on the opposition between the central and the peripheral series, this distinction is given by the fricativization of the first series before *t/s*.

3.5.1 The development of the peripheral series

The development of both peripheral/grave series has no special outcomes besides the expected alternation of voice; the clusters were neither fricativized nor simplified.

For the development of the labial series, the trajectory could be modelled as:

i. **P + t** > **pt** (Common Baltic)

i. **P + s** > **ps** (Common Baltic)

For the development of the (labio)velar series (labiovelars merged with plain velars in all *satəm*-languages), the trajectory could be modelled as:

i. **K$^{(u̯)}$ + t** > **kt** (Common Baltic)

i. **K$^{(u̯)}$ + s** > **ks** (Common Baltic)

The interesting point is whether the IE *K*$^{(u)}$*s* was affected by Pedersen's Law (the *ruki*-rule) as it was in Indo-Iranian (cf. OIA √*vac*- 'speak': ft. *vakṣyáti*, ds. *vívakṣati*; Av. √*vac*- 'speak': OAv. fut. *vaxšiiā*, both from IE *√*u̯ek*^{u}-) and Slavic (ao. *těxъ* 'flow' from IE *√*tek*^{u}-). If Pre-Baltic **s* was affected by the *ruki*-rule after **k* (of different origin), the expected outcome would be **kš*, the same outcome as **Ḱs* already has (and is attested in Lithuanian). We have to bear in mind that Indic, Iranian and Baltic register the same outcome for **Ks* and **Ḱs*; the Baltic situation remarkably deviates from its parallels. The possible solution we propose is: the cluster palatovelar + *s* was soon realized as *çš*, but original *Kš* was preserved as *kš*. The further development of the original cluster of *Ḱš* was: *çš* > *šš* > *0š* (see above) but of the original cluster of *Kš* had a development: *kš* > *ks*, i.e., with the later depalatalization of the sibilant. We assume similar depalatalizations as a general process in Latvian (and similarly for Prussian).

3.5.2 The development of the central series I: original palatovelar series

The second oldest development is that of the original palatovelar series, which is attested for all *satəm*-languages.

As with the development of clusters of *Tt/Ts*, there are two possible trajectories, first the **affricativization** trajectory, second the **spirantization** trajectory, both leading to the sibilant outcome, hence again both are two variants of the more general **fricativization model**.

The affricate model assumes the affrication of original IE palatovelars to palatal affricates (in all positions, but we are interested only in the context of *t/s*), and the later loss of the plosive segment of an affricate. The clusters with sibilants were hence formed by two sibilants, one of which was elided. For Latvian (and possibly for Prussian) we assume the later depalatalization:

i. **Ḱ + t** > t$^{\check{s}}$t > **št**	(Lithuanian)
ii. **Ḱ + t** > t$^{\check{s}}$t > št > **st**	(Latvian)
iii. **Ḱ + t** > t$^{\check{s}}$t > št > **st/št** (?)	(Prussian)

i. **Ḱ + s** > t$^{\check{s}}$š > šš > **0š**	(Lithuanian)
ii. **Ḱ + s** > t$^{\check{s}}$š > šš > 0š > **0s**	(Latvian)
iii. **Ḱ + s** > t$^{\check{s}}$š > šš > **0s/0š** (?)	(Prussian)

We model the spirantization trajectory with a spirantization of IE palatovelar to palatal spirant *ç*, later sibilantized on *š*, later depalatalized in Latvian (and Prussian ?). The cluster of *Ḱt* is then preserved as *št* in Lithuanian, as *st* in Latvian. The cluster of *Ḱs* first underwent palatalization of **s* to *š* due to Pedersen's Law, but later the first segment was also replaced by the *ç* due to analogy. This cluster turned into a sibilant geminate, which was later simplified (and depalatalized in Latvian – we have no firm data on Prussian):

i. **Ḱ + t** > çt > **št**	(Lithuanian)
ii. **Ḱ + t** > çt > št > **st**	(Latvian)
iii. **Ḱ + t** > çt > št > **st/št** (?)	(Prussian)

i. **Ḱ + s** > çš > šš > **0š**	(Lithuanian)
ii. **Ḱ + s** > çš > šš > 0š > **0s**	(Latvian)
iii. **Ḱ + s** > çš > šš > **0s/0š** (?)	(Prussian)

However, palatovelar + *s* clusters were simplified in a similar way to *Ts* clusters and *palatovelar* + *t* cluster was preserved as *sibilant + t* as the *Tt* cluster was (see above).

Balto-Finnish languages, or more precisely, loanwords from Baltic into them bring external proof that the old palatovelars were originally palatal sibilants . The old palatal sibilants *š and *ž are realized as *h* in Balto-Finnish, cf. Finn. *hammas,* Est. *hammas* 'tooth' (cf. Lith. *žam̃bas* 'sharp edge', Latv. *zuôbs* 'tooth' < IE **ǵomb^{h}o-*), Finn. *herne,* Est. *hernes* 'pea' (cf. Lith. *žìrnis,* Latv. *zir̃nis* < IE **ǵṛH_2no-*), Finn. *lohi,* Est. *lõhe* 'salmon' (cf. Lith. *lašišà, lašis,* Latv. *lasis* 'salmon' (< IE **loḱso-*) (Young 2017: 498). It is hardly imaginable that Balto-Finnish forms traceable to palatal sibilants came through another channel than the North Baltic dialects, i.e. the ancestors of Modern Latvian, hence the original existence of palatal sibilants (from original palatovelars) should be taken for granted for the whole Baltic area.

3.5.3 The development of the central series II: dental series

The oldest stratum of the development is the development of the dental series of the central block, which is shared with all other Indo-European branches. Its input is *Tt/Ts;* its output is *st/0s*.

To model this development, we can use two possible strategies, that of **affricatization** and that of **spirantization**, though both end with the same final outcome.

The classic affrication model assumes the affricatization of the first dental, the later loss of the plosive section of the affricate, and simplification (for clusters of *Ts*). This model is based on the affricatization model for IE languages, developed initially by Kräuter (1877: 88)[106] and popularized by Brugmann (firstly 1880: 140–142, used since). This model is supported by the fact that affricates are outcomes of *T* in clusters of **Tt* attested in Anatolian (cf. Hitt. 3rd sg. preterite <*e-iz-ta*> and 3rd sg. imperative <*e-iz-du*> from √*H_1ed-* 'eat'); this feature of Anatolian was first noted by Götze (1928: 126), but put in the light first by Sturtevant (1933a: 6–7; 1933b: 129); later especially see Oettinger (1979: 530–532) and Melchert (1994: 113, 151, 249). It has to be emphasized that attested affricates in Anatolian do not prove that this process was universal for all Indo-European languages. The trajectory as such is expressed by Otrębski (1958: 338–339).

The affricate model could be modelled as:

i. **T + t** > t^st > **st** (Common Baltic)

i. **T + s** > t^ss > ss > **0s** (Common Baltic)

[106] Interesting is that Kräuter speaks about affrication, but his *description* of the feature is that of a *spirantization*! Verner (1878: 341–342) has a critical evaluation of the idea.

The alternative spirantization model assumes the spirantization of the left plosive and later sibilantization of the spirant (and the subsequent simplification of clusters from *Ts* – this feature is the same for both models). This model is based on the ideas of Bartholomae (1895: 16 and later), who assumed *Tt* > *ϑt* > *st*, and the model is taken as a possibility by Leumann (1942: 13). It is also interesting that Brugmann (1886: 347), otherwise the popularizer of the affricatization theory, in his first version assumes the development: *Tt* > $t^{þ}t$ (i.e., $t^{\vartheta}t$ [sic!]).

i. **T + t** > ϑt > **st** (Common Baltic)

i. **T + s** > ϑs > ss > **0s** (Common Baltic)

The spirantization model has clear advantages for the development of Indo-Iranian languages. However, no internal data are leading us to prefer it over the traditional affrication model within the development of Baltic languages, though, on the other hand, there is similarly no reason to prefer the affricativization trajectory over that of spirantization. Both, however, lead towards the same outcome (a dental sibilant), and both could be generalized as **fricativization trajectories**.

3.5.4 The development of the sibilants

The development of the Baltic sibilants is simple: the clusters of the *sibilant* + **t* are preserved as such, the clusters of *sibilant* + **s* are simplified, and these processes are parallel to the development of clusters of palatovelars, as described above.

It should be noted that cluster *st* is merged with original cluster *Tt*; similarly, clusters of *ss* and clusters of *Ts*. A similar process is attested in Iranian and Slavic.

The processes are fully preserved in Lithuanian; Latvian later depalatalized clusters *št/0š* of any origin (Prussian dates are inconclusive, hence the Latvian outcome is simplified it its outputs.

Here we have to emphasize that clusters of *št* and *Ḱt* are merged (as they are in other *satəm*-languages), as are outcomes of clusters of *šs* and *Ḱs*.

i. **s + t** > **st** (Common Baltic)

i. **š + t** > **št** (Lithuanian)
ii. **š + t** > št > **st** (Latvian)
iii. **š + t** > št > **st** (Prussian)

i. **s + s** > ss > **0s** (Lithuanian)
ii. **s + s** > ss > **0s** (var. → **sīs**) (Latvian)

iii. **s + s** > ss > **0s** (Prussian)

i. **š + s** > šš > **0š** (Lithuanian)
ii. **š + s** > šš > ss > **0s** (var. → **sīs**) (Latvian)
iii. **š + s** > šš > **ss/0š** (?) (Prussian)

To shed some light on the development of clusters of *št, šs*, we have to make an excursion on the problem of the *ruki*-rule in Baltic (see the excursion).

3.5.5 An excursion on the *ruki*-rule in Baltic

Clusters with **š*, resulting from the earlier **s* due to Pedersen's Law deserve special attention.

This law operates in Indo-Iranian and Slavic after triggers[107], represented by the shortcut *ruki*. The rule as a mechanism is attested directly only in Lithuanian (if this rule was limited to dialects preceding Lithuanian is also a matter of debate).

The problematic points are:
i. the context of the rule;
ii. the dialectal extension of the rule.

To this, we have to add that *št/0š* are securely preserved in Lithuanian but not in Latvian (the Prussian state was commented on above).

The (Lithuanian) examples (and contra-examples) of Pedersen's rule:

r + s: *viršùs* 'summit' (Latv. *vìrsus*, OCS *vrъxъ*); *širšuō* 'wasp' (Latv. *sir̂sins*, Pruss. *sirsilis*, OCS *sъrъšenь* 'hornet'); *pir̃štas* 'finger' (Latv. *pìrst*, Pruss. *pirsten*, OCS *prъstъ*);
k + s:[108] *ašìs* 'axle, axis' (Latv. *ass*, Pruss. *assis*, OCS *osь*); *lašišà*, *lašìs* etc. 'salmon' (Latv. *lasis*, Pruss. *lalasso* [instead of *lasasso*?[109]], Cz. *losos*, ON *lax*, Toch B *laks* 'fish');
i + s: *maĩšas* 'bag, sack' (Latv. *màiss*, Pruss. *moasis* 'bellows', OCS *měxъ*); *ríešutas* 'nut' (Latv. *riẽks*, OCS *orěxъ*);
but:
visas 'all' (Latv. *viss*, Pruss. *wissa-*, OCS *vьsь*); *lysė* '(garden)bed' (Pruss. *lyso*, OCS *lěxa* 'row, furrow';
u + s: *aušrà* 'dawn' (Latv. *àustra*, OCS *utro*); *ẽpušė*, *ãpušė* 'aspen' (Latv. *apse*, Ru. *osína*, OHG *aspa*); *vẽtušas* 'old, archaic' (OCS *vetъxъ*);
but:
ausìs 'ear' (Latv. *àuss*, Pruss. *āusins*, OCS *uxo*, L. *auris*); *saũsas* 'dry' (Latv. *sàuss*, Pruss. *sausā*, OCS *suxъ*).

It was already Pedersen himself (Pedersen 1895) who first assumed that the rule affected even the Baltic continuum to the same extent in the whole area, though he was aware of discrepancies and a general lack of regularity of the rule in Baltic (in fact, in Lithuanian). Similarly, Otrębski (1954: 32) considers the development to be originally developed in all four contexts if **s* was followed by *i̯*, but later partially undone after *i/u* (in contrast, the universality of the law is assumed in Otrębski 1958: 301–302, 309). Rozwadowski (1961: 100–101) and Szemerényi (1957: 106–107) argue for all-contexts change, later re-archaized (a case of a partial regression), and they strongly argue for the universality of the *ruki*-rule in Baltic, not only Lithuanian, as later does Andersen (1968), who emphasizes the structural reasons to assume original *satəm* unity of the process called Pedersen's Law and brings models of the assumed levelling due to morphology (Andersen 1968: 183–185). The old 'universal' application of the rule is supported by Kortlandt (1980: 245) or Smoczyński (2001: 22). Petit (2018: 1649) surprisingly gives no statement on this question.

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[107] Surprisingly, in Iranian, the trigger could even be *p*, cf. YAv. *drafša-* "flag" (cf. OIA *drapsá-*), OAv. *dißžaidiiāi* (cf. OIA *dípsati*, √*dab*^{h}- "harm"). That this process is a later analogy is betrayed by the fact that it affects even sibilants from original palatovelar in given contexts, cf. Av. *fšu-* "cattle" (cf. Av. *pasu-*, OIA *paśu-*). However, this innovation is far from universal since we meet: pr. YAv. *tafsat̰* (√*tap-* "heat"); pr. YAv. *x*^{v}*afsa, x*^{v}*afsata* (√*x*^{v}*ap-* "sleep"). The original extension covered only original **s*, not clusters with it.
[108] All examples are on original cluster *Ḱs*, not on *Ks* (cf. Stang 1966: 95–96). The outcome of *Ḱs* is in Lithuanian *0š*, in Latvian *0s*. The cluster *Ks* has outcome: *ks*
[109] Derksen 2015: 274–275

In contrast, Endzelin (1923: 110; Endzelin 1939: 107–115), Fraenkel (1950a: 113–114), defended the thesis that Baltic/Lithuanian extension of the law was limited to the context of *r, k* only and that Lithuanian examples on the effectuation in context *i u* have other etymologies. Pisani (1947) even restricts the extension of the law to the context of *r*; in this, he is followed later by Senn (1966: 82).

Karaliūnas (1966) produced the idea that Pedersen's law affected Lithuanian[110] **s* only in unproductive words, while **s* was unchanged in productive contexts. Karaliūnas hence tried to resolve why there Lith. *maĩšas* is 'sack' but Lith. *ausìs* 'ear', but though his observations on productivity have value, it is an example of an improper extension of modern synchronic productivity to diachronic development and should be rejected.

One of the most influential was Stang's 'dialectal solution' (Stang 1966: 94–100, especially see 99–100), which assumes that the *ruki*-rule was not unexceptional and did not cover all possible incomes, i.e., it never happened in all positions as it was realized in other languages affected by it (Indo-Iranian, Slavic) and that the 'core' of the rule was the context of *r/k*: in the context of *i/u* original *s* was preserved, especially in the productive affixes (cf. Karaliūnas above), with the cases of *š* in this context being secondary. Stang does not even recognize *š* after *i/u* as being an outcome of a single phenomenon and that current state in Lithuanian is a result of a mixing of dialects with various degrees of the application of the rule. Kümmel (2007: 406) and Young (2017: 497) follow the Stang's ideas.

Our opinion could be stated fully within the aforementioned 'universalist approach':

i. Pedersen's Law was fully operational on whole Pre-Baltic area, without any early dialectal differences (hence we reject Stang's 'dialectal solution', in all four *ruki*-contexts;

ii. the later appearance of *s* in *ruki*-contexts in Lithuanian is a result of two processes: either of a levelling due to morphological processes, or of a later depalatalization resulting from the same process which fully affected Latvian (and probably also Prussian);

iii. this depalatalization in Latvian (and partially in Lithuanian) has its parallel outside the Baltic area, in Middle Indo-Aryan, where OIA *ś*, *ṣ*, *s* (< IE **ḱ, š, s*) merged, according to the given dialect, either to 'Western' *s* or 'Eastern' *ś* (cf. OIA *su-* 'well', *daśa-* 'ten', *puruṣa-* 'man' and Pāli *su-*, *dasa, purisa* or Māgadhī *śu-, daśa-*, *puliśa*; Bubenik 1996: 34). In Middle Indo-Aryan, as in Latvian, the seemingly archaic state of sibilants is a result of later processes, not the actual old state – in Latvian and Prussian, even prevocalic sibilants from original palatovelars were affected and merged with *s* – again the same situation we meet in MIA.

3.6 Conclusive remarks to the Baltic development

The oldest stratum of the development is the development of the dental series clusters. There are two possible trajectories for this development: the traditional Kräuter/Bruggmann affricativization trajectory and the de Saussure/Cocchia/Bartholomae spirantization trajectory, both being variants of a wider fricativization trajectory. The preferred trajectory is that of spirantization, since it fully explains the loss of the plosive in the IE cluster **Ts*.

Similar alternative trajectories could be proposed for the development of the IE palatovelar clusters. Again, since they better explain the development of the **Ḱs*-clusters, we prefer the spirantization over the affricativization.

The development of the peripheral clusters is uniformly conservative, preserving unchanged plosives in all three contexts, the development of the (labio)velar series is extraordinary (in the comparison with other *satəm*-languages), which, probably due to the analogy, lost the presumed *ruki*-sibilant, replacing it by *s*. However, the analogical restorations of the non-palatal sibilant are frequent in the wider Baltic continuum (it is total in Latvian and Prussian).

[110] He seems to be not willing to accept the Pan-Baltic extension of the rule.

Similarly conservative is the development of the clusters with a sibilant: the *_St_ clusters are preserved (those afflicted by the _ruki_-rule are depalatalized in Latvian and Prussian), the _*Ss_ clusters are degeminated (again, the _ruki_-clusters are depalatalized in Latvian and Prussian).

4 The development of the two-obstruent clusters from Indo-European into Slavic

4. 0 Slavic languages

Slavic people came into the light of history first in the sixth century AD; however their languages enter history first in the ninth century in the earlier forms of Old Church Slavonic, the dialect based on the South Slavic dialect, which was spread later over the Slavic territory as a cultural language. Other written languages arose over the whole area later (Langston 2017).

The original Slavic language continuum has undergone rapid development, resulting in dialectal split, later languages often following parallel trajectories (c. f. the loss of yers is a universal process, but hardly a single process; it is rather independent processes following similar trajectories, i.e., result of a drift).

4.1 Common Slavic and Old Church Slavonic

On the following lines, we will focus on the development of the Indo-European two-obstruent clusters into Common Slavic. The development of the Indo-European plosives into Common Slavic is well described if we focus exclusively on plosives in prevocalic positions (either in *anlaut* or *inlaut* positions). It is the development of two-obstruent clusters which still has some uncertainty if following trajectories, as we will see below.

Slavic languages are usually considered a sub-branch of the Balto-Slavic family, but the observations of similarities between both IE sub-branches are not valid for the developments of the clusters of our interest. Baltic developments of the peripheral series are more conservative than those of Slavic; hence we deal with both branches independently.

4.2 Common Slavic and Indo-European

The typical features separating the Common Slavic obstruent system from that of Indo-European, relevant for our analysis, are:

i. the merging of the reconstructed voiced aspirates and non-aspirated voiced plosives in a single modal class;[111]
ii. the loss of labiovelars (the merge with plain velars), the *satəm*-series preserved;
iii. the development of the IE cluster *Tt* into a cluster of *st*;
iv. palatalization of old IE plain velars and labiovelars;
v. the *ruki*-rule (=Pedersen's Law), i.e., the shift of IE **s* to Common Slavic *x* (or *š* before palatal vowels).

[111] The original distinction between both modal classes could be traced due to Winter's Law, which causes the lengthening of vowels before original IE voiced non-aspirated plosives (Winter 1976; Kortlandt 1978c; Kortlandt 1978d; Kortlandt 1985a; Korlandt 1985b; Kortlandt 1994a. Kortlandt assumes the original glottal nature of IE voiced non-aspirates; cf. also Sukač 2013, here especially detailed overview of the given literature; note that Winter 1979 and Winter 2011 reject any glottalic explanations). For similar processes in Latin (the Lachmann's Law), Slavic and Tocharian see given chapters.

Baltic, Iranian and Celtic have the same outcome in the development of the modal classes . We can securely assume a direct connection between processes in the first case and a probable connection in the second case; the Celtic development is on the other hand securely independent. The loss of labiovelars is present in all *satəm*-languages; however, a similar development is attested in the *centum*-languages as well, often in the later stages of the same branch (cf. Greek development as a good example). The Pre-Slavic palatovelars were, as usual in *satəm*-languages, later sibilantized (and depalatalized), the same process as we know from the Iranian. The development of clusters of two dentals is universal in the Indo-European family, the Indic development forming not an exception, but a restoration. Similarly, the palatalization of velar plosives is known from Indo-Iranian, but we cannot state it being anything more than a parallel process. The *ruki*-shift is securely attested in Baltic (though not with such a wide scope as in Slavic), and Indo-Iranian, but the examples of such process in Armenian and Albanian are scarce and insecure.

4.3 Slavic clusters and their IE origins

As seems to be regular outside the Indo-Iranian languages, Slavic clusters of plosive + *t/s*- are not subjected to Bartholomae's Law, otherwise the development of clusters formed by -D^h + *t*- would have the output †Dd^h (*DD* after deaspiration), similarly -D^h + *s*- in †*Dz* (after deaspiration). The final voicedness of all clusters is hence given by the quality of voice of the right obstruent.

Old Church Slavonic, as the most archaic attested Slavic language, will serve as the primary source of Slavic data; only in cases of etymologies when OCS data are not attested will other Slavic languages provide data – the OCS data will not be marked in the following lines. We will focus again on productive examples of clusters with *t* or *s* from synchronic data, supported when needed by purely etymological data (especially in cases of 'minor' etymologies of clusters of velar or labial plosives + *t*-).

When speaking about diachrony and synchrony, we have to point out that the clusters of labials + *t* and (labio)velars + *t* have two different outcomes each. One of the outcomes is a result of the synchronic productive process on the contact of two morphs; this will be termed a *major development*. The other outcome is detectable only by means of etymological analysis and is not synchronically productive, and it will be termed a *minor development*.

Note: In the lines below, the examples of verbal flexion are given concerning the Indo-European phonemes in the left position of the cluster. Pokorny IEW, LIV^2, ESJS and Derksen (2008) were used as reference sources; other sources will be quoted when used, especially Arumaa (1976: 54–184).

4.3.1 The development of clusters of labials + *t/s*

The clusters of labials + *t/s* show both a productive (major) development and an etymological (minor) development.

The major development of the cluster **Pt* results in *0t*, and the development of the cluster **Ps* in *0s* (there is, again, no minor development of such clusters):

P + t = OCS pt:

inf. *teti* 'beat' (pr. *tepǫ* < IE*√*tep*-; cf. Lith. *tepù* 'smear'; cf. van Wijk 1931: 52; ESJS: 957; LIV2: 630; Derksen 2008: 491–492);

inf. *-črěti*, sup. *črětъ* 'scoop, draw' (pr. *-črьpǫ* < IE*√(*s*)*kerp*-; cf. L. *carpere* 'pick, pluck', Lith. *kerpù* 'chop, cut'; cf. Pokorny IEW: 944–945; ESJS: 668; LIV2: 559; Derksen 2008: 84);

inf. *greti*, sup. *gretъ* 'row' (< *'dig, bury',[112] pr. *grebǫ* < IE*√*g^{h}reb^h*-; cf. OIA *gṛbhnā́ti* 'seize', Lith. *grė́bti* 'rake, seize'; cf. van Wijk 1931: 52; Pokorny IEW: 455–456; ESJS: 201; LIV2: 201–202 ; Derksen 2008: 186);

inf. *zęti* 'tear' (pr. *zębǫ* < IE*√*ǵemb^h*-; cf. OIA *jambháyati* 'crush'; cf. Pokorny IEW: 369; ESJS: 1128; LIV2: 162–163; Derksen 2008:);

P + s = OCS 0s:

ao. *gresъ* 'row, bury' (< *'dig, bury', pr. *grebǫ* < IE*√*g^{h}reb^h*-; cf. OIA *gṛbhnā́ti* 'seize', Lith. *grė́bti* 'rake, seize'; cf. van Wijk 1931: 52; Pokorny IEW: 455–456; ESJS: 201; LIV2: 201–202 ; Derksen 2008: 186);

CS nom. **osina/osika* (R. *osína*, Pol., Cz. *osika*) 'aspen' (< IE **ap-s*-; cf. Arm. *op'i* 'white poplar', Lith. *ēpušė*, *āpušė* (dial.); Latv. *apse*, *epse*; cf. Vasmer 2: 282; Pokorny IEW: 55; Shevelov 1964: 188; Arumaa 1976: 138; Derksen 2008: 378);

CS nom. **osa* (Ru. *osá*, Cz. *vosa*, Pol. *osa*) 'wasp' (< IE **u̯ob^h-s*-; cf. L. *uespa*, OHG *wafsa*; cf. Vasmer 2: 280; Pokorny IEW: 1179; Shevelov 1964: 188; Derksen 2008: 377);

The minor development of the cluster **Pt* is **st*. The factor determining this development is not clear at the moment, and some of the examples are doubted. Note that not all are attested in OCS:

P + t = OCS st:

CS nom. **stryjь/strъjь/strycь* (SerbCS *strъi*, ORu. *strъi*, *stryi*, Uk. *stryj*, Cz. *strýc*, Pol. *stryj*, SCr. *strîc*, Sln. *stríc*, etc.) 'uncle (lit. father's brother)' is connected to OIA *pítṛya-*, Av. *tūirya-* L. *patruus*, Gr. πάτρως OHG *fatureo* 'fatherly' and shows the initial *str-* < *ptr-* < **pH$_2$tr*- (cf. Vasmer 3: 29; Vey 1931a: 65–66; Kortlandt 1982: 26; Patri 2003: 121; NIL: 554–562; Derksen 2008: 470). It should be noted that Gippert (2002) rejects any connection between **stryjь* and **pH$_2$ter-*,but assumes a connection with Ir. *struith*.

Similarly, the deity name ORu. *Stribogъ* can be derived from *pH$_2$tr*- as well, if this name is considered as a compound with the meaning 'Father/fatherly god', reflecting probably PIE voc. **di̯éu̯ pH$_2$tér* 'father

[112] This meaning is attested in OCz. *hřésti* ; 'bury', Sln. *grébsti* 'dig', etc. The meaning 'row' is attested in Ru. *grestí*, B. *grebá* (beside 'spoon, scoop, rake').

heaven!' > Gk. Ζεῦ πάτερ, Lat. *Iuppiter* (cf. Vey 1958; Schmidt 1973: 75ff., 79f.; 82f.; Pohl 1980: 62; NIL: 554–562; but again, for a contrary view, see Kortlandt 1982: 26; for further ref. cf. Vasmer 3: 27; Hock 2004: 12f.).

And from the same root cf. CS nom. **pastorъkъ* 'stepson' (Uk. *pastorok*, SCr. *pastorak*, Cz. *pastorek* etc.) is allegedly derived from **pa-pH₂tr̥-* (Vey 1931: 65–66; NIL: 554–562). However, this etymology was strongly rejected by Zubatý (1891) and by Kortlandt (1982: 26), cf. Vasmer (2: 322).

CS nom. **nestera* ʽniece' (RuCS. *nestera*, OPol. *nieściora*, SCr. *nèstera*), **netьjь* ʽnephew' (ORu. *netii*, OPol. *nieć*, Sln. *nečák* etc.) . It is remarkable that we find here two variants of the realization of the hypothetical cluster **pt*, i.e., either with regular -*0t*- or with minor -*st* , as both forms are derived from IE **nep(ō)t-* (cf. OIA *naptī*, L. *neptis*, OIr. *necht*; cf. Vasmer 2: 215–216; Pokorny IEW: 764; Schmidt 1973: 78ff. with n. 254; NIL: 520–524; Derksen 2008: 351; ESJS 538). Shevelov (1964: 192) links the different developments to the context of *e* or *i* respectively. We should note that Meillet (1902: 167) supposes an original form **nept-terā*, which would regularly give -*st*- < *-*tt*-. Vey (1931b: XV) considers the *pt*-clusters to have been realized as -*0t*- across morpheme boundaries, but within a single morpheme as -*st*-. Fraenkel (1950b: 63–64) favors analogical contamination with *sestra* ʽsister'.

CS nom. *(*j*)*as*(*ъ*)*trębъ* 'hawk' (Ru. *jastrjabь*, *jástreb*, SCr. *jàstrijeb*, Cz. *jestřáb*, etc.) was reconstructed by Vey as deriving from **HeHḱú-* + *ptr̥-* 'fast flyer' (Vey 1953, supported by Pohl 1980; NIL: 200–201;, strictly rejected by Kortlandt 1982: 26; cf. Patri 2003: 121–122; cf. Vasmer 3: 497–498; ESSJ 1995: 5, 274–275; Derksen 2008: 29).

There are other possible etymologies, but items 1 and 2 (including given sub-items) seem to be the most reliable and promising (for a list of possible etymologies, see especially Pohl 1980; for a strongly opposing view see Kortlandt 1982, but note Arumaa 1976: 139–141). Shevelov (1964: 192) proposes a shift *Pt* > *st* before *i* (cf. the major development of the clusters of velar + *t* below), while Patri (2003: 132) states the minor formula as: *#Pt-* > *#tt-* > *#st-*. It seems that the fragmentary nature of the attested etymologies following the minor development could not give us a definitive statement on the causes of the minor development, should there be any (again, cf. Kortlandt 1982). Darden (1978) proposes two independent processes: *#pt-* > *#st-* in the word-initial and *-pt-* > *0t* in other positions, but this does not explain both *nestera* and *jastrębъ* with *st* in the middle of the word. The minor development **Pt* > *st* is also accepted by Greenberg (2017: 528). It seems most probable that **Pt* > CS *st* in the context of the following *r*. Note that three examples above are on **Ptr*; **nestera* could be the result of a later levelling from **neptr-i̯-* (a reduced grade), which could explain why CS **netьjь* ʽnephew' is with *0t* outcome – here was no *r* within the context of **pt*).

4.3.2 The development of clusters (*labio*)*velar* + *t/s*

There are two possible developments of clusters of IE (labio)velars + *t*-, the first one regular and fully productive in OCS (a major development), the second attested only etymologically (a minor development).

The regular (major) development of the IE clusters of **Kt* results in OCS *št*, the output of the development of IE **Ks* is regularly *0x/0š* (the second being a palatal variant of the first one). The development of labiovelars mirrors that of plain velars since Slavic is a *satəm*-language, hence the outcomes are necessarily the very same:

Note: There is a dialectal difference between main Slavic sub-branches. The outcome *št* for IE *$K^{(u̯)}t$* is attested for Old Church Slavonic, and closely related East South Slavic, West South Slavic and East Slavic have the outcome *č* and West Slavic the outcome *c*.

K + t = OCS št (major development):

inf. *vlěšti*, sup. *vlěštъ* 'drag' (cf. pr. *vlěkǫ* < IE*√*H₂u̯elk*-; cf. YAv. *-*vərəciṇta*, Lith. *velku*̀ 'haul, pull'; cf. Pokorny IEW: 1145; ESJS: 1069–1070; LIV^{2}: 289–290; Derksen 2008: 514);

inf. -*lęšti*, sup. *leštъ* 'bend' (cf. pr. -*lękǫ* < IE*√*lenk*-; cf. Latv. *lùocu* 'bend repeatedly'; cf. Pokorny IEW: 676–677; ESJS: 417; LIV^{2}: 413; Derksen 2008: 277);

inf. *rešti*, sup. *reštъ* 'say' (cf. pr. *rekǫ* < IE*√*rek*-; cf. OIA *racayati* 'effect' (?); cf. Pokorny IEW: 863; ESJS: 761–762; LIV^{2}: 506; Derksen 2008: 433);

inf. *sěšti* 'cut, mow' (cf. pr. *sěkǫ* < IE*√*sek*-; cf. L. *secō*; cf. Pokorny IEW: 896–897; ESJS: 809–810; LIV^{2}: 524; NIL: 604–605; Derksen 2008: 446);[113]

inf. *tlěšti* 'pound' (cf. pr. *tlъkǫ* < IE*√*telk*-; cf. Pokorny IEW: 1062; ESJS: 699; LIV^{2}: 623; Derksen 2008: 490);[114]

inf. -*sęšti* 'touch' (cf. pr. -*segǫ* < IE*√*seg*-; cf. OIA *sájati*, Lith. *segu*̀ 'attach, fasten';cf. Pokorny IEW: 887–888; ESJS: 141; LIV^{2}: 516; Derksen 2008: 449);

inf. *strěšti* 'keep' (cf. pr. *strěgǫ* < IE*√*sterg*-; cf. Gr. στέργω 'love'; cf. Pokorny IEW: 1032; ESJS: 890; LIV^{2}: 598; Derksen 2008: 467);

inf. *strišti* 'cut' (cf. pr. *strigǫ* < IE*√*strei̯g*-; cf. Lith. *striégiu* 'bait, pin'; cf. Pokorny IEW: 1036; ESJS: 890–891; LIV^{2}: 604; Derksen 2008: 469);

inf. -*brěšti* 'take care of' (cf. pr. -*brěgomъ* < IE*√*b^herg^h*-; cf. OE *borgian* 'lend'; cf. Pokorny IEW: 658–659; ESJS: 79; LIV^{2}: 79; Derksen 2008: 36);

inf. *lešti* 'lie' (cf. pr. *lęgǫ* < IE*√*leg^h*-; cf. Goth. *ligan*, Gr. λέχομαι; cf. Pokorny IEW: 658–659; ESJS: 408–410; LIV^{2}: 398–399; Derksen 2008: 270);

inf. *mošti*, sup. *moštъ* 'be able' (cf. pr. *mogǫ* < IE*√*mag^h*-; cf. Goth. *mag* 'be able'; cf. Pokorny IEW: 695, 697; ESJS: 492–493; LIV^{2}: 422; Derksen 2008: 321);

K^{u} + t = OCS št:

inf. *pešti*, sup. *peštъ* 'bake' (cf. pr. *pekǫ* < IE*√*pek^{u}*-; cf. OIA *pácati*, L. *coquō*; cf. Pokorny IEW: 798; ESJS: 636–637; LIV^{2}: 468; NIL: 548–552; Derksen 2008: 393);

inf. *tešti*, sup. *teštъ* 'flow' (cf. pr. *tekǫ* < IE*√*tek^{u}*-; cf. OIA *takti* 'goes through', Lith. *teku*̀ 'run, flow'; cf. van Wijk 1931: 53; Pokorny IEW: 1059–1060; ESJS: 956–957; LIV^{2}: 620–621; Derksen 2008: 489);

inf. *vrěšti* 'throw' (cf. pr. *vrъgǫ* < IE*√*u̯erg^{u}*-; cf. Goth. *wairpan* 'throw'; cf. Pokorny IEW: 1153; ESJS: 1088-1090; LIV^{2}: 689; Derksen 2008: 515);

inf. *žešti* 'burn' (cf. pr. *žegǫ* < IE*√*d^heg^{uh}*-; cf. OIA *dáhati*, Lith. *degu*̀ 'burn' ; cf. Pokorny IEW: 240–241; ESJS: 1150–1151; LIV^{2}: 133–134; Derksen 2008: 554);

K + s = OCS 0x (/0š):

[113] LIV^{2}: 524 reconstructs √*sekH*- based on L. pf. *secuī*, but Slavic form would be ***sex*-.

[114] No secure cognates outside Slavic.

ao. -*vlěxъ* 'drag' (cf. pr. *vlěkǫ* < IE*√*H₂uelk*-; cf. YAv. *-vərəciṇta*, Lith. *velkù* 'haul, pull'; cf. Pokorny IEW: 1145; ESJS: 1069–1070; LIV²: 289–290; Derksen 2008: 514);
ao. -*lęxъ* 'bend' (cf. pr. -*lękǫ* < IE*√*lenk*-; cf. Latv. *luòcu* 'bend repeatedly'; cf. Pokorny IEW: 676–677; ESJS: 417; LIV²: 413; Derksen 2008: 277);
ao. *rěxъ* 'say' (cf. pr. *rekǫ* < IE*√*rek*-; cf. OIA *racayati* 'effect' (?); cf. van Wijk 1931: 52; Pokorny IEW: 863; ESJS: 761–762; LIV²: 506; Derksen 2008: 433);
ao. *tlěxъ* 'pound' (cf. pr. *tlъkǫ* < IE*√*telk*-; cf. Pokorny IEW: 1062; ESJS: 699; LIV²: 623; Derksen 2008: 490);

K^{u} + s = OCS 0x (/0š):
ao. *těxъ* 'flow' (cf. pr. *tekǫ* < IE*√*tek^u*-; cf. OIA *takti* 'goes through', Lith. *tekù* 'run, flow'; cf. Pokorny IEW: 1059–1060; ESJS: 956–957; LIV²: 620–621; Derksen 2008: 489);
ao. *žaxъ*, *žašę* 'burn' (cf. pr. *žegǫ* < IE*√*d^heg^{uh}*-; cf. OIA *dáhati*, Lith. *degù* 'burn'; cf. van Wijk 1931: 52; Pokorny IEW: 240–241; ESJS: 1150–1151; LIV²: 133–134; Derksen 2008: 554);

The minor (etymological) development of the cluster of velar + *t* leads to the loss of the velar plosive, the examples are not numerous, but also not insignificant:

$K^{(u)}$ + t = OCS 0t:
letěti but Lith. *lė̃kti* 'fly', the Slavic form is extended by the suffix -*t*- (< IE *√*lek*-; cf. Meillet 1902: 180; Vasmer 2: 35; Pokorny IEW: 673; ESJS 410; LIV²: 411; Derksen 2008: 271);
netopyrъ 'bat' is considered to be related to OCS *nošti*, L. *nox, noctis*, Hit. gen. *nekuz* 'night' (with the *e*-grade as in **netopyrъ*!) (< IE *√*nek^u*-; cf. Pokorny IEW: 762–763; Vasmer 2: 216; ESJS 540; NIL: 504–513; Derksen 2008: 350);
pętь 'five', the Slavic form going back to the abstract **pénk^u-ti*- 'unity of five',[115] which also explains the construction with gen. pl. (cf. Vasmer 3: 471; Comrie 1992: 752–754; Blažek 1999: 225–226; ESJS 643–644; Derksen 2008: 400);
potъ 'sweat' is an *o*-grade allomorph of the same root-morpheme as in *pekǫ, pešti* 'bake', i.e., from the IE root *√*pek^u*-, again extended by the -*t*-suffix (cf. Zupitza 1899: 266; Vasmer 2: 417; ESJS 689; NIL: 548–552; Derksen 2008: 415). This development is of a special importance, since we have attested a major productive development as well.

Note: There is no special minor development of the cluster of *$K^{(u)}$*s*.

The different major and minor outcomes were, it seems, initially determined by the context; however the assumption of a twofold development of the clusters of velar + *t* is sometimes rejected, as by Hujer (1913), who strongly argues for merely a single development: *Kt* > *0t^j* > *št/c/č*, according to the dialect (via gemination and simplification).

[115] Or it is a backward form of the ordinal *pętъ* cf. Lith. *peñktas*, Latv. *pìektais*, OPruth. *penckts* 'fifth', OIA *pakthā́ḥ*, Gr. πέμπτος; cf. Blažek 1999: 224);

The prevailing opinion is, however, that the different outcomes are caused by the palatal context, before *i̯/i* (but some scholars suppose this development even before *e*): *Kt^i̯* > *št*, in other contexts: *Kt* > *0t*, the palatal outcomes being later extended to all productive contexts due to analogy. This opinion was first formulated by Fortunatov (1888: 566–568) and later by Uhlenbeck (1894: 519), and it was accepted by Vaillant (1950: 83), Shevelov (1964: 191), Mareš (1969[1]: 75; 1999[2]: 67), Lamprecht (1987: 51), Arumaa (1976: 111–113), Rejzek (2008: 169) and others, accepting a trajectory through gemination for both variants. Kortlandt (1994a: 101) presupposes the development *kt* > *k^ć* > *ti̯* (> *št*/*c*/*č*) for the palatal context and does not mention other contexts, and in rejecting gemination, he differs from the other authors listed above.

It is worth noting that the reflexes of the *Kt^i̯*-clusters have merged with the development of the *ti̯*-clusters, and these dialectally differ among the Slavic languages. Old Church Slavonic and the East South Slavic languages have *št*; the West Slavic languages have *c*, East Slavic and West South Slavic have *č*, SCr. *ć*, cf. OCS *noštь*, B. *nošt*, Cz., Pol. *noc*, Ru. *noč*’, Sln. *nôč*, SCr. *nôć* ‘night’ (similarly for **ti̯*: OCS *svěšta*, B. *svešta*, Cz. *svíce*, Pol. *świeca*, Ru. *sveča*, Sln. *sveča*, SCr. *svећa/svijeća* ‘candle’).

4.3.3 The development of the clusters *palatovelar* + *t/s*

All clusters formed by an original palatovelar and *t* or *s* follow the regular formulae. The development seems to correspond to the behaviour of **st*/*ss*-clusters, with which the original Indo-European *Ḱt*/*Ḱs*-clusters have merged. The original palatovelar is depalatalized before *t*- and lost before *s*-, surprisingly there is no palatalization of this suffixal *s*- according to Pedersen’s Law (*ruki*-rule), known from Indo-Iranian and securely attested for Slavic clusters from IE **K^(u̯)s* > CS *0x/0š* (see above):

Ḱ + t = OCS st:

inf. *nesti*, sup. *nestъ* ‘carry’ (cf. pr. *nesǫ* < IE*√*H₁neḱ*-; cf. Lith. *nešù*` ‘carry’, Toch. B. *eṅtār* ‘grab, carry’; cf. Pokorny IEW: 316–318; ESJS: 538–540; LIV[2]: 250; Derksen 2008: 350);

nom. *pьstrъ* ‘colorful’ (inf. *pьsati* ‘draw’ < IE*√*pei̯ḱ*-; cf. OIA *piśānā́*- ‘draw’, Toch. B *piṅken* ‘draw, color’; cf. Pokorny IEW: 794–795; ESJS: 740–741; LIV[2]: 465–466; NIL: 546–548; Derksen 2008: 430–431);

nom. *mastъ* ‘anoint’ (pr. *mazati* < IE*√*maǵ*-; cf. Gr. μάσσω, Att. μάττω ‘knead, wipe’; cf. Pokorny IEW: 696–697; ESJS: 459–460; LIV[2]: 421; Derksen 2008: 304–305);

RuCS inf. *mlěsti* ‘bring down’ (RuCS pr. *mъlzǫ* < IE*√*H₂melǵ*-; cf. Gr. ἀμέλγω ‘milk’; cf. Pokorny IEW: 722–723; ESJS: 482; LIV[2]: 279; Derksen 2008: 307–308);

inf. -*lěsti*, sup. *lěstъ* ‘crawl’ (pr. -*lězǫ* < IE*√*leH₁ǵ^h*-; cf. Pokorny IEW: 660; ESJS: 259–260; LIV[2]: 400; Derksen 2008: 275–276);

inf. *vesti*, sup. *vestъ* ʽcart, lead’ (pr. *vezǫ* < IE*√*u̯eǵ*^{h}-; cf. OIA *váhati* ʽcart, lead’, L. *uehō* ʽdrive’; cf. Pokorny IEW: 1118–1119; ESJS: 1047; LIV^2: 661; Derksen 2008: 517);
inf. -*vrěsti* ʽbound’ (pr. -*vrъzǫ* < IE*√*u̯erǵ*^{h}-; cf. Pokorny IEW: 1154–1155; ESJS: 693; LIV^2: 688; Derksen 2008: 515);

Ḱ + s = OCS 0s:
ao. *nesъ* ʽcarry’ (cf. pr. *nesǫ* < IE*√*H_1neḱ*-; cf. Lith. *nešu*̀ ʽcarry’, Toch. B. *eṅtār* ‘grab, carry’; cf. Pokorny IEW: 316–318; ESJS: 538–540; LIV^2: 250; Derksen 2008: 350);
ao. *lěsъ* ʽcrawl’ (pr. -*lězǫ* < IE *√*leH_1ǵ*^{h}-; cf. OPruss. *līse* ‘crawl’; cf. Pokorny IEW: 660; ESJS: 259–260; LIV^2: 400; Derksen 2008: 275–276);
ao. -*věsъ* ʽcart, lead’ (pr. *vezǫ* < IE*√*u̯eǵ*^{h}-; cf. OIA *váhati* ʽcart, lead’, L. *uehō* ʽdrive’; cf. Pokorny IEW: 1118–1119; ESJS: 1047; LIV^2: 661; Derksen 2008: 517);
ao. -*vrěsъ* ʽbound’ (pr. -*vrъzǫ* < IE *√*u̯erǵ*^{h}-; cf. OE *wyrgan* ‘strangle’; cf. Pokorny IEW: 1154–1155; ESJS: 693; LIV^2: 688; Derksen 2008: 515);
adj. *desnъ* ʽright’ (< IE *√*deḱs-n*; cf. OIA *dákṣiṇa*-, L. *dexter*, Lith. *dẽšinas*; cf. Pokorny IEW: 190–191; ESJS: 127; Derksen 2008: 100–101);
nom. *osь* ʽaxle’ (< IE *√*H_2eḱs-i*; cf. OIA *ákṣa*-, L. *axis*, Lith. *ašìs*; cf. Pokorny IEW: 6; Arumaa 1976: 100; ESJS: 603; NIL: 259–263; Derksen 2008: 380);
*CS *lososъ* ʽsalmon’ (cf. Cz. *losos*, Ru. *losós*, Pol. *łosoś*; < IE **loḱs-os*-; cf. Lith. *lašišà*, ON *lax* ʽsalmon’, TochB *laks* ʽfish’; cf. Pokorny IEW: 653; Vasmer 2: 61; Derksen 2008: 285);

4.3.4 The development of clusters *dental* + *t*/*s*

All clusters of dental + *t* and dental + *s* follow regular formulae of the sibilantization of the dental before an obstruent; both sibilants are later simplified for clusters of *Ts*:

T + t = OCS st:
inf. *gnesti* ‘knead’ (pr. *gnętǫ* < IE *√*gnet*-; cf. OHG *knetan* ‘knead’; cf. Pokorny IEW: 371; ESJS: 182; LIV^2: 191; Derksen 2008: 168);
inf. *cvьsti* ‘flourish’ (pr. *cvьtǫ* < IE *√*ḱu̯ei̯t*-; cf. OIA *cetati* ‘glow, shine’; cf. Pokorny IEW: 916–917; ESJS: 97; LIV^2: 347; Derksen 2008: 258–259);
inf. *čisti* ‘count, read’ (pr. *čьtǫ* < IE *√*k*^{u}*ei̯t*-; cf. OIA *cikéta* ‘beware, know, understand’; cf. Pokorny IEW: 637; ESJS: 108–109; LIV^2: 382; Derksen 2008: 89–90);
inf. *mesti* ‘throw’ (pr. *metǫ* < IE *√*met*-; cf. Lith. *mèsti* ‘throw’; cf. Pokorny IEW: 703–704; ESJS: 462–463; LIV^2: 442; Derksen 2008: 308–309);
pr. *dastь*, *daste*, *dasta*, sup. *dastъ* ‘give’ (inf. *dati* < IE*√*deH_3*-; cf. OIA *dattá*-; cf. Pokorny IEW: 223–225; ESJS: 123–124; LIV^2: 105; Derksen 2008: 96);
inf. *jasti*, pr. *jastъ* ‘eat’ (nom. *jadъ* ‘food’ < IE*√*H_1ed*-; cf. OIA *átti*, L. *edō*; cf. Pokorny IEW: 287–288; ESJS: 273–274; LIV^2: 230; NIL: 208–210; Derksen 2008: 154);
inf. *pasti*, sup. *pastъ* ‘fall’ (pr. *padǫ* < IE*√*ped*-; cf. OIA *pádyate* ‘fall’; cf. Pokorny IEW: 790–792; ESJS: 628–629; LIV^2: 458; NIL: 526–540; Derksen 2008: 392);
inf. *sěsti* ‘sit’ (pr. *sedǫ* < IE*√*sed*-; cf. OIA *sádathas*, L. *sēdī*; cf. Pokorny IEW: 884–887; ESJS: 808–809; LIV^2: 513–514; NIL: 590–600; Derksen 2008: 445, 447);
inf. *bosti* ‘pierce, stab’ (pr. *bodǫ* < IE*√*b*^{h}*ed*^{h}*H_2*-; cf. L. *fodiō*, Lith. *bedu*̀ ‘dig’; cf. Pokorny IEW: 113–114; ESJS: 74; LIV^2: 66; Derksen 2008: 59);
inf. *bljusti* ʽpay attention’ (pr. *bljudǫ* < IE*√*b*^{h}*eu̯d*^{h}-; cf. OIA *bódhayati* ‘observe’, Gr. πεύθομαι ‘give notice’; cf. Pokorny IEW: 150–152; ESJS: 69; LIV^2: 82–83; NIL: 36–37; Derksen 2008: 46);

inf. *žlěsti* ʽcompensate' (pr. *žlědǫ* < IE*√*g*^{h}*eld*^{h}-; cf. Goth. *-gildan* 'repay'; cf. Pokorny IEW: 436; ESJS: 1157–1158; LIV^2: 197; Derksen 2008: 556–557);[116]
inf. *gręsti* ʽgo' (pr. *grędǫ* < IE*√*g*^{h}*reịd*^{h}-; cf. Goth. *grid* 'step', OIr. *in:greinn* 'persecute, follow'; cf. Pokorny IEW: 457–458; ESJS: 202–203; LIV^2: 203; Derksen 2008: 188);
inf. *klasti* 'put' (pr. *kladǫ* < IE*√*k*$^{(u)}$*leH*$_2$*-d*^{h}-; cf. Lith. *klóju* 'spread, cover'; cf. Pokorny IEW: 599; ESJS: 310–311; LIV^2: 362; Derksen 2008: 222–223);
inf. *vesti*, sup. *vestъ* 'lead, conduct' (pr. *vedǫ* < IE*√*ụed*^{h}-; cf. OIr. *fedid*, Lith. *vèsti*; cf. Pokorny IEW: 1115–1117; ESJS: 1046–1047; LIV^2: 659; Derksen 2008: 517);

T + s = OCS 0s:
ao. *-cvisę* ʽflourish' (pr. *cvьtǫ* < IE *√*ḱụeịt*-; cf. OIA *cetati* 'glow, shine'; cf. Pokorny IEW: 916–917; ESJS: 97; LIV^2: 347; Derksen 2008: 258–259);
ao. *čisъ* 'count, read' (pr. *čьtǫ* < IE *√*k*^{u}*eịt*-; cf. OIA *cikéta* 'beware, know, understand'; cf. van Wijk 1931: 52; Pokorny IEW: 637; ESJS: 108–109; LIV^2: 382; Derksen 2008: 89–90);
pr. *dasi* 'give' (inf. *dati* < IE*√*deH*$_3$-; cf. OIA *dátsvá*, *dítsant*-; cf. Pokorny IEW: 223–225; ESJS: 123–124; LIV^2: 105; Derksen 2008: 96);
ao. *jasъ*, pr. *jasi* 'eat' (nom. *jadъ* 'food' < IE*√*H*$_1$*ed*-; cf. OIA *átti*, L. *edō*; cf. Pokorny IEW: 287–288; ESJS: 273–274; LIV^2: 230; NIL: 208–210; Derksen 2008: 154);
ao. *basъ* 'pierce, stab' (pr. *bodǫ* < IE*√*b*^{h}*ed*^{h}*H*$_2$-; cf. L. *fodiō*, Lith. *bedu*`'dig'; cf. Pokorny IEW: 113–114; ESJS: 74; LIV^2: 66; Derksen 2008: 59);
ao. *-bljusъ* ʽpay attention' (pr. *bljudǫ* < IE*√*b*^{h}*eụd*^{h}-; cf. OIA *bódhayati* 'observe', Gr. πεύθομαι 'give notice'; cf. van Wijk 1931: 52; Pokorny IEW: 150–152; ESJS: 69; LIV^2: 82–83; NIL: 36–37; Derksen 2008: 46);
ao. *žlěsъ* ʽcompensate' (pr. *žlědǫ* < IE*√*g*^{h}*eld*^{h}-; cf. Goth. *-gildan* 'repay'; cf. Pokorny IEW: 436; ESJS: 1157–1158; LIV^2: 197; Derksen 2008: 556–557);
ao. *klasъ* 'put' (pr. *kladǫ* < IE*√*k*$^{(u)}$*leH*$_2$*-d*^{h}-; cf. Lith. *klóju* 'spread, cover'; cf. Pokorny IEW: 599; ESJS: 310–311; LIV^2: 362; Derksen 2008: 222–223);
ao. *věsъ* 'lead' (pr. *vedǫ* < IE*√*ụed*^{h}-; cf. OIr. *fedid*, Lith. *vèsti*; cf. Pokorny IEW: 1115–1117; ESJS: 1046–1047; LIV^2: 659; Derksen 2008: 517);

4.3.5 The development of clusters *sibilant + t/s*

All clusters of a sibilant (with either *s* or *š*) + *t* or + *s* have regular development: the clusters with *t-* are preserved, the clusters of two sibilants are simplified:

s + t = OCS st:
inf. *tręsti* 'shake' (pr. *tręsǫ* < IE *√*tre*(*m*)*s*-; cf. OIA *trásati*, Gr. τρέμω, L. *tremō* 'shiver'; cf. Pokorny IEW: 1095; ESJS: 982–983; LIV2: 650–651; Derksen 2008: 497);
pr. *jestъ*, *jeste* 'be' (pr. *jesmь* < IE *√*H*$_1$*es*-; cf. OIA *ásti*, L. *est*, Goth. *ist*; cf. Pokorny IEW: 340–341; ESJS: 283–284; LIV2: 241–242; Derksen 2008: 146);
inf. *pasti* 'pasture, herd' (pr. *pasǫ* < IE *√*peH*$_2$*-s*-; cf. Pokorny IEW: 787, 839; ESJS: 629–630; LIV2: 460; Derksen 2008: 392);
nom. *gostь* 'guest' (< IE **g*^{h}*osti*-; cf. L. *hostis* 'enemy, stranger', Goth. *gasts* 'guest'; cf. Vasmer 1: 300; Pokorny IEW: 453, 540; ESJS: 193; NIL: 173;Derksen 2008: 180–181);

[116] Derksen (2008: 597) considers a borrowing from Germanic, however if valid, it still fully participates on developments *Tt* > *st* and *Ts* > *0s*.

š + t = OCS st:

ao. -*kryste* 'cover' (ao. *kryxomъ*, pr. *kryjǫ* < IE*√*kreu̯H*-; cf. Lith. *kráuju*; cf. Pokorny IEW: 616; ESJS: 372–373; LIV^2: 371; Derksen 2008: 254);

nom. *prъstъ* 'finger' (< IE *√*pr̥-stH*$_2$-; cf. OIA *pr̥-ṣṭhám* 'back, ridge', Lith. *pir̃štas*; cf. Vasmer 2: 344; Pokorny IEW: 813; ESJS: 732–733; Derksen 2008: 428–429);

nom. *pьrstь* 'dust, earth' (< IE *√*pr̥s-t*-; cf. OIA *pr̥ṣant*- 'dotted', Lith. dial. *pir̃kšnys*; cf. Vasmer 2: 344; Pokorny IEW: 823; ESJS: 733; Derksen 2008: 429);

usta 'mouth' (< IE **Heu̯s-t*; cf. OIA *óṣṭha*- 'lip'; cf. Vasmer 3: 191–192; Pokorny IEW: 499, 739; Arumaa 1976: 43; ESJS: 1025–1026; NIL: 390–391; Derksen 2008: 509;);

s + s = OCS 0s:

pr. *jesi* 'be' (pr. *jesmь* < IE *√*H*$_1$*es*-; cf. OIA *ási*, L. *es*, Gr. Aeol. ἔσσι, Ep., Dor. ἐσσί; cf. van Wijk 1931: 52; Pokorny IEW: 340–341; ESJS: 283–284; LIV2: 241–242; Derksen 2008: 146);

ao. -*gasъ* 'extinguish' (pr. -*gasiti* < IE*√(*s*)*g*^{u}*esH*$_2$-; cf. OIA *jajāsa* 'gone', Toch. A *ksalune* 'extinguish'; cf. Pokorny IEW: 479–480; ESJS: 1017; LIV^2: 541–542; Derksen 2008: 161);

š + s = OCS 0š:

ao. -*sъxъ* 'dry' (pr. -*sъxnǫti*[117] < IE*√*H*$_2$*seu̯s*-; cf. OIA *śúṣyati*; cf. Pokorny IEW: 880–881; ESJS: 900; LIV^2: 285; Derksen 2008: 473–474, 479);

The cluster *š* is regularly depalatalized to *st* (cf. Martinet 1955: 240; Andersen 1968: 176–177), similarly to clusters of *Ḱt* (cf. examples above and more on it below). The alternation is visibly attested for the sigmatic aorist endings: 1st sg. -*sъ/xъ*, 1st pl. -*somъ/xomъ* vs. 2nd pl. -*ste*, 2nd du. -*sta*, 3rd du. -*ste*.

4.3.7 Overview of Old Church Slavonic development

The peripheral series in the *t*-context tend to be realized either as a sibilant cluster or as *0t*. Both central series are realized as *st* within the *t*-context. All clusters formed in the *s*-context are realized as a simple sibilant:

IE	**OCS**	*t-*	*s-*
-*ḱ/ǵ/ǵ*^{h}	*s/z*	*st*	*0s*
-*k/g/g*^{h}	*k/g*[118]	*št/0t*	*0š*
-*k*^{u}*/g*^{u}*/g*^{uh}	*k/g*[7]	*št/0t*	*0š*
-*t/d/d*^{h}	*t/d*	*st*	*0s*
-*p/b/b*^{h}	*p/b*	*0t/st*	*0s*
-*s*	*s*	*st*	*0s*
-*š*	*x/š*	*st*	*0š*

[117] The aorist could be otherwise asigmatic.

[118] Or the palatalized forms, valid also for labiovelars.

4.4 Trajectories of Slavic development

The whole development could be split into three blocks: the development of two central series (dental and palatalovelar); the development of the peripheral series (plain velar + original labiovelar and labial series); and sibilants (though this group is not based on its location properties but its sonority)

The most archaic is the development of the central block, especially that of dental series, which underwent similar processes as in other IE languages (cf. OCS *sěsti*, Lith. *sėsti*, Av. *hasta-* < **sed-to-*, etc. the same process **Tt* > *st*; similarly to that in Italic, Germanic and Celtic, too, where the development is **Tt* > *ss*, cf. L. *-sessus*, OIr. *sess*, ON. *sess-* < **sed-to-* etc.).

Similarly, the original Indo-European palatovelar series was sibilantized in an independent process, with parallels in other Indo-European *satəm*-languages. Here again, the first stage of the whole transformation of the Late Indo-European palatovelars into Slavic sibilants started very early, being a part of the complex and shared development of all *satəm*-languages.

The old plain velar and labiovelar series are merged, but a remarkable feature of their development is twofold outcomes, similar to that of the labial series. Arumaa (1976: 56) proposed two possible strategies for the Pre-Slavic development of the peripheral series of clusters of plosive + *t* and plosive + *s*: either the *strategy of spirantization* of the left plosive (he explicitly points to Iranian as an example of this process) or the *strategy of gemination* (Arumaa gives the development of Italian as an example). It must be added that some authors seem to prefer the 'direct' *strategy of simplification* due to the law of open syllables.

The sibilant block preserved the sibilant before *t-* (with depalatalization of **š*, see below); the two sibilant clusters are simplified.

4.4.1 The strategies of the development of peripheral series – (labio)velars and labials

As we have already stated, there are three possible strategies for the development of the peripheral series (the simplification trajectory, the gemination trajectory and the spirantization trajectory). These developments are later than the developments of the dental clusters (which are already Late-Indo-European) or the palatovelar clusters (which are common *satəm*-areal at least in their first phases), but specifically Pre-Slavic, since they are not shared with Baltic languages and (in the case of the development of velars) even dialectally split between different sub-branches of the Slavic languages.

4.4.1.1 The strategy of simplification

The 'law of open syllables' is an assumed tendency in the development of Slavic; however the development of plosives in clusters of plosive + *t* and plosive + *s* does not necessarily have a direct relation to any 'law of open syllables' since the whole process can be split into a series of independent developments,[119] and does not represent a single process appearing at a single moment.

Different versions of the simplification strategy are present in van Wijk (1931: 39, 52–53), Martinet (1952); Mareš (1969[1]: 28; 1999[2]: 34), Lamprecht (1987: 42), Carlton (1991: 100), and Schenker (2002: 67–68). In some respect, the simplification strategy is a convenient descriptive shortcut; however, it can hardly be a proper description of the trajectory itself. On the other hand, the simplification of clusters of two syllables (*SS*) is within the model of the 'simplification' trajectory.

The trajectories for all three peripheral series would be (note the dialectal distinction between given Slavic languages in the case of the major development of *$K^{(u̯)}t$):

$K^{(u̯)}$t > št	(major)	(East South Slavic)
$K^{(u̯)}$t > c	(major)	(West Slavic)
$K^{(u̯)}$t > č	(major)	(West South, East Slavic)
$K^{(u̯)}$t > 0t	(minor)	(Common Slavic)
Pt > 0t	(major)	(Common Slavic)
Pt > st	(minor)	(Common Slavic)
$K^{(u̯)}$s > 0x/0š		(Common Slavic)
Ps > 0s		(Common Slavic)

The strategy of simplification would mean that the input plosives were changed into the output elements (including zero) in a single stroke (i.e., directly from the input to the output). Tempting though this strategy could be, it is hardly a workable model: why would part of the clusters of *$K^{(u̯)}t$ be realized as *št/c/č* and another part as *0t* – the explanation needs at least one intermediate stage between the input and the output. Similarly, the twofold development of the cluster of **Pt* needs at least one intermediate stage for the same reasons. The development of $K^{(u̯)}s$ also

[119] This is strongly supported by the fact that some of the partial developments considered to be part of the Pre-Slavic 'law of open syllables' are attested in other Indo-European branches as well: the loss of final plosives is known from Ancient Greek and Lithuanian, the loss of the final -*s* is attested in numerous branches, the nasalization of vowels and monophthongizations of diphthongs from Middle Indo-Aryan, etc.

requires an intermediate stage affected by Pedersen's Law; again, the outcome could not be a result of a single process.

4.4.1.2 The strategy of gemination

The strategy of gemination is preferred not only by Arumaa himself but also by other scholars (cf. Meillet 1924: 111; Mikkola 1942: 162; Vaillant 1950: 73–74, 82; Shevelov 1964: 188; Townsend/Janda 1996: 52). Arumaa (1979: 56) mentions the development of Italian as an external typological example.

Note: The gemination in Italian can be documented in the following examples:
Vulgar Latin *Kt*-clusters in *factus, octo, cocta, directus, frigidus* are realized in Italian *fatto, otto, cotta, diritto, freddo* (L. *Kt* > It. *tt*); Vulgar Latin *Pt*-clusters in *scriptus, raptus, subtus* are realized in Italian *scritto, ratto, sotto* (L. *Pt* > It. *tt*); Vulgar Latin *Ks*-clusters in *rixa, saxum, lapsus* are realized in Italian *ressa, sasso, lasso* (L. *Ks* > It. *ss*); the Vulgar Latin *Ps*-clusters in *gypsum, capsa, ipse* are realized as Italian *gesso, cassa, esso* (L. *Ks* > It. *ss*); The central *Tt/Ts*-cluster had shifted to *ss* already before. Note that the gemination product always reflects the right obstruent both in location and sonority.

As we have noted, in Slavic, the development of the clusters of (labio)velar + *t* has, as noted above, two different outcomes: either the major *št* (or its replacement *c/č* according to the given dialect) or the minor *Øt*. It seems that the context initially governed the outcomes: palatalized Kt^{i} gave *št* while a non-palatal context gave *Øt*. The palatal context seems to be limited to the position before a high palatal vowel only. The palatal variant later superseded the non-palatal variant in all productively formed clusters, even those where the palatal form could not be original, as in the supine forms where the supine suffix was *-tъ* (from IE **-tum*, cf. OIA *dātum*, L. *datum*, OCS *otъ-datъ*). This process was probably caused by analogy with numerous forms in the palatal contexts. It has to be noted that Hujer (1913) rejects the two-way development of the clusters of (labio)velar + *t* and assumes only one universal development *Kt* > *tt* > t^{i} (> *št*/*c*/*č*).

As mentioned above, the theory of the context-based parallel development was originally presented by Fortunatov (1888: 566–568) and Uhlenbeck (1894: 83) and later, in minor variants, it has been generally accepted by Mikkola (1942: 162),[120] Vaillant (1950: 83) and others, becoming the prevailing view. Shevelov (1964: 191) assumes the development *kt* > *tt* > *ti̯* (> *št*/*c*/*č*) before *i*, otherwise the simple development *kt* > *tt* > *Øt*. Martinet (1955: 353)

[120] Mikkola (1942: 162) uses the development of the Romance cluster *kt* before a palatal vowel to demonstrate the two-way development of Slavic *kt*. Mikkola assumes the trajectory kt^{i} > *ćt* > *št*. Independently, Kortlandt presupposes a development kt^{i} > *kć* > *ti̯*.

suggests that the left plosive became implosive[121] and later formed a geminate with the right plosive (*kt* > *g̊t* > *tt*). Mareš (1969[1]: 75; 1999[2]: 67) prefers the trajectory: *kt* > $kt^{\text{i̯}}$ > $k^{\text{i̯}}t^{\text{i̯}}$ > $t^{\text{i̯}}$ (> *št*/*c*/*č*) for the palatal version, and his idea was accepted later by Lamprecht (1984: 51). Different trajectories, both for palatal and non-palatal clusters, are assumed by Arumaa (1976: 111–113). Rejzek (2008: 169) described the trajectory as: *kt* > $k^{\text{i̯}}t$ > $t^{\text{i̯}}t$ > $t^{\text{i̯}}t^{\text{i̯}}$ > (*št*/*c*/*č*). Collins (2017: 1451) assumes a secondary spread of the palatal variant to the original non-palatal (productive) contexts. We prefer the trajectory as described by Mareš for the velar clusters in the palatal context, Shevelov's for the non-palatal context (see below).

Similarly, the clusters of labials + *t* have two outcomes too, probably governed by contexts, though the contexts of both variants could not be specified as the same as the clusters of (labio)velar + *t*. The gemination theory seems to be a prevailing explanation (cf. Meillet 1924: 111; Vaillant 1950: 73–74, 82; Shevelov 1964: 188; Townsend/ Janda 1996: 52). For the major development, the trajectory could be stated as *Pt* being first geminated to *tt*, and later this geminate being simplified to 0*t*. The minor development shares the gemination stage, but instead of simplification, it is subjected to dissimilation, hence the trajectory *Pt* > *tt* > *st* (Vey 1931: 64–65; Patri 2003: 124–127). Patri assumes that the dissimilation was essentially the same as that of the 'acute' labial clusters, and this provides an explanation for why this dissimilation would affect only parts of the geminates (especially since even *Pt* gave *tt*, according to the gemination strategy).

All the clusters of the peripheral plosive + *s* underwent, according to the geminate strategy, development through universal gemination and simplification: *Cs* > *ss* > 0*s* (cf. Shevelov 1964: 188–190).

The gemination trajectory could be modelled as follows:

$\mathbf{K^{(\text{u̯})}t^{\text{i̯}}}$ > $tt^{\text{i̯}}$ > **št**	(major)	(East South Slavic)
$\mathbf{K^{(\text{u̯})}t^{\text{i̯}}}$ > $tt^{\text{i̯}}$ > **c**	(major)	(West Slavic)
$\mathbf{K^{(\text{u̯})}t^{\text{i̯}}}$ > $tt^{\text{i̯}}$ > **č**	(major)	(West South, East Slavic)
$\mathbf{K^{(\text{u̯})}t}$ > tt > **0t**	(minor)	(Common Slavic)
Pt > tt > **0t**	(major)	(Common Slavic)
Pt > ? > **st**	(minor)	(Common Slavic)
$\mathbf{K^{(\text{u̯})}s}$ **>** kš > šš > **0x/0š**		(Common Slavic)
Ps > ss > **0s**		(Common Slavic)

[121] It seems that Martinet by the term meant 'un-exploded' stop, not the true implosive stop.

What is questionable is the minor development of the cluster of **Pt*, resulting in *st* since it would be the same as that of IE **Tt* > CS *st*, but since all other peripheral clusters do not share this development, it has to be later than the development of the dental series!

4.4.1.3 The strategy of spirantization

The strategy of spirantization is considered as another possibility by Arumaa (1976: 56), who offers the Iranian development as a parallel. Arumaa himself rejects the spirantization trajectory, but it is present in some works by other scholars. Martinet (1955: 353, 365–366) works at least in some cases with spirantization as a model for the development of the palatalized Kt^i-cluster, since he assumes the trajectory kt^i > *çt'*, at least for a part of the Slavic dialectal continuum (otherwise he operates within the limits of gemination/simplification strategy for kt^i > t^it^i > $0t^i$). Similarly, Mikkola (1942: 162) reconstructs a cluster of *ćt'*. A general spirantization of the velar in the *Kt*-cluster is also considered by Rejzek (2008: 169), but afterwards, he prefers the traditional gemination strategy. Vey (1931b: XV) mentions a personal communication with Maurice Grammont, who favored the idea of a spirantization of the clusters *Pt* > *ft* (and later > *st*).[122] The spirantization of the peripheral series is well attested for Sabellian languages, Celtic, Iranian and Middle Greek, being the common strategy of development.

The spirantization model can be viewed as only a part of a broader lenition model, as we will see in the following. For the *Pt*-clusters, we suppose the following development: *Pt* was spirantized to *φt*, this cluster was in the second phase debuccalized to *ht*, and this cluster was in the third phase subjected to the elision of *h*, resulting in 0*t* in the major development.

The minor development of the clusters of *Pt* was the same in the first phase, i.e., in the spirantization *Pt* > *φt*, but in the second phase instead of debuccalization, the cluster was sibilantized to *st*.

The non-palatal *Kt*-clusters developed similarly to the development of the cluster of labial + *t*: *Kt* was spirantized to *xt*. This cluster was later debuccalized to *ht* and elided to 0*t*, which is in accord with the minor development as described above.

The palatalized velar clusters of Kt^i had a slightly different trajectory of development: Kt^i was spirantized to xt^i in the first phase, but there appear different developments according

[122] By *ft* is highly probably meant any cluster formed by a labial spirant, either bilabial or labiodental.

to the later dialectal split, because the *Kt*$^{i̯}$-clusters are realized as *št* in Old Church Slavonic and Bulgarian (East South Slavic), but in West Slavic they appear as *c*, in East Slavic and Slovenian as *č* and in West Balkan languages as *ć*; cf. OCS (*pekǫ* ~) *pešti* ‘bake’, but OCz. (*peku* ~) *péci*; Pol. (*piekę* ~) *piec*; Ru. (*pekú* ~) *peč̍*; Sln. *péči*; SCr. *pèći*, etc. In all branches of Slavic, the result of this process merged with the result of the development of the *ti̯*-cluster (cf. OCS *svěšta* ‘candle’ but OCz. *sviecě*, Pol. *świeca*, Ru. *svěčá*, Sln. *svẹ́ča*, SCr. *svijèća*). According to the spirantization/lenition trajectory, the *Kt*$^{i̯}$-cluster in the dialect preceding Old Church Slavonic/Bulgarian was spirantized first to *xt*$^{i̯}$ and later to *çt*, and the cluster later became sibilantized to *št*. In other dialects, where the output is *c/č*, the cluster of *çt* was realized in the second phase as a cluster of *i̯t*, and in the third phase turned into an affricate according to the specific (and later) parallel developments in given dialects (cf. Schenker 2002: 76; but previously Belić 1921).

For the development of the labial plosive + *t*, we assume the spirantization of the labial plosive, later debuccalized and subjected to elision according to the major trajectory. In the minor trajectory we assume a sibilantization of the labial spirant (probably valid for *ptr*-clusters only).

All peripheral plosives were spirantized before *s*-. Later this spirant was uniformly sibilantized, and the cluster was even later degeminated:

K$^{(u̯)}$**t**$^{i̯}$ > xt$^{i̯}$ > çt > **št**	(major)	(East South Slavic)
K$^{(u̯)}$**t**$^{i̯}$ > xt$^{i̯}$ > i̯t > **c**	(major)	(West Slavic)
K$^{(u̯)}$**t**$^{i̯}$ > xt$^{i̯}$ > i̯t > **č**	(major)	(West South, East Slavic)
K$^{(u̯)}$**t** > xt > ht > **0t**	(minor)	(Common Slavic)
Pt > φt > ht > **0t**	(major)	(Common Slavic)
Prt > φtr > **st**(**r**)	(minor)	(Common Slavic)
K$^{(u̯)}$**s >** xx/šš > **0x/0š**		(Common Slavic)
Ps > φs > ss > **0s**		(Common Slavic)

Note that the null minor outcome of **Kt* is realized as the major outcome of **Pt* and there is a similar parallel between the sibilant major outcome of **Kt* and the minor outcome of **Pt*.

4.4.2 The development of the central series I: the palatovelar series

The development of IE reconstructed palatovelars is a matter of the whole *satəm*-area, in that at least the oldest stage was common for all later *satəm*-languages and for later stages of development we can assume at least a common drift in the similar direction towards sibilants.

The second phase of the development of IE palatovelars was earlier assumed to be a sibilant. Inside this model, we can only assume a depalatalization both before *t*- and *s*- (and later simplification of **śs* on *0s,* as with old IE cluster **ss*).

However, in the last decades the prevailing opinion, based on Nūristānī evidence, is that old Indo-Europeans were realized as affricates in the common *satəm*-phase, and these were later sibilantized. Within this model, the trajectory of the development could be modelled with affrication in the first phase, later loss of the plosive segment of the affricate and later depalatalization. That in Slavic the IE palatovelars were depalatalized could be demonstrated by the parallel development in Iranian, where, though palatovelars were depalatalized in general, palatalization was preserved before a plosive, cf. YAv. ppp. *vašta-* vs YAv. pr. *vazaiti,* both from the root √*vaz-* 'drive' < IE *√*u̯eǵ*^{h}-. We assume a similar process for Slavic, especially since even a cluster of **št* resulting from Pedersen's Law was probably also depalatalized (cf. Andersen 1968: 175–177, 188–190). For IE **Ḱt* > CS **st* we model the following trajectory (a similar trajectory for Indo-Iranian was modelled by Lipp 2009 I: 139–140):

Ḱt > t^{š}t > št > **st** (Common Slavic)

The development of IE clusters **Ḱs*, according to the affricate model could be modelled with an affricatization, and later a loss of the plosive segment and simplification (cf. Andersen 1968: 175–177 and Lipp 2009 I: 155; Lubotsky 2018: 1885 for the parallel Indo-Iranian development):

Ḱs > t^{š}s > šs > ss > **0s** (Common Slavic)

The problematic point of this development is why **šs* (< **Ḱs*) would lose its palatal segment when **šs* (from the *ruki*-cluster **šs*) is realized as CS *0š*. The solution could be to assume that **Ḱs* was subjected to another development than that of affricatization, but this argument just brings another variable to the list of possible trajectories.

We propose a different variant, assuming that the old palatovelars were realized before obstruents neither as sibilants nor affricates, but as spirants, before an *t/s*- as *ç* (the spirantization model). This palatal fricative was later depalatalized to *ϑ* both before *t*- and *s*-. This dental spirant was sibilantized and preserved before *t*-, the two-sibilant cluster (from **Ḱs*) was simplified (cf. Andersen 1968: 189):

Ḱt > çt **>** ϑt **> st** (Common Slavic)

Ḱs > çs **>** ϑs > ss > **0s** (Common Slavic)

4.4.3 The development of the central series II: the dental series

The traditional model, popularized by Brugmann (1880 and since, but originally by Kräuter 1877) assumes the affricatization of the first dental plosive and a later loss of the plosive segment of this affricate. This **affricatization** model is usually used for the Slavic development as well[123] (cf. Vaillant 1950: 80–81; Arumaa 1976: 79–80). The popularity of this model was supported by the fact that in Hittite the outcome of IE **Tt* is $t^s t$ (cf. Hitt. pr. *ezši* 'eat' < IE *√H_1*ed-*; Pokorny 1959: 287–289; Friedrich 1990: 44; Melchert 1994: 97, 109; HED 1–2: 315–321; Kloekhorst 2008: 26, 261–263).

The affricatization trajectory for the development of IE **Tt* then could be modelled as:

Tt > t^st > **st** (Common Slavic)

On the other hand, the same affricatization trajectory for the development of IE **Tt* then would be modelled with an affricatization first, followed by the loss of the plosive segment of the affricate and later simplification:

Ts > t^ss > ss > **0s** (Common Slavic)

Note: The universal strategy both for **Tt* and **Ts* is usually abandoned, and authors usually assume the 'direct' assimilation outside the 'affrication trajectory', cf. Vaillant (1950: 80); Arumaa (1976: 78): ***Ts*** > *ss* > ***0s***.

Another trajectory was proposed for the development of IE cluster **Tt* , assuming spirantization instead of affrication. For Italic languages, it was proposed by Cocchia (1883: 16–58), for Indo-Iranian by Bartholomae (1895: 16 and later works), and later taken as a possibility by Leumann (1942: 13). Within this model, the trajectory for both *Tt* and *Ts* will contain first the spirantization of the plosive, later sibilantized (and the first sibilant being degeminated for **ss* as it was with all other sibilants-only clusters):

Tt > ϑt > **st** (Common Slavic)
Ts > ϑs **>** ss > **0s** (Common Slavic)

The advantage of this model is its simplicity and universality for both clusters; it is worthy of mention that Armenian development (see below), as described by Winter (1962: 261): ****Tt*** >

[123] The development of IE **Tt* is often omitted in general overviews on the phonemic development of Slavic; it is not a subject of analysis in Meillet 1924; Shevelov 1964; Mareš 1969 (1999); or Townsend/Janda (1996) at all.

tϑ > *ϑt* > ***u̯t***[124] (Arm. *giwt* 'find' < IE **u̯id-ti-*) assumes spirantization and could serve as a counter-proof to the Hittite example.

4.4.4 The development of the sibilant series

The development of the cluster of **st* is conservative; clusters are fully preserved. The development of the *ruki*-cluster of *št* is more interesting, which has undergone a depalatalization, as did clusters from IE **Ḱt* (cf. Martinet 1955: 240; Andersen 1968: 176–177, 188–190). The alternative solution could be that Pedersen's Law was not operating before **t-* (cf. Shevelov 1964: 127; Arumaa 1976 II: 43; Pedersen himself had the idea that his law did not operate in Slavic before a plosive, cf. Pedersen 1895: 74).

We prefer the later depalatalization of a cluster for we have attested the aforementioned similar development **Ḱt* > *st* (in Iranian, where IE palatovelars were depalatalized as in Slavic, the palatalization was preserved before a plosive, cf. YAv. ppp. *vašta-* vs YAv. pr. *vazaiti*, both from the root √*vaz-* 'drive' < IE *√*u̯eǵ^h^-*):

st > **st**	(Common Slavic)
št > **st**	(Common Slavic)

Note: The development of the Pre-Slavic *ruki*-sibilant could be even more complicated if the outcome of the Pedersen's rule was originally a palatal non-sibilant spirant *ç* (depalatalized universally to *x* later, *š* being its later palatal sibilant variant before front vowels). In this case, the input would be *çT*, with later palatalization of a second sibilant, assimilation and degemination: ***çt*** > *št* > ***st***, alternatively ***çt*** > *ϑt* > ***st*** (as in the case of the spirantization model of the development of the IE cluster **Tt*).

The development of the two-sibilant clusters is simple; the cluster was degeminated (the *ruki*-cluster was first assimilated):

ss > **0s**	(Common Slavic)
šs > šš > **0š**	(Common Slavic)

Note: Again, if the outcome of Pedersen's Law was originally a palatal non-sibilant spirant *ç* (later *x*, except before front vowels, where *š*), the input would be *çs*, with later palatalization of a second sibilant, assimilation and degemination: ***çs*** > *çš* > *šš* > ***0š***, alternatively ***çs*** > *çš* > *ϑš* > *sš* > ***0š*** (as in the case of the spirantization model of the development of the IE cluster **Tt*).

4.5 Concluding remarks

The Pre-Slavic development is remarkably different from that of Baltic, since almost all the clusters of our interest were totally or partially remodelled.

The oldest part is the development of the clusters of *dental* + *t/s*. Instead of the traditional *affricativization* trajectory of Kräuter and Brugmann we prefer its *spirantization* variant, since

[124] We assume the variant trajectory: ***Tt*** > *ϑt* > *ht* > ***u̯t***

it could better explain the transition of the IE **Ts* into Slavic *0s*. The spirant is more probably to be sibilantized instead of the affricate in the *s*-context.

The second oldest is the development of the clusters of *palatovelar + t/s*. Here we also prefer the spirantization trajectory, again because of the **Ḱs* cluster and for similar reasons as we do with the assumed development of the **Ts* cluster. The output clusters were later both depalatalized.

For the development of peripheral series, we have to reject any trajectory assuming the simple loss of the plosive via 'the law of open syllables': this model could only be a shorthand explanation, nothing more. If we have to choose from other two proposed trajectories, we have to prefer the spirantization trajectory, since it fits the known outcomes more fully, especially if considering the explanation of the *minor developments*, inexplicable as results of a gemination process. Spirantization is a very common development, attested at least for Iranian (but not for Indic), Sabellian (but not for Latin) and Celtic, and even as a later development for the Middle Greek and Italian.

The **st* cluster is preserved, but the *ruki*-cluster **št* is depalatalized, as is the cluster **Ḱt*; both clusters were merged before this development.

Both two-sibilant clusters were simplified, as were all *s*-context clusters with the original plosive in the left position.

5 The development of the two-obstruent clusters from Indo-European into Armenian

5.0 Armenian language

Armenian is a *satəm*-language, forming its own branch within the Indo-European family, related, as many suggest, especially to Greek. This is often as a part of a wider branch of IE languages, often including Phrygian and relic languages of Balkan peninsula (cf. Pedersen 1904; Solta 1960; Džaukjan 1967: 9-31; Hamp 1976; Martirosyan 2013; but rejected by Clackson 1994 or Kim 2018). More recently, the closeness of Armenian and Albanian was put forward ('Proto-Albano-Armenian'); there is at least of strong parallelism in their development (cf. Kortlandt 1980b; Kortland 1986).

Armenian is literally attested since 5th century AD, with its own script. Armenian was influenced in its development by its extensive contacts with the Urartian substrate, by Middle-Eastern adstrates, by the Caucasian languages, by the Iranian superstrate, Greek adstrate and cultural superstrate and many other influences both in the lexicon and grammatical features, resulting in a very complex and intricate language, in many aspects extremely transformed from the reconstructed Indo-European state (cf. Olsen 2017: 421–423).

5.1 Armenian and Indo-European

The typical features separating Armenian obstruent system from that of Indo-European are:

i. a partial merging of old labiovelars and plain velars[125] and the existence of palatovelars (again, in the modified form);
ii. a shift in the modality of plosives, shortly described as transition of voiceless non-aspirated plosives to voiceless aspirated (T > Tʿ; cf. Winter 1954; Winter 1955 – Winter assumes an original spirantization, followed by a fortition on an aspirate; in this he follows Meillet 1903: 7–8, 12–15; Meillet 1936: 25–26, 31–34; similarly Kortlandt 1980b: 28; Kümmel 2007: 370–371; Kim 2016); of voiced non-aspirated plosives to voiceless non-aspirated (D > T); and of voiced aspirates to voiced non-aspirates (D^h > D) (cf. Kortlandt 1978a: 24; Kortlandt 1980a: 100; Macak 2018: 1047–1048);
iii. a probable split of IE *s according to Pedersen's Law (*ruki*-rule), at least after IE *r* (see below). IE **s* in other positions than before a voiceless plosive or after *r/n* underwent numerous processes: *#s-* > *#h-* before *i*, *-s#* > *-x#* > *-kʿ#*[126], *s* > *h* > *0* in all other positions (cf. Winter 1955: 7; Beekes 2003: 169–170).

The first feature is shared with Albanian since Albanian has etymologically preserved at least partially the distinction between old labio- and plain velars in similar conditions as Armenian; the second process has a parallel in the development[127] of the Germanic consonantal shift (*Lautverschiebung*), Pedersen's Law/the *ruki*-rule is securely attested for Indo-Iranian, Balto-Slavic and is also possible (but not securely proven) for Albanian.

The development of given obstruents is far from being simple when covering the main tendencies (for general overviews and internal chronology, cf. esp. Solta 1963; Džaukjan 1967,

[125] The labiovelars were palatalized before **e*, *i*, cf. Stempel (1994); Job (1995); Beekes (2003: 177–179); Schmitt (2007: 62–65, 78–79); Martirosyan (2010: 711); Macak (2018: 1056).
[126] Note that IE *-s#* also gave *-ḥ#* in OIA, this spirant *visarga* was later elided in MIA.
[127] Though we cannot accept the idea that Armenian and Germanic languages are more close to the reconstructed IE triad of modal classes, as proposed by Griffen (1988: 162–189; Griffen 1989).

especially 313–332; Godel 1975: 61–91; Kortlandt 1976; Kortlandt 1980a; Job 1995; Beekes 2003; Schmitt 2007: 56–79; Martirosyan 2010: 705–747; Kim 2016; Olsen 2017: 423–434; Macak 2018). An overview of the Armenian historical phonology by Mann (1963) is very unreliable, and his findings are not shared or quoted by other authors; hence we should use them with the greatest caution.

5.2 Armenian clusters and their IE origins

Since Armenian morphology is a result of deep and significant structural changes, the attested system remarkably differs both from the reconstructed Indo-European morphology and from that of Greek or Indo-Iranian, forcing us to use the etymological data exclusively.

Note: For an overview of Armenian morphology from the Indo-European point of view, cf. especially a short overview of the verbal system by Kortlandt (1996), for a wider description of the same Klingenschmitt (1982), for the noun morphology Olsen (1999; especially 815–856); an overview of the historical morphology of Armenian in the complex was given by Godel (1975, especially 92–129) or later by Olsen (2017: 434–447; 2018).

Since Armenian does not show any signs of Bartholomae's Law, all clusters with a left voiceless obstruent are also voiceless in their particular outcome; however, such clusters are often subsequently modified in their later developments.

5.2.1 The development of the cluster of *labial* + *t/s*

The development of the IE clusters of *labial* + *t* has the output *u̯tʿ* in the *inlaut* and *0tʿ* in the *anlaut*. The IE cluster **Ps* has the output *0s*, but the output *pʿ* is also attested, resulting probably from original clusters of **sp* after metathesis:

P + t = Arm. u̯tʿ:

ewtʿn 'seven' (< IE **septḿ̥-*; cf. OIA *saptá-*, Gr. ἑπτά, L. *septem*; cf. Hübschmann 1897: 445; Winter 1955: 6; Pokorny IEW 909; Džaukjan 1967: 96; Godel 1975: 80; Winter 1992a: 350; Kortlandt 1994b: 254; Görtzen 1998: 344; Blažek 1999: 247; Beekes 2003: 172; Schmitt 2007: 57, 59; Martirosyan 2010: 270–271; Kim 2016: 151, 155);

kartʿ 'fish hook; leg' (< PArm. **kar(p)ti*; < IE **gr̥b-ti*; OIA *grapsa-* 'bunch', MHG *krëbe* 'basket'; cf. Džaukjan 1967: 95; Pokorny IEW: 387; Görtzen 1998: 338; Olsen 1999: 81; Martirosyan 2010: 354, 725);

#pt = Arm. tʿ:[128]

tʿer 'side, leaf' (< IE **ptero-*; derived from IE **√pet-* 'fly'; Gr. πτερόν 'wing, feather'; cf. Bugge 1893: 40; Winter 1955: 5; Džaukjan 1967: 95; Pokorny IEW: 826; Godel

[128] For this alternation cf. Bugge 1893: 39–40. However, the loss of the approximant in the word-initial is not surprising.

1975: 80; Klingenschmitt 1983: 99; Olsen 1999: 51–52; Martirosyan 2010: 286–287; Kim 2016: 152; Macak 2018: 1019);

tʿekʿem ‘twist, warp, weave’ (< IE *√*tek-*; cf. Hitt. *takkeszi* ‘undertake, prepare’, L. *texō* ‘weave’; cf. Pokorny IEW: 1058; LIV[2] 619–620; Kim 2016: 152);

P + s = Arm. 0s:

eres ‘face’ (< IE *prep-s-*; cf. Gr. πρέπω ‘be clearly seen’; cf. Pokorny IEW: 845; LIV[2] 492; Beekes 2003: 198; Beekes 2016b: 1663–1664);

sut ‘lie’ (< IE *√*pseu̯d-/kʷseu̯d-* (?); cf. Gr. ψεύδω ‘cheat, lie’, Slk. *šudiť* ‘deceive’; cf. Bugge 1893: 25–26; Meillet 1903: 18; Meillet 1936: 39; Pokorny IEW: 1058; Görtzen 1998: 339; Beekes 2003: 198; Martirosyan 2010: 587–588; Macak 2018: 1057);

P + s = Arm. pʿ:

epʿem ‘ boil’ (< IE *(*s*)*eps-*; cf. Gr. ἕψω; no other IE cognate, cf. Hübschmann 1883: 69; Mann 1963:165; Pokorny IEW: 325; Beekes 2003: 198, who suspects it to be a borrowing from non-IE;);

Arm. *kapʿankʿ* ‘enclosure, lid, trap’, *kapʿnum* ‘cover, shut’ (< IE *√*keH₂p-*; cf. Gr. κά(μ)ψα ‘basket, case’, L. Plautus *capsō* ‘I will take’, W. *caffio* ‘to cacht’, OE *haespian, haepsian* ‘fasten’, Lith. *kapsiù* ‘peck at’; cf. Mann 1963: 165; Pokorny IEW: 527–528; LIV[2]: 344–345);

Arm. *opʿi* ‘white poplar’ (< IE *ap-s-*; cf. OE *æpse*, Ru. *osína*; cf. Pokorny IEW: 55; Beekes 2003: 198–199 suspects it to be a borrowing);

Pst = Arm. st:

stin ‘woman’s breast’ (< IE *psteno-* (?); cf. Gr. στήνιον Hsch., Av. *fštāna-* ‘breast’; cf. Hübschmann 1897: 493;Pokorny IEW: 990; Olsen 1999: 135–136; Beekes 2003: 198; Martirosyan 2010: 584–585; Macak 2018: 1057);

5.2.2 The development of the cluster *velar + t/s*

There are only a few examples for the development of the IE clusters **Kt*. Godel (1975: 80) even assumed there are none and he relates such pairs as *aɫačʿem* ‘I pray’ vs *aɫawtʿkʿ* ‘prayer’; *čanačʿem*, aor. *caneay* ‘I know’ vs *canawtʿ* ‘notice’ (in *canawtʿs tam* ‘I give notice); *amačʿem* ‘I am ashamed’ vs *amawtʿ* ‘shame’; he traced the stem morpheme to **ak-i̯e-* (cf. Gr. ἀλλάσσω ‘change, alter’) and the above-mentioned action nouns on *-awtʿ* as being from **ak-ti-*.

Nevertheless, other authors propose more etymologies, with the same outcomes:

Note: Mann (1963: 119) gives a list of other possible examples on **Kt*, not accepted by other research, though fitting to the assumed pattern: *butʿ* ‘blunt’; *latʿ* ‘rag, cloth’, *satʿ* ‘amber’. Similarly, Mann (1963: 120) sees the outcome of IE **Kst* in *laxt* ‘stick, cudgel’.

K + t = Arm. (u̯)tʿ:

katʿn ‘milk’ (< IE **gl̥kt-*; cf. Gr. γάλα, -κτος; L. *lac*, *-tis*; cf. Džaukjan 1967: 95; Pokorny IEW 400–401; Beekes 2010: 256; Martirosyan 2010: 345);

but ‘food’ (< IE **bʰeu̯g-ti*; cf. OIA *bhunákti* ‘create enjoyment’, L. *fungor* ‘enjoy’; cf. Hübschmann 1897: 430; Pokorny IEW 153; LIV[2]: 84–85; Martirosyan 2010: 187)

Note: There is ‘non-etymological’ *utʿ* in *owtʿ* ‘eight’ from *-ḱt-* (cf. OIA *aṣṭáu*, Lith. *aštuonì* etc.). The Armenian form is explained from PArm. **optṓ* resulting from the analogy to **septm̥* (cf. Hübschmann 1897: 483–484; Winter 1955: 6; Solta 1960: 111–112; Pokorny IEW: 775; Godel 1975: 80; Kortlandt 1994b: 255; Blažek 1999: 265; Schmitt 2007: 59, 75; Martirosyan 2010: 631; Kim 2016: 151), only if we assume the neutralization of the palatovelar before *t (to *kt*, otherwise irregular in Armenian) and a regular development: *Kt* > *0tʿ*, followed by its assimilation to *pt*.

Similarly poorly attested is the development of *K* + *s*, limited at the moment to a single example:

K + s = Arm. 0š:

uši either 'storax-tree' or 'holm-oak' (< PArm. **hoši* < **hošíya* < IE **H₃ek-s-i̯eH₂*; cf. Lith. *úosis* 'ashtree' (?); cf. Džaukyan 1967: 255; Martirosyan 2010: 641–642, 710, but cf. other etymologies he mentions l.c.);

5.2.3 The development of the cluster *labiovelar* + *t/s*

There are no secure etymologies for the development of the IE clusters of **K^u̯t/s*, but since we assume that the distinction between IE plain- and labiovelars was neutralized in all *satəm*-languages in all contexts, we can assume the same outputs as with the IE clusters of **Kt/s* mentioned above. It seems, that there is a single (and doubtful) example of **K^u̯* + *ti̯*, resulting in *cʿ*, which could be assumed to be a palatalized version of a regular cluster **Kt*:

K^u̯ + t = Arm. *u̯t:

not attested

K^u̯ + ti̯ = Arm. cʿ:

hacʿ 'bread' (< IE **√pek^u̯-ti̯a-* (?); etymology disputed, cf. Lith. *kėptas* 'cooked', L. *coctor* 'cook'; cf. Pokorny IEW 798; LIV² 468; NIL 548–552; Martirosyan 2010: 396–397, especially for further literature);[129]

K^u̯ + s = Arm. *0š:

not attested

Note: Mann (1963: 176) proposes IE **K^u̯s* > Arm. *x* (as he does for **sk^u̯*), but the examples he gives are both few and not persuasive (*xotor* 'awry, oblique'; *xul* 'deaf')

5.2.4 The development of the cluster *palatovelar* + *t/s*

The development of IE cluster **Ḱt* is relatively securely attested:

Ḱ + t = Arm. st:

erastankʿ 'buttocks' (< IE **prHḱto-* an ablaut variant of **prōḱtós*, cf. Gr. πρωκτός, 'anus'; cf. Hübschmann 1897: 443; Bugge 1889: 12–13; Pokorny IEW: 846; Winter 1962a: 256; Olsen 1999: 320; Schmitt 2007: 57; Martirosyan 2010: 258; Kim 2016: 152; Macak 2018: 1019);

dustr 'daughter' (PArm. **dust(i)r*; < IE **dʰuḱtḗr* < *-ǵʰt-/-ǵHt-*; cf. Lith. *duktė̃*, Goth. *daúhtar*; cf. Hübschmann 1897: 440; Mann 1963: 75; Pokorny IEW: 277; Godel 1975: 80; Olsen 1999: 148; Beekes 2003: 173; Schmitt 2007: 61; NIL 126–130; Martirosyan 2010: 244–245; Kim 2016: 152; Macak 2018: 1019);

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129 This etymology is often disputed; cf. Olsen 1999: 83, 827, who relates to parallel to *ti̯* > Arm. *cʿ*.

hast ‘firm, hard, solid’ (< IE **pH₂ḱt-*; cf. Gr. πηκτός ‘stuck in’, L. *pāctus* ‘fixed’, OHG *festi, fasti* ‘firm, steady’; cf. Hübschmann 1897: 464; Mann 1963: 75; Olsen 1999: 201; Martirosyan 2010: 390–391);[130]

Clusters of *Ḱs* are also realized either as Arm. *c‘* or *č‘*:

Ḱ + s = Arm. c‘:

vec‘ ‘six’ (< IE **su̯eḱs-*; cf. Gr. ἕξ, Lat. *sex*, W. *chwech*; cf. Hübschmann 1897: 495; Meillet 1903: 19; Meillet 1936: 40; Mann 1963: 101, 155; Pokorny IEW: 1044; Winter 1992a: 349–350; Kortlandt 1994b: 254; Blažek 1999: 236; Beekes 2003: 201; Schmitt 2007: 74; Martirosyan 2010: 594; Macak 2018: 1019);

ayc‘ ‘goat’ (< IE **aiǵ-s*; cf. Gr. αἴξ; cf. Hübschmann 1897: 417; Olsen 1999: 816–817; Martirosyan 2010: 58);

Ḱ + s = Arm. č‘:

č‘ir, č‘or ‘dried fruit’ is reconstructed from IE **ḱsēro-*; this etymology is often considered doubtful (cf. Gr. ξερόν ‘dry land’, OHG *serawēn* ‘become dry’; cf. Hübschmann 1897: 485; Pokorny IEW: 625; Džaukjan 1967: 257; Kortlandt 1995: 15; Martirosyan 2010: 546);

ḱst = Arm. št: *veštasan* ‘sixteen’ (< IE **sweḱs-deḱm-* (a result of the *ruki*-law?[131]); cf. Meillet 1903: 19; Meillet 1936: 40; Winter 1992a: 350; Blažek 1999: 236; Beekes 2003: 201; Martirosyan 2010: 709);

5.2.5 The development of the cluster *dental + t/s*

Persuasive and secure examples of this development (otherwise a common process in all Indo-European languages) are hard to find since they are limited to a singly commonly accepted example (we add another example, though of a limited acceptance, but within the limits of the first one):

T + t = Arm. u̯t:

giwt ‘find’ (cf. Arm. *gitem*; < IE **u̯id-ti-m* < √*u̯ei̯d-*; cf. OAv. *vīnastī* ‘find’, L. *uīdī, uīsum* ‘see’; cf. Hübschmann 1897: 435; Pokorny IEW: 1125; Winter 1962a: 261; Schmidt 1980: 43; Peters 1997; Görtzen 1998: 337, 344–345; Olsen 1999: 851; LIV$^{2:}$ 665–667; Schmitt 2007: 52, 134; NIL: 717–722; Martirosyan 2010: 211, 723);

hat ‘grain, seed, piece’ (< PArm. **hawt-i-* < IE **H₂ed-ti-*; cf. L. *ador* ‘coarse grain, spelt’, Goth. *atisk* ‘cornfield’; cf. Pokorny IEW: 3; Martirosyan 2010: 392–393, 723[132]);

Note: Another example brought by Martirosyan (2010: 451–452, 723–724) is Arm. √*mat-* ‘approach, come close’, *mawt* ‘near, close’ (Martirosyan does not give any details of the development, relating this to ON *mót* ‘meeting’). Klingenschmitt (1982: 70–71) explains these forms from **mədu-*.

Nawt‘i ‘hungry, fasting’ is often quoted as another example of this process, if from **n̥-H₁d-ti̯o-* (cf. Gr. νῆστις ‘not eating, fasting’; Klingenschmitt 1982: 501; Martirosyan 2010: 501), but in contrast to *giwt*, there is an aspirated plosive, hence others are sceptical (cf. Olsen 1999: 437),

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[130] But cf. LIV^2: 536–537, where the root is related to IE √**ses-*, NIL (637–660) relates to *√*steH₂-*.

[131] Cf. analogy in Arm. *harc‘* “question” < IE **pr̥ḱsḱā* (OIA *pr̥cchā*; Schmitt 2007: 71).

[132] See especially the other possible etymologies listed there.

though it is semantically plausible. Another etymology for *nawťi* is related to Gr. νῆψις 'sobriety' (< IE *nag^{uh}-tii̯o-*; Bugge 1889: 22; Pokorny IEW: 754; NIL: 208–220), which fits better phonemically, but worse semantically – we leave the question open. Similarly, *małtʿ* 'prayer' is often related to Lith. *maldýti* 'implore' (Bugge 1889: 15) or OCS *moliti* 'ask, pray' etc., is derived, according to Martirosyan (2010: 445–446) from IE *$m̥ld^h$-ti-*. Again the outcome does not accord with the expected one.

T + s = Arm. cʿ:

kʿacʿax 'vinegar' (< IE *ku̯atH₂-so-*; cf. OCS *kvasъ*; cf. Pokorny IEW 627–628; Džaukjan 1967: 229; Olsen 1999: 949; LIV^2: 384; Martirosyan 2010: 659–660)

5.2.6 The development of the cluster *sibilant + t/s*

The outcome of an IE cluster **St* is a simple *st*, the outcome of IE clusters of **Ss* is *0s*:

S + t = Arm. st:

sterj 'sterile' (< **steri̯a-* < IE **stér-iH₂-* ~ *str̥-yéH₂*; cf. Gr. στεῖρα 'barren cow', L. *sterilis* 'unfruitful'; cf. Meillet 1903: 18; Meillet 1936: 39; Winter 1955: 6–7; Winter 1962a: 256; Pokorny IEW: 1031; Godel 1975: 80; Beekes 2003: 169, 198; Kim 2016: 152; Macak 2018: 1019);[133]

stêp 'quickly, often', *stipem* 'urge, compel' (< **stei̯b-*; cf. Gr. στείβω 'tread, stamp on'; cf. Pokorny IEW: 1015; LIV^2: 592; Beekes 2003: 167, 198; Kim 2016: 152);

astł 'star' (< IE **H₅stḗr*; cf. Gr. ἄστρον, L. *stēlla* 'star'; cf. Hübschmann 1897: 421; Pokorny IEW: 1027–1028; Godel 1975: 80; Olsen 1999: 159–161, 843; Beekes 2003: 169, 198; NIL 348–354; Martirosyan 2010: 120–122; Kim 2016: 152; Macak 2018: 1019)

zgest 'cloth(es), dress' (< IE **u̯es-ti*; cf. Lat. *vestis*, Goth. *wasti* 'garment'; cf. Hübschmann 1897: 446; Pokorny IEW: 1172–1173; Godel 1975: 80; Görtzen 1998: 337; Beekes 2003: 169, 198; Martirosyan 2010: 274; Kim 2016: 152);

Note: Bugge (1893: 43–46) gives possible examples of the development **st* > Arm. *c*.

S + s = Arm. 0s:

es 'thou art' (< IE **H₁es-si*; cf. OIA *ási*, L. *es* ; cf. Hübschmann 1897: 442; Meillet 1903: 18; Meillet 1936: 39; Godel 1975: 40–41, 72, 112, 116–117, 124; Schmitt 2007: 65, 139; Olsen 1999: 159–10, 44; Martirosyan 2010: 255; Macak 2018: 1057). But Klingenschmitt (1982: 278) considers a secondary analogical building, re-archaizing the older simple sibilant, cf. OIA *asi* as realization of *as-si* etc.). Similarly loc. Pl. *-s* < **-s-su* (under the assumption of an analogical reconstitution in the *s*-stems; Macak 2018: 1057);

S + s = Arm. cʿ is assumed by Klingenschmitt (1982: 278) as a regular outcome. This opinion is based on a sigmatic aorist, to this cf. Kortlandt 1995; Kortland 1996.

5.2.7 The overview of the Armenian development

[133] But Mann (1963: 101) gives another etymology; he considers the initial *s-* being from IE **eḱs-*!

The Armenian outcomes are given in the reconstructed forms of spirants (not aspirates, since we assume that spirants, not aspirates, were regular outcomes of the Proto-Armenian shift), given here in the form of archiphonemes (marked by capitals):

IE	Armenian	t-	s-
-k/g/gʰ	-X	*utʿ*	*š*
-kᵘ̯/gᵘ̯/gᵘ̯ʰ	-X	(*utʿ*	*š*)
-ḱ/ǵ/ǵʰ	-Ç	*st*	*cʿ/čʿ*
-t/d/dʰ	-Θ	*u̯t*	*cʿ*
-p/b/bʰ	-P	*utʿ*	*0s/pʿ*
-s[134]	-S	*st*	*0s*

5.3 Trajectories of the development

There are at least two remarkable features: the almost universal loss of plosives before a consonant (cf. Kortlandt 1980: 29; Beekes 2003: 204; Schmitt 2007: 56–65; Martirosyan 2010: 723; Kim 2016: 154), the exception being palatovelars before *t*-, and the lack of a fricative outcome for cluster *Tt* (otherwise almost universal in Indo-European languages).

5.3.1 Development of the clusters *labial* + *t/s*

In the development of the IE cluster *labial* + *t* we assume, as for clusters of (*labio*)*velar* + *t*, the spirantization of both plosives in the first phase, followed by the debuccalization of the first segment and later by the elision (and with the shift of the spirant of the aspirated plosive) (cf. Winter 1955: 549–553; Winter 1962: 554–562; Kümmel 2007: 371):

P + **t** > φϑ > hϑ > **u̯tʿ**

Note: For all word-initial clusters with two plosives, we assume the loss of the debuccalized approximant.

Similarly, the development of clusters of **Ps* are parallel to clusters of *Ks*. We assume the spirantization of the plosive, later either a debuccalization (or sibilantization), followed by the simplification:

P + **s** > φs > hs > **0s** / **P** + **s** > φs > ss > **0s**

5.3.2 Development of the clusters *velar* + *t/s*

The cluster velar + *t* (including labiovelars) was, similarly to clusters of *labials* + *t*, first spirantized in both plosives, later the first was debuccalized, and elided and the right obstruent

[134] Including **š* according to Pedersen's Law.

became a voiceless aspirated plosive (cf. Winter 1955: 549–553; Winter 1962: 554–562; Kümmel 2007: 371):

K^(u̯) + **t** > kt > xϑ > hϑ > **u̯t**ʿ ʿ

To model a trajectory for the development of clusters of *$K^{(u̯)}$ is harder, especially since there is a single example we have to depend on. We assume that the plosive was first spirantized, later debuccalized and then elided, and that the sibilant was afflicted by the *ruki*-law (a variant could be sibilantization instead of debuccalization):

K^(u̯) + **s** > xš > hš > **0š** / **K^(u̯)** + **s** > xš > šš > **0š**

5.3.3 Development of the clusters *labiovelar* + *t/s*

A remarkable feature of Armenian (shared with Albanian) is that it partially distinguishes the original plain velars and labiovelars, since IE labiovelars *kᵘ̯, gᵘ̯, gᵘ̯ʰ* realize as Arm. *čʿ, č, j/ž* before **e, *i*, but have the same outputs as IE plain velars in other positions (i.e. as *kʿ*, *k*, *g*) (cf. Stempel 1994; Job 1995; Beekes (2003: 177–179); Schmitt (2007: 62–65, 78–79); Martirosyan (2010: 711).

Unfortunately, we have no secure data for the development of clusters of **Kᵘ̯t*, but since this position is not the one in which the old distinction between plain and labiovelars could be preserved, we can assume it was the same development as with the plain velars (see above). Similarly, we have no secure data for the development of the IE clusters of **Kᵘ̯s* into Armenian.

Note: Beekes (2003: 201) assumes the outcome *cʿ*, based on the analogue with clusters of *Ḱs* and sk^(u̯) but gives no examples to support his model.

5.3.4 Development of the clusters *palatovelar* + *t/s*

The development of clusters of *palatovelar* + *t* followed a similar trajectory as in other *satəm*-languages since their outcome is a sibilant + *t*. A remarkable feature, shared with the development of dental series and contrary to the development of the (labio)velar and labial series, is the lack of aspiration of the outcome.

The palatovelars are usually expected to be later palatal affricates (*ć*) in the later development of *satəm*-languages. Accepting that such an affricate was present in the position before *t*- would lead us to the trajectory: ****Ḱt*** > *ćt* > *śt* > **st**, assuming the loss of the plosive segment of the affricate and later depalatalization.

Here a problem arises within the affricativization trajectory: if this trajectory is applied to the development of both of the central clusters, even the output for both clusters should be similar in nature, since the affricates in both clusters have to undergo the essentially the same developments (the assumed loss of the plosive segment of the palatovelar cluster has no counterpart with the development of the dental cluster).

We assume as more probable the spirantization of the palatovelar before *t-*, later sibilantized and depalatalized. However, we assume that the aspiration of the outcome was blocked by the existence of the cluster *fricative* (either a sibilant or a spirant) + *t*, as it was blocked in the cases of clusters of *st* and *Tt*:

Ḱ + **t** > çt > śt > **st**

Note: Beekes (2003: 201) assumes for cluster *Ḱst* the development: *ḱst* > *ḱšt* > *ćšt* > *št*.

Again, the development of a cluster with a sibilant is worse attested, though usually the development **Ḱs* > *c*ʿ is accepted (cf. Olsen 1999: 965), though Godel (1975: 81) assumes a neutralization of **Ḱs* on **Ks*. This development is not in accord with the attested development of *Ks*, which results in *0š* (see above).

A remarkable feature is that the outcome is the same as with the development of clusters of **Ts*, both resulting in *c*ʿ. The trajectory is, again, hard to establish, but we propose spirantization, followed by a transition to dental clusters and later affricatization and aspiration:

Ḱ + **s** > çs > ϑs > **c**ʿ

5.3.5 Development of the clusters *dental* + *t/s*

What can be taken for granted is that IE **Tt* is realized in Armenian without the aspiration of the right plosive, similarly to the outcome of IE **Ḱt* and **st* and unlike to outcomes of **Kt* and **Pt* and that the development, unlike in all other IE languages, is not a cluster with a sibilant. Even the earlier sibilantization of the dental plosive is impossible, considering that the cluster *st* is preserved. The lack of aspiration of the right plosive excludes any chance of an earlier preservation of the left dental (‘archaic’ or ‘re-archaized’ **Tt*).

The traditional **affricativization** model is probably impossible: it would have the trajectory: ****Tt*** > *t*^{s}*t* > *tt* > ***0t***, which is at odds with the assumed trajectory of the other central series (the palatovelars, cf. above) and it does not explain the frequent approximant before the suffixed *t-*, the lack of aspiration excludes the existence of the second plosive in a cluster at all.

Görtzen (1998: 342–343) assumes re-archaization to *tt* (as in Old Indo-Aryan) and later simplification of a geminate (in contrast to the development of non-geminate: **t* > Arm. *t*ʿ), but there is no reason why assumed central geminates (without aspiration) should behave differently from the peripheral geminates (with the aspiration).

Martirosyan (2010: 723) and Kim (2016: 154) assume **t* > Arm. *u̯* after vowels as a universal process (cf. also Kümmel 2007: 371), hence this is independent from any Common IE process otherwise attested in the whole IE area.

For these reasons we prefer, as we do with the development of the palatovelars, the **spirantization/lenition** trajectory.

Winter (1962a: 261) assumes the trajectory: ****Tt*** > *tϑ* > *ϑt* > ***u̯t***[135], i.e. with a spirantization of the **right** plosive, with later metathesis and lenition.

Our model is based, similarly to that of Winter, on assumed spirantization, but of the **left** dental plosive, its later debuccalization and replacement of an approximant by a labial one. In Armenian the cluster *fricative* + *t* is never subjected to aspiration (as we can see in the development of clusters of **st* and **Ḱt*); the *u̯* is a regular continuation of a plosive, not an inserted vowel (cf. Görtzen 1998: 346), thus:

T + **t** > ϑt > ht > **u̯t**

The development of clusters of **Ts* are harder to establish: we propose the spirantization of the dental plosive, and that later the whole cluster became affricate and was aspirated (in other words: the two fricative clusters became an aspirated affricate within the same process which turned all reconstructed spirants into the affricates):

T + **s** > ϑs (?) > **c**ʿ

Note: Martirosyan (2010: 719–720) documents a development of *cC* > *sC*. It is hard to establish how old this process is, but if IE **Tt* had an outcome in PArm. **ct* (according to the affrication trajectory), the outcome in Armenian would be *st*, which is not attested; hence the sibilantization of an affricate never affected clusters originating from IE *Tt*, not being clusters of *affricate* + *plosive*. Olsen (2017: 431) assumes plosive + plosive> *0t*ʿ. On the other hand, Martirosyan (2010: 724) mentions the alternation -*c* ~ -*wt* (*arac*- 'browse, graze' ~ *arawt* 'pastureland' and two more highly questionable attested).

5.3.6 Development of the clusters of *sibilant* + *t/s*

A remarkable feature of the Armenian development is that though IE **t* usually gives Arm. *t*ʿ (but neither in a word-initial before a consonant nor before/after a resonant or between vowels)

[135] Since the only example Winter could depend on is from *dt*, he uses **dt*; we generalize it here.

it is realized as *t* in the cluster *st*, arising either from IE **st* or from IE clusters (**Ḱt* and **Tt*) (Beekes 2003: 173).

The IE cluster **rs* has a unique development, resulting in Armenian **r̄*:[136] Arm. *or̄* 'back (body part)' < IE **H₁orsos* (Hitt. *arras*, Gr. ὄρρος, OHG *ars*; Meillet 1903: 19; Meillet 1936: 40; Beekes 2003: 196); Arm. *tʿar̄amim, tʿaršamim* 'wither' (OIA *tŕ̥ṣyati*, Gr. τέρσομαι, L. *torreō*, Goth. *gaÞaursan*; Meillet 1903: 19; Meillet 1936: 40; Beekes 2003: 196; Schmitt 2007: 72; Macak 2018: 1057). How much this process is related to the *ruki*-rule is questionable. Martirosyan (2013: 89) takes *tʿar̄amim* vs *tʿaršamim* for a proof of the validity of Pedersen's Law in Pre-Armenian (especially for the alternation *r̄* ~ *rs*, but cf. already Meillet 1903: 19; Meillet 1936: 40). Martirosyan (2010: 709–710) asserts that the *ruki*-rule was also applied to clusters of **r/k + s*, following Meillet (1903: 19; 1936: 40) again, though Godel (1975: 77) limits the *ruki*-rule to cluster **rs*. Macak assumes the *ruki*-rule after **r/k/ḱ* 2018: 1057–1058).

S + **t** > st

As far as we can judge from poorly attested examples, the trajectory of the development of two-sibilant clusters is straightforward: the geminate is simplified:

S + **s** > **0s**

Klingenschmitt (1982: 287) assumes the trajectory *Ss* > *cʿ* (i.e. the dissimilation of the left fricative, similar to OIA *a-vās-sam* > *avātsam*, followed by an aspiration). This marker was later used as a marker of the aorist.

If we accept the existence of PArm. *š* resulting from Pedersen's Law, the possible (and purely speculative) trajectory would be similar to that of *st/ss*-clusters and the reader could simply derive them.

5.4 Conclusion and final remarks

The modelling of possible trajectories of the development of the Indo-European clusters of our interest into Armenian faces many complications given by the complex changes affecting Armenian phonology in general, hence it will necessarily be very sketchy and with many undisclosed variables inside the 'black box'.

[136] It should be noted that the same process affected the cluster **sr*: Arm. *kʿer̄*, gen. sg. to *kʿoyr* "sister" < IE **su̯esrós*; *jer̄n* "hand" < IE **ǵʰésr̥m̥* etc., cf. Schmitt 2007: 72).

We can postulate the following main points of the development of clusters of IE *plosive* + *t* into Armenian:

The oldest development is that of the dental series, as it is present in the all other branches of IE languages (with a virtual exception of OIA), resulting either in *st* (Iranian, Balto-Slavic, etc.) or *ss* (Italic, Germanic, Celtic). Neither of outcomes fits for Armenian (as much as we can depend on poorly attested examples) since if the outcome were at some point of development **st*, such a cluster would be preserved as clusters of IE **st* are, attested as Arm. *st* (but cf. *IE *Tt* > Arm. *u̯t*); similarly, the outcome *ss* (including that from IE **Ts*) would merge with the outcome of IE **ss*, which is not valid, since IE **ss* > Arm. *0s* but IE **Tt* > Arm. *u̯t*.

We can securely conclude that there was no sibilant as an intermediate stage in the Armenian development of the IE cluster **Tt* (cf. the development of IE cluster *Ḱt*, which results in a sibilant + plosive). Another remarkable feature of the Armenian development of the central series is that the right plosive is not aspirated, unlike all clusters of the peripheral plosive + *t*.

The proposed trajectory assumes that all clusters of *fricative* + *t* (of any origin) were not subjected to the shift *voiceless plosive* > (*voiceless spirant* >) *voiceless aspirate* (in the intermediate fricative stage cf. Pisani 1951: 68–71; Winter 1954: 200; Winter 1955: 7; Kortlandt 1980: 28; Kim 2016: 157–159). However the spirant was later debuccalized.

The second oldest development is that of palatovelar clusters, as in other *satəm*-languages. As in the case of IE clusters of **Tt* and **st*, the left plosive was not (first spirantized and later) aspirated, and the original palatovelar was, similarly to other *satəm*-languages, sibilantized. The model trajectory requires a spirant intermediate stage and assumes that all clusters of *spirant* + *t* were not subjected to the shift of IE voiceless plosives to (spirants and later) aspirates.

The (labio)velars and labials clusters were not spirantized at the moment of the shift; hence the right *t* was (spirantized and later) aspirated to Arm *t*ʿ. However, the loss of the right plosive could be attributed to spirantization, probably happening at the same time as that of the right plosive (*Kt* > *xϑ*, *Pt* > *φϑ*). The left spirants were later debuccalized to *u̯* in word-internal clusters; the first spirant was elided in word-initials: *#x/ϑ/φC-* > *#0C-*, and here we can assume an intermediate stage with a debuccalization. The process is similar to debuccalization of **s* before resonants (cf. Arm. *now* 'daughter in law' < IE **snusós*; Arm. *k*ʿ*oyr* 'sister' < IE **su̯ésōr*; Arm. gen.-dat. sg. *hawr* 'father' < IE **pətrós*). The loss of a plosive before any consonant is a standard and universal development in Armenian (cf. Kortlandt 1980: 29; Schmitt 2007: 56–65; Martirosyan 2010: 723; Kim 2016: 154).

The trajectories of clusters of IE *plosive + s* are even harder to reconstruct. We can surely presume that it was parallel to the development of clusters of *plosive + t*; however, we should keep in mind that data are usually even worse attested.

The oldest stratum was the development of the cluster **Ts* (as with *Tt*), resulting in *c*ʿ, merging it with that of the IE cluster **Ḱs*. We assume in both cases the spirantization of plosives and later the merging of both clusters (via *ϑs*?) and their later affrication and aspiration at once.

The spirantization of both peripheral series was a later process, but in this case, both spirants were later elided, either through debuccalization or through sibilantization and later simplification.

The IE cluster *st* is fully preserved (as are all clusters of *s + plosive*), the IE cluster *ss* is simplified due to elision.

6 The development of the two-obstruent clusters from Indo-European into Albanian

6.0 Albanian language

Albanian is a *satəm*-language, forming an independent branch within the Indo-European family, related usually to Illyrian or Thracian/Dacian languages (cf. Pedersen 1900b; for an overview of the debate see Jokl 1963; Ködderitzsch 1991; Matzinger 2009; Matzinger 2012). The relationship of Albanian to Armenian shows traces if not of a common descent ('Proto-Albano-Armenian'), then at least of strong parallelism in their development (cf. Kortlandt 1980b; Kortlandt 1986). How much this assumed 'closeness' of both IE branches is present in the development of the clusters of obstruent + **t/s* will be demonstrated below.

6.1 Albanian and Indo-European

The development of Albanian from Indo-European is a trajectory with stages: Indo-European > Pre-Proto-Albanian (PPAlb.; before contact with Latin) > Proto-Albanian (PAlb.; affected by contact with Latin and Early Slavic) > Old Albanian (OAlb.; after the Tosk–Geg split) > Modern Albanian (Alb.; since 19th century) (cf. Hock 2005[137]; Rusakov 2017: 539–560; Schumacher 2006: 23, 85–86; de Vaan 2018: 1732–1733).

The typical features separating the Albanian obstruent system from that of Indo-European are:

i. merging of voiced and voiced aspirated plosives;
ii. merging of old labiovelars and plain velars[138] and the existence of palatovelars;
iii. palatalization of velars;
iv. a probable split of IE **s*[139] according to Pedersen's Law (the *ruki*-rule).

The first feature is shared with Iranian, Balto-Slavic and Celtic, the second and fourth with all the *satəm*-languages, the third has its reflexes in the Indo-Iranian and Slavic, but hardly could be a result of a single process. More probably we face parallel processes on similar grounds; the existence of Pedersen's sibilant **š* in Albanian is questionable, though the feature is common within the *satəm*-area.

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[137] Hock uses the set of terms: *Urindogermanisch, Vorlateinisches Voruralbanisch, Vorslavisches Voruralbanisch, Uralbanisch*, (*Albanisch*), since he points out the influence of various adstrates on the development of Albanian phonology.

[138] It seems that old plain velars and labiovelars merged everywhere except before front vowel – Albanian hence uniquely preserving the IE triad palatovelar – plain velar – labiovelar, cf. Pedersen (1900a: 305–307); Jokl (1937); Kortlandt (1980: 246).

[139] Later, the IE **s* underwent palatalization to **š* as a default development, hence the effects of the *ruki*-rule, if there were any at all, are indistinguishable (cf. Jokl 1963: 127; Kortlandt 1987; Demiraj 1997: 56; Kortlandt 1998; Schumacher 2013: 258–265, de Vaan 2018: 1746). However, Orel (2000: 61–62) assumes that the regular development was IE **s* > Alb. *ɟ* <*gj*> and assumes the *ruki*-rule after *i, u* (examples *dash* "ram" < PPAlb. **dausa* < IE **dʰou̯so-*; *lesh* "wool" < PPAlb. **laiša*).

The development of given obstruents is far from being straightforward, and has to be reconstructed with great carefulness and with a lot of dark spots and trajectories not always unarguably established. Mann (1952); Kortlandt (1998); Demiraj (1997: 56–58, 61–97), Orël (1998: xvii–xxii), Orël (2000: 60–101), Hock (2005); Schumacher (2006: 68–73, 77–79, 87–92; 2013: 233–244, 258–264); Rusakov (2017: 569–570) and de Vaan (2018: 1745–1746) give variously detailed overviews of the developments of obstruents, covering the main tendencies.

Note: The Albanian etymologies are often insecure, since many details of the etymologies and developments are only partially described. Such questionable examples, without the wider support of other research, will be listed in square brackets.

6.2 Albanian clusters and their IE origins

Since Albanian morphology is a result of deep structural changes (cf. the development of Albanian morphology in Camaj 1966; the historical morphology of Albanian in Demiraj 1993; or specifically of the Albanian verbal system in Schumacher/Matzinger 2013: 25–198), we cannot use productive examples on the formation of the clusters of our interest and we are forced to use exclusively the etymological data, with all disadvantages and difficulties such source has.

Note: Since Albanian does not show any traces of the operability of the Bartholomae's Law, all clusters formed with a right voiceless obstruent are also voiceless in their respective output. More to that, the clusters are often simplified in the development.

6.2.1 The clusters *labial* + t/s

A remarkable feature of the Albanian development is the *labial plosive* + *t-*, results in *0t* (a development shared with the development of the plain velar and labiovelar plosives). The output of the IE cluster of **Ps* is, as far we can judge, *fš*, though *f* (as we can see in examples) was proposed as another output:

P + t = Alb. 0t:

shtatë 'seven' (< **š*(*ē*)*tátë* < IE **septm̥-tā-*; cf. OIA *saptá-*, L. *septem*; cf. Meyer 1891: 415; Pokorny IEW: 909; Kortlandt 1988: 221; Hamp 1992: 914; Demiraj 1997: 370; Orël 1998: 436; Blažek 1999: 248; Schumacher 2013: 56);

P + s = Alb. fš:

fshij 'wipe, clean' < **b*^{h}*si*(*H*)-*i̯o-* (< IE **b*^{h}*si*(*H*)-*i̯o-*; cf. OIA *psā́ti* 'devour', Gr. ψάω 'rub smooth', OHG *bes*(*a*)*mo* 'brush, wipe'; cf. Mann 1952: 40; Pokorny IEW: 145–146; Demiraj 1997: 66, 173; LIV^2: 82)[140];

[140] But Orel (2000: 104, 414) considers it as a borrowing (Lat. *exigere*) + a labial prefix (on such prefixes see Mann 1952: 40)

P + s = Alb. 0f (?):

[*afër* ‘near’ < PPAlb. **apsera* (contamination of **aps-*, a variant of IE **apo-*, cf. Orël 1998: 1–2; Orël 2000: 9), but this etymology is not widely accepted, for other etymologies cf. Meyer (1891: 3); Jokl (1923: 271); Demiraj 1997: 70–71);]

6.2.2 The clusters *plain velar* and *labiovelar* + *t/s*

The ancient IE clusters of **Kt* and **Kᵘt* are both realized in Albanian as *0t*, i.e., the velar plosive is totally elided. This process has an exact analogy with the development of the labial plosives (and in some sense even with dental clusters). Similarly, the cluster of **Ks*, which is rarely attested, develops with the same output as the cluster of **Kᵘs*, both resulting in *0š*:

K + t = Alb. 0t:

butë ‘soft, smooth’ (< IE **bʰeu̯gʰ-to-* (?); cf. OHG *biugan* ‘bend’ ; cf. Pedersen 1900b: 341; Pokorny IEW: 152–153; Demiraj 1997: 114; Orël 1998: 43; Orël 2000: 101; LIV^2: 84–85);

fletë ‘wing, leaf’(< PPAlb. **awa-lekta-* < IE *√*lek-*; cf. Lith. *lekiù* ‘fly’; cf. Pokorny IEW: 673; Orël 1998: 100; Orël 2000: 101; LIV^2: 411)[141];

gjatë, glatë ‘long’ < PPAlb. **dlata-* < IE **dl̥gʰ-to-*; cf. L. *longus* ‘long’, Goth. lag ‘long’,OCS *dlъgъ* ‘long’; cf. Pedersen 1900a: 308; Pokorny IEW: 197; Demiraj 1997: 184–185; Orël 1998: 130; Orël 2000: 101)

Kᵘ + t = Alb. 0t:

natë ‘night’ (< IE **nokᵘti*; cf. OIA *naktam* ‘at night’, Goth. *nahts* ‘night’; cf. Meyer 1891: 298; Mann 1952: 35; Pokorny IEW: 762–763; Hamp 1961c; Demiraj 1997: 283–284; Orël 1998: 282–283; Orël 2000: 101; LIV^2: 449; NIL: 513–515; Schumacher 2013: 243);

Note: The possible output could also be *0s* in *pesë* ‘five’ if derived from **penkᵘ-ti* (Meyer 1891: 329), but this could be directly from **penkᵘe-ās/om* (cf. Pedersen 1900a: 307; Jokl 1937: 157–158; Orël 1998: 316). The ‘mixed’ form of both variants is another variant, proposed by (Huld 1984: 102–103; cf. Demiraj 1997: 315–316; Blažek 1999: 221). We prefer that *pesë* is a direct result of an antevocalic form of this numeral.

K + s = Alb. 0š:

[*shesh* ‘plain, plane, flatness, square’ < IE **kesi̯o-* (Mann 1952: 40)];[142]

Kᵘ + s = Alb. 0š:

shoh ‘see, show’ either (< PPAlb. **(V)kśē-(sḱ)-* < IE **H₃(e)kᵘ-s-*; cf. OIA *ī́kṣate* ‘see’, Gr. ὄσσομαι ‘see (in spirit)’; cf. Pokorny IEW: 775–777; Demiraj 1997: 57; LIV^2: 297) or (< PPAlb. **sāskska*, < IE *√*sekᵘ-*; OIA *sácate* ‘follow’, Gr. ἕπομαι ‘follow’, L. *sequor* ‘follow’, Goth. *saiƕan* ‘see’; cf. Meyer 1892: 411–412; Pokorny IEW: 896–897; Orël 1998: 100, 148, 184; Orël 2000: 425–426[143]; LIV^2: 552);[144]

[*shore* ‘rash of the skin, eruption’ < IE **kᵘsēros* (Mann 1952: 40)];

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[141] But Meyer (1891: 108) considers it to be from It. *foglietta.*

[142] But Orel (1998: 412) considers it a borrowing from L. *sessus* “seat”, following in this Meyer (1891: 402).

[143] Orel reconstructs PPAlb. **sāksa-* with a dissimilation of sibilants, otherwise to the same root as Demiraj (l.c.)

[144] However, both reconstructions lead towards the cluster of a labiovelar and *s-*.

[*shale* 'pair of trousers, saddle' < IE *k^{u}*salis* (Mann 1952: 40)[145]];

6.2.3 The clusters *palatovelar + t/s*

IE clusters of *Ḱt* and *Ḱs* are realized in Albanian as *0t* and *0š*, similarly to all velar clusters, unlike prevailing tendencies in the *satəm*-languages, where the outputs of palatovelars are usually different from the outputs of the plain- and labiovelars:

Ḱ + t = Alb. 0t:

tetë 'eight' (< **oḱtō+tā*; < IE **oḱtō*; cf. Gr. ὀκτώ, Goth. *ahtau* 'eight'; cf. Meyer 1891: 428; Mann 1952: 34; Pokorny IEW: 775; Hamp 1992: 915–916; Demiraj 1997: 385; Blažek 1999: 266; Orël 1998: 453; Orël 2000: 64, 101);

dritë f. pl. 'light, lustre, pupil of an eye' (< **driktā*; < IE **derḱ-to-* ; OIA *darśam* 'seeL, Gr. δέρκομαι 'see'; cf. Meyer 1891: 74; Pokorny IEW: 213; Demiraj 1997: 145; Orël 1998: 75; Orël 2000: 101; LIV^2: 122–123; Schumacher 2013: 243);

Ḱ + s = Alb. 0š:

the intensive prefix *sh-* (< IE *$H_1 e\acute{g}^h s$-; cf. L. *ex-* 'out, from', OIr. *ess-* 'out', Gr. ἐξ 'from', OCS *iz* 'out'; cf. Pokorny IEW: 292–293; Demiraj 1997: 57);

Note: Schumacher (2018: 238) assumes the development of IE *Ḱs* > Alb. *ϑ*, without a specification of a trajectory, but this model also is based just on a single example (IE **deḱsaH₂* > Alb. *djathlë*).

Note: IE cluster **Ḱst*, has a different output realized as Alb. *0ϑ*:

Ḱst = Alb. 0ϑ:

gjashtë 'six' (< PPAlb. **šeštā* < IE **seḱs-ti-*; cf. OIA *ṣaṣṭhá-* 'sixth', L. *sextus, sestus* 'sixth''; cf. Meyer 1891: 138; Pokorny IEW: 1044; Kortlandt 1988: 221; Hamp 1992: 913; Demiraj 1997: 184; Orël 1998: 130; Blažek 1999: 236; Orël 2000: 101, 248; Schumacher 2013: 238);

djáthtë, *djáthë* 'right' (< PPAlb. **detsa* < IE **deḱs-t-*; cf. L. *dexter* 'right'; cf. Meyer 1891: 69; Pokorny IEW: 190–191; Demiraj 1997: 58, 137–138; Orël 1998: 67–68; Orël 2000: 64, 100; Schumacher 2013: 238);[146]

jashtë 'out' (< PPAlb. **ekšta* < IE *$e\acute{g}^h$*s-to;* cf. L. *extrā*; cf. Mann 1952: 40; Pokorny IEW: 292–293; Demiraj 1997: 42; Orël 1998: 158);

6.2.4 The clusters *dental + t/s*

As far as we can judge from scarce data, the regular output of IE cluster **Tt* is *0s* in Albanian, the output of IE cluster **Ts* is Albanian *0š*:

T + t = Alb. 0s:

besë 'pledge, truce, trust' (cf. *bind* 'convice'; < PPAlb. **baitšā*; < IE *$b^h e\underset{\frown}{i} d^h$-*to-*[147]; cf. Gr. πείθω 'persuade', L. *fīdō* 'trust'; cf. Pedersen 1900a: 308; Mann 1952: 34; Pokorny

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[145] But Orel (1998: 407; 2000: 26) considers it a borrowing of L. *sella* "saddle, seat", cf. also Meyer (1892: 398) and Demiraj (1997: 118).

[146] Kortlandt (1998: 36) reconstructs **deḱs-no-*, the loss of *-s-* attributed to following *-n-*.

[147] But Meyer (1891: 93) etymologizes from IE *$b^h end^h$-*ti*, similarly Pedersen (1900a: 308), which was rejected by Hamp (1961b). However, the solution of the clusters is the same.

IEW: 117; Hamp 1961a; Demiraj 1997: 96–97; Orël 1998: 22; Orël 2000: 101; LIV^2: 71–72; NIL 12–13; Schumacher 2013: 244);

OGeg. *pasë* ‘have’[148] (< PPAlb. *pat-ta-* < IE **pot-tó-*; cf. OIA *pátyate* ‘rule’, L. *potior* ‘become master’; cf. Pedersen 1900a: 308; Pokorny IEW: 842; de Vaan 2008: 484–485; Schumacher 2013: 244);[149]

Note: Johannson (1903: 268 and 1906: 115) assumes IE **Tt* > Alb. *št*: *bisht* ‘tail’ < **bhid-t-*; *bushtër* ‘female dog’ < **bhid-trī*; *gisht* ‘finger’ < **g^{h}l̥t-t-* (cf. Jokl 1923: 261; Demiraj 1997: 103–104, 178; Orël 2000: 27, 43, 117–118 for alternative etymologies).[150] It should be noted that such an output is possible (since IE **st* > Alb. *št*, but valid only if IE **Tt* is merged with **st*, which is not the case).

T + s = Alb. 0š:

[*láshë*, *lashtë* ‘old, early, premature’ (either < PPAlb **ladśa*; < IE **lH₁u̯ds-m̥*; cf. Demiraj 1997: 57; or < PPAlb **lauša*; < IE **leud^h-s-*; cf. Orël 1998: 214–215);]

përposh ‘below, underneath’ (< IE *-*pēd-su*; cf. Pedersen 1900a: 290; Jokl 1937: 32–33; Demiraj 1997: 329–330; Orël 1998: 322, 340) ;

The IE cluster **d^{h}st* is realized as Alb. *0ϑ*, similarly to the cluster **Ḱst* (see above):

d^{h}st = Alb. 0ϑ:

ethe ‘fever’ (< IE **ai̯dhstis*; cf. OIA *óṣati* ‘burn, Gr. εὕω ‘singe’, αἰθός ‘burnt’; cf. Mann 1952: 40; Pokorny IEW: 348; Demiraj 1997: 168–169; Orël 1998: 91; LIV^2: 245);

6.2.5 The clusters *sibilant + t/s*

All clusters of IE *sibilant* + *t* are realized regularly as *št* in all positions, including the clusters possibly affected by Pedersen’s Law (the *ruki*-rule), therefore we can assume the merging of IE *s* with **š* (cf. Huld 1984: 147-148; Demiraj 1997: 56; Matzinger 2006: 77; Kümmel 2007: 372):

S + t = Alb. št:

shteg ‘path, road’ (< IE *√*stei̯g^h*-; cf. OIA *stighnóti* ‘climb’, Gr. στείχω ‘walk’; cf. Meyer 1891: 415; Pokorny IEW: 1017–1018; Kortlandt 1988: 221; Demiraj 1997: 371–372; Orël 1998: 437; Orël 2000: 96; LIV^2: 593–594; NIL 660–661; Schumacher 2013: 260; Rusakov 2017: 571);

shton ‘add’ (< IE **st-né-H₂-*; cf. Arm. *stanam* ‘arise’, OCS *stanǫ* ‘step’; cf. Pokorny IEW: 1004–1006; Demiraj 1997: 378; Orël 1998: 440; LIV^2: 590–591; NIL 637–659; Schumacher/Matzinger 2013: 998);

është ‘be’ (< IE **es-t*; cf. OIA *ásti*, L. *est*; cf. Pokorny IEW: 241; Demiraj 1997: 207–208; Orël 2000: 156; LIV^2: 241–242; Schumacher/Matzinger 2013: 972–973);

asht ‘bone’ (< IE **H₂ost*(*i*)-; cf. OIA *ásthi* ‘bone’, L. *oss* ‘bone’; cf. Meyer 1891: 19; Mann 1952: 39; Pokorny IEW: 783; Kortlandt 1988: 221; Demiraj 1997: 82–83; Orël 1998: 11; Orël 2000: 96; Schumacher 2013: 260);

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[148] A suppletive participle of *kā* “have”, 3rd sg. ao. (cf. Schumacher 2013: l.c.).

[149] But Demiraj (1997: 313–314) is very sceptical about this explanation.

[150] For simplicity, Johannson’s examples are present here in the modern Albanian orthography, not in the orthography he actually used.

The output of IE cluster of two sibilants **Ss* is realized by a single palatal sibilant, including the possible clusters arising according to the Pedersen's law:

S + s = Alb. 0š:

kush 'who' (< PPAlb. **kuśśa* < IE *$k^{u̯}$*ós só*; cf. Pokorny IEW: 694–648; Schumacher 2013: 264)[151];

thóshe 'say' (< IE **ḱeH₁s-si*; cf. OAv. *sīšā* 'show'; cf. Pokorny IEW: 533; Demiraj 1997: 57, 399–400; Orël 1998: 480; LIV^2: 318–319);

6.2.6 The overview of the Albanian development

The outputs of the Albanian development listed here are limited to the 'secure' ones; the variant outputs are entirely omitted here. The Albanian outputs of IE phonemes are listed here, for simplicity as archiphonemes.

IE	Albanian	t-	s-
-$k^{u̯}$/$g^{u̯}$/$g^{u̯h}$	-K[152]	*0t*	*0š*
-k/g/g^h	-K	*0t*	*0š*
-ḱ/ǵ/$ǵ^h$	-Θ	*0t*	*0š*[153]
-t/d/d^h	-T	*0s*	*0š*
-p/b/b^h	-P	*0t*	*fš*[154]
-s[155]	-š	*št*	*0š*

6.3 Trajectories of the development

There are at least two remarkable features of the development of IE clusters of *plosive + t*:

i. all clusters of *plosive + t* (except those with dentals) are realized as *0t*, even those with original IE palatovelars, a feature unknown in any other *satəm*-languages;

ii. dental clusters of **Tt* are realized as *0s* – it is clear that this output is not from the intermediate **st*, since original IE **st* has the Albanian output *št*, i.e., the Pre-Albanian never merged outputs of the IE **Tt* and **st*, as Iranian, Baltic and Slavic. More than that, since the output of the IE cluster of **ss* is *0š* in Albanian (at least if we can judge from scarce data), it is impossible to assume a merging of the outputs of IE **Tt* with those of **ss*, attested in Italic and Celtic (this process is also otherwise unknown in the *satəm*-languages).

On the contrary, the development of clusters of *plosive + s* is very simple: the Albanian output is always *0š*, except with IE **Pš* (a single example has an output *fš*, but this could be a result of

[151] But Orel (2000: 207) assumes this to be from *$k^{u̯}$*u-so*, and the reduced form of the first root is also assumed by Demiraj (1997: 228).

[152] The primary output is **K* (a plain velar), the secondary is **S* (due to palatalization before **e/i/i̯*), cf. Schumacher 2013: 241. Since we deal with the original labiovelar in the positions before *t/s* only, the difference of both outputs is irrelevant.

[153] Schumacher (2013: 238) brings another output *ϑ*.

[154] We will return below to the output *f* seen in *afër* "near" < PPAlb. **apsera* brought by Orel (1998: 1–2; Orel 2000: 95).

[155] Including **š* according to Pedersen's Law.

the development of clusters in a word-initial; we have no secure data for the development of world-internal clusters of *Ps).

6.3.1 The development of the IE clusters of *labial* plosive + *t/s*

The clusters resulting from IE *labial + t* are realized according to the pattern: *P + t > 0t*, similarly to all velar clusters (see below). The trajectory we propose assumes a spirantization[156] of the labial, a debuccalization and later simplification (cf. Huld 1984: 142, 148; Orël 2000: 35–36; Kümmel 2007: 372):

P + **t** > pt > φt > ht > **0t**

Note: Schumacher (2013) does not propose his own trajectory for the development of this cluster, but we can model his trajectories for labials as follows, with a gemination inserted between a debuccalization stage and a simplification stage: **Pt** > φt > xt > tt > **0t**.

The ‘double output’ of the IE cluster **Ps* either as Albanian *fš* or just *f*. In our opinion, the ‘regular’ output is just *fš-*, at least in the word-initial (there are no secure data for the word-internal position). The trajectory we model (with a high degree of uncertainty) as:

#P + **s** > #φs > #fs > #**fš**[157]

(**P** + **s** > φs > hs > 0s > **0š**) (?)

The output *f*, seen by Orël in *afër* ‘near’ (< PPAlb. **apsera*; Orël 1998: 1–2; Orël 2000: 95) should be probably rejected (for other etymologies cf. Meyer (1891: 3); Jokl (1923: 271); Demiraj 1997: 70–71), being a result of a shift of **ps* to PPAlb. **sp* (if related to Orël’s **apsera*), since **sp* was realized as *0f*, at least in a world-initial (Schumacher 2013: 233, 260 brings word-initial examples: *farë* ‘seed, breed’ < PPAlb. **p^harā* < IE **sporáH₂*; *fier* ‘fern’ < PPAlb. **p^hera* < IE **(s)perHom*; there are attested no secure examples on intervocalic **sp* (cf. Huld 1984: 149; Orël 2000: 95; Matzinger 2006: 78; Matzinger 2007: 78, 88; Kümmel 2007: 372).

The trajectory we dare to propose is based on metathesis, spirantization and debuccalization and simplification (cf. Huld 1984: 142; Orël 2000: 36; Kümmel 2007: 372):

P + **s** > ps → sp > hf > **0f**

[156] Here, we prefer a bilabial spirant *φ* instead of a labiodental *f*.
[157] Matzinger (2007: 78, 88) proposes the trajectory of the IE inverse cluster **sp* as: ***sp*** > *hφ* > ***0f***, which could serve as an analogy for the development of IE **Ps*.

Note: For the development of the cluster of *sp* Schumacher (2013: 233) gives a slightly different trajectory (exclusively for the word-initial cluster!); assuming aspiration before a spirantization of a plosive, we modify it for cluster of *ps* by adding the metathesis stage: ***Ps*** > *sp* > *hp* > *ph* > p^h > ***0f***.

6.3.2 The development of the IE clusters of *velar* plosive + *t*/*s*

In the original IE clusters of *velar* + *t*, as in all clusters of *plosive* + *t* (except *dental* + *t*), the left plosive is lost: **K* + *t* > *0t*.

The trajectory we dare to propose has the following stages: spirantization of a velar, debuccalization of the spirant, simplification due to elision of *h* (cf. Huld 1984: 142, 148; Orël 2000: 35–36; Kümmel 2007: 372):

K + **t** > kt > xt > ht > **0t**

Note: Schumacher (2013: 243) proposes a trajectory (for both plain and labiovelars): ***$K^{(u̯}$t*** > *xt* > *tt* > ***0t***, i.e, with a gemination instead of debuccalization.

The trajectory of the cluster **Ks* is similar in its main features; the sibilant is later palatalized (cf. Huld 1984: 142; Orël 2000: 36; Kümmel 2007: 372):

K + **s** > ks > xs > hs > 0s > **0š**

Note: If Pedersen's rule were valid for Pre-Proto-Albanian, the trajectory would be: ***Ks*** > *kš* > *hš* > ***0š***.

6.3.3 The development of the IE clusters of *labiovelar* plosive + *t*/*s*

For the IE clusters of *$K^{u̯}t$/$K^{u̯}s$, we assume the loss of labial markers before an obstruent, similarly to the development of Latin clusters with a labiovelar. For this reason, we can also surely assume the full merging of clusters of *$K^{u̯}t$ with **Kt* and of *$K^{u̯}s$ with **Ks*. The trajectories of development of clusters of *$K^{u̯}t$ and *$K^{u̯}s$ are hence essentially the same as for clusters of **Kt* and **Ks*, described above:

$K^{(u̯)}$ + **t** > kt > xt > ht > **0t**

Note: For the trajectory proposed by Schumacher (2013: 243) see above.

A remarkable feature is that Pre-Albanian seems to preserve the old neutralization of a palatovelar before a sibilant, otherwise known from OIA:

$K^{(u̯)}$ + **s** > ks > xs > hs > 0s > **0š**

Note: As said above, in the case of the validity of the *ruki*-rule for Proto-Albanian, the development would be: ***$K^{u̯}$s*** > *kš* > *hš* > ***0š***.

6.3.4 The development of the IE clusters of *palatovelar* plosive + *t/s*

As in preceding cases, the original IE palatovelar is lost before *t*-: **Ḱt + t > 0t*. This output is remarkable in the context of all *satəm*-languages since it indicates that Proto-Albanian had no merging of the original IE cluster of **Ḱt* with the cluster of *sibilant + t* since cluster of *sibilant + t* is realized in Albanian as *št*. Since we have no signs of a loss of any sibilant (original or secondary) before *t*-, we have to accept that Proto-Albanian never had a sibilant from an original palatovelar (or dental, as we will see below) before *t*-.

A palatal affricate as an intermediate stage is usually reconstructed for the trajectory from IE palatovelars to sibilants in given *satəm*-languages. A similar affricate is assumed for the development of the cluster of **Ḱt* into Albanian by Schumacher (2013: 243); the trajectory he reconstructs is: ***Ḱt*** > *ćt* > *ct* > *tt* > ***0t***, i.e, with affrication, depalatalization, gemination and elision.

Our spirantization model is slightly different, assuming the spirantization of a palatovelar before a plosive, its depalatalization, debuccalization and elision:

Ḱ + **t** > çt > xt **>** ht > **0t**

Note: An alternative model, assuming the depalatalization of a palatovelar as the earlier phase (***Ḱt*** > *xt* **>** *ht* > ***0t***), is possible, but unknown (in contrast to a position before *s*-) from other *satəm*-languages.

The trajectory of the development of the cluster of *palatovelar + s* could be analogically modelled as a sequence of a spirantization, depalatalization, debuccalization and simplification:

Ḱ + **s** > çs > xs **>** hs > **0š**

Note: An alternative model, assuming the depalatalization of a palatovelar as the earlier phase (***Ḱs*** > *xs* **>** *hs* > *0s* > ***0š***), is also possible, since it has a parallel in the development of Old Indo-Aryan, where the cluster of *Ḱs* is preserved as *kš*.

Note: Again, as with (labio)velars, if Pre-Albanian was affected by *ruki*-rule, the development would be: ***Ḱs*** > *kš* > *xš* >*hš* > ***0š***.

Note: Schumacher (2007: 79; 2013: 238) proposes a trajectory: ***Ḱts*** > *st* > ***št***. for the cluster of *Ḱst* He even assumes the development of *Ḱs* > Alb. *ϑ*, without a specification of a trajectory, but this model is based on a single example (IE **deḱsa*H_2 > Alb. *djathlë*). Demiraj (1997: 58) limits this output to word-final only (cf. Orël 2000: 96).

6.3.5 The development of the IE clusters of *dental* plosive + *t/s*

The development of IE clusters of **Tt* and **Ts* are rightly considered the oldest layer of all the processes concerning clusters of *plosive + t/s* since it is shared with all Indo-European branches.[158] It was Pedersen (1900a: 308; cf. also Jokl 1923: 261–262; Hamp 1961a: 252; Ködderitzsch 1991) who proved that the output of the IE *Tt in Albanian is *0s*.

Note: On the contrary, we have to reject Johannson's opinion that IE *Tt > Alb. *št*, though phonetically plausible[159] (Johannson 1903: 268 and 1906: 115; cf. esp. Jokl 1923: 261).

To model the trajectory we have to deal with many sub-questions, especially because of the fact that the IE dental clusters of *Tt are realized as *0s*, an output which cannot be a result of the intermediate (Johannson's model) **st*, since original IE **st* has the Albanian output *št*. We can thus be sure that the Pre-Albanian never merged outputs of *Tt* and *st* (cf. Görtzen 1998: 372), as Iranian, Baltic and Slavic did. What is more, since the output of the IE cluster **ss* is *0š* in Albanian (at least if we can judge from scarce data), it is impossible to assume a merging of the outputs of IE *Tt with **ss*, attested in Italic and Celtic. Hence **both** outputs known from the development of IE languages (outside of Indo-Aryan) are impossible as intermediate stages in the Albanian development, which makes Albanian development unique.

Though both the input and the output are clear, the details of the trajectory stay foggy[160] with many details unknown. We can be sure that the output *0s* is later than the palatalization of old IE **s* to Alb. *š*, which could otherwise affect this sibilant, being older than the palatalization process, hence the output is later than the palatalization.

Traditionally, the first step of the whole process of development of the cluster of *Tt* in Indo-European is considered the affrication of the left dental plosive; this idea was brought up first by Kräuter (1877: 88) and popularized by Brugmann (1880: 140–142 and used since). We dare to propose the model, assuming as a second step the affrication of the whole cluster and its later simplification and the merging of the outputs of the cluster of **ti̯* (which results in *c*; Ködderitzsch 1991: 121; Schumacher 2013: 234–235). The very sketchy trajectory we dare to propose is then:

T + **t** > t^st > t^st^s > $0t^s$ > **0s**

Note: This trajectory does not seem very probably, if we accept that Alb. *ethe* 'fever' is related to L. *aestus* 'heat' and derived from IE *$ai̯d^h$-sti-* and Alb. *dríthë* 'fever' related to L. *hordeum* 'barley' < IE *$\acute{g}r\bar{\imath}d^h$-st-* (Mann 1952: 40; Demiraj 1997:145–146, 168–169; Orël 1998: 75, 91; Görtzen 1998: 372–378). In this case *T^st would give Alb. *ϑ*, not the otherwise attested *0s*. The development could not be related to Bartholomae's Law, since in such case the voicedness would be preserved as it is in other Albanian developments. If given etymologies are correct, they entirely exclude the affricate trajectory for the Albanian development.

158 Indo-Aryan being a false exception since re-archaized later (c.f. the chapter on Aryan development of the present study.).

159 "Johannson's trajectory" would be easier to model as the affrication/sibilantization/palatalization trajectory: ***Tt*** > t^st > *st* > ***št***, similar to those of Baltic, Slavic and Iranian.

160 As has Schumacher (2013: 244) noted: "die Zwischenstufen bleiben unklar."

If we try to sketch a spirantization/lenition trajectory within the similar lines as de Saussure (1877); Cocchia (1883: 16–58) (both for Italic) and Bartholomae (1895: 16; for Iranian), we replace propose a spirant stage instead of the affricate; if we accept this for the development of Albanian, the trajectory could be modelled as a sequence of the subsequent spirantization of both dentals, followed by the later dissimilation on an affricate, which finally lost its plosive segment:

T + **t** > ϑt > ϑϑ > 0t^s > **0s**

Both trajectories are within the wider **fricativization** trajectory. It should be noted that the sibilant outcome is late, since it is not a subject of the palatalization of the sibilant. We can in both cases reject the possibility that IE **Tt* ever was realized as *ss* (as in Italic, Celtic and Germanic), since IE **ss* is realized as Albanian *0š* (see below).

In stark contrast with the cluster of **Tt*, the development of the cluster of **Ts* seems to be very simple, we propose the model trajectory, assuming the affrication of the dental plosive:

T + **s** > t^ss > ss > 0s > **0š**

The alternative model, based on the spirantization in the first phase, is otherwise similar to the preceding one, again, both trajectories are within the frame of the wide fricativization trajectory. The fricativization model is simpler, since sibilantization of a fricative is a more probably process than de-occlusivization of an affricate, hence more probable:

T + **s** > ϑs > ss > 0s > **0š**

6.3.6 The development of the IE clusters of *sibilant* + *t*/*s*

Clusters of original IE *sibilant* + *t* are regularly realized as *št*. Since Alb. *š* is an output of the all IE sibilants (cf. Kortlandt 1987; Demiraj 1997: 56; Kortlandt 1998; Orël 2000: 96; Schumacher 2013: 258–265, de Vaan 2018: 1746), we are not able to resolve whether Proto-Albanian ever was subjected to Pedersen's Law. The cases assumed to be originally affected by the *ruki*-rule could be those following (according to Orël 2000: 62): *dash* 'ram' < PPAlb. **dausa* < IE **d^houso-*; *lesh* 'wool' < PPAlb. **laiša*, etc. However, Orël is probably mistaken in his premise that a regular development of IE **s* with an Albanian output is a palatal affricate ɟ

(<*gj*>)[161], since this output is limited to the word-initial position before an accented vowel (cf. Demiraj 1997: 56; Schumacher 2007: 77–79, 87–88, 92; Schumacher 2013: 258–260).

The trajectory of the IE clusters of **st* is then straightforward and simple, with just a palatalization of a sibilant (Matzinger 2006: 78; Matzinger 2007: 78):

S + **t** > st > **št**

The development of the IE cluster of **Ss* could be reconstructed as a simple trajectory of simplification and palatalization:

S + **s** > ss > 0s > **0š**

Note: If the palatalization happened earlier than the gemination, the trajectory would be: ***Ss* > šš > *0š***.

6.4 Conclusion and final remarks

A remarkable feature of the development of the Indo-European clusters of *plosive* + *t* into Albanian is that all such clusters, with the exception of the IE **Tt*, have an output *0t*. The development of dental series hence had to be dealt with separately, on a different trajectory, that those of other series. From this we can deduce that even the cluster of *palatovelar* + *t* had a similar development as the peripheral series, unlike to the situation of the same series in other *satəm*-series.

The development of the cluster of *dental* + *t/s* underwent a fricativization trajectory, either within an affricativization or spirantization frame.

For the development of the IE cluster of **Ḱ+t/s*, we can also model either an affricativization or a fricativization trajectory, but the second seems to be more probable. However, the most atypical feature is depalatalization of the original palatovelar, either older of the plain velar plosive (which would be the unique feature in the development of the *satəm*-languages) or later of the spirant.

The development of the peripheral series follows the general lines of spirantization as the first step, followed by the debuccalization and later elision of the former plosive (except of the cluster of *fš*).

Note: An alternative possibility could be gemination, with the trajectory for velars: ***Kt*** >*tt* > ***0t***, for labials: ***Pt*** >*tt* > ***0t***, for palatovelars: ***Ḱt*** >*tt* > ***0t***. Such a trajectory could be even possible for the dental series: ***Tt*** >t^st > t^st^s > *ss* > ***0s***.

[161] This output merged with an output of #*i̯*- (Schumacher 2013: 258).

The development of the IE cluster of **st* is trivial, since the only process affecting it is the palatalization of the sibilant. The cluster of **ss* was affected in its development, besides palatalization, by the simplification of the cluster (technically degemination).

7 The development of the two-obstruent clusters from Indo-European into Greek

7.0 Greek language

The Greek language is the oldest attested Indo-European language of Europe, Mycenaean already in the last centuries of the second millennia BC, Homeric Greek from the second half of the first millennia BC, classical and post-classical Greek from the first half of the same millennia, with Greek being used until the present day not only in modern Greece and Cyprus but even inside a world-wide diaspora (for the short overview of Greek from Indo-European point of view, cf. Thompson 2017: 287–291). The Greek language, due to the developments of Greek culture/science/arts, affected all other European languages, especially Latin and through Latin the rest of the world, being a source of terminology until today.

Our focus in on the development of Ancient Greek tongue, the Mycenaean data will be used, if at hand, and especially if bringing different outcomes than the later language. The later Middle-Greek developments are omitted, though offering interesting parallels to the development in other IE languages (cf. Horrocks 2017).

Note: Quoted Greek data are from Attic dialect; if not, the dialect will be mentioned.

7.1 Greek and Indo-European

The typical features separating the Greek obstruent system from that of Indo-European, related to our field of interest, are:

i. preservation of three modal classes of plosives (the third modal class preserved as a voiceless aspirate);
ii. preservation of old IE labiovelars in Mycenaean, but labiovelars are merged with other series in Classical language (cf. Lejeune 1972: 34–37, 43–53; Bartoněk 2003: 137–139);
iii. the loss of the IE **s* (preserved next to a plosive) in the post-Mycenaean period[162];
iv. Grassmann's law of deaspiration of the left aspirate ($T^h\_T^h > T\_T^h$).

The first feature is shared with Italic (where the third class was spirantized), with Germanic and Armenian (where the number of classes is preserved, but classes themselves were subjected to the shift) and with Indo-Aryan (where there is a fourth class).

Labiovelars are almost fully preserved in Latin (but not in any other Italic languages) and in Germanic.

The IE **s* underwent some of the similar developments (especially **sV-* > *hV-*) like in Iranian; the loss of the intervocalic sibilant is reflected in the rhotacism in Germanic and Italic.

Grassmann's Law is operational in Indo-Aryan (in the form: $D^h–D^h > D–D^h$), though it is hard to establish if both processes are accidentally parallels or reflecting an old inherited pattern[163] (cf. Lejeune 1972: 56–58; Sihler 1995: 142–144).

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[162] But at least intervocalic -*s*- was preserved in Mycenaean, cf. Myc. fut. *do-so-si* (= *dōsonsi*, cf. δίδωμι), Myc. ao. e-re-u-te-ro-se (= eleut^{h}erōse,; cf. ἐλευθερόω); Bartoněk 2003: 114.

[163] If the IE triad was **T – D – D^h*, the expected outcome of the Grassmann's Law in Greek should be: †*D_T^h*. For this reason, we more readily assume the secondarily remodelling of the older mechanism both in Greek and Indo-Iranian, especially since the process affects even Greek *h* arisen from IE **s*, which hardly could already be an Indo-European feature.

Note: The operationality of Bartholomae's Law is doubtful, cf. Brugmann (1987: 658–659); Rix (1992: 32); Görtzen 1998: 355–356.

7.2 Classical Greek clusters and their IE origins

For the Greek cluster the assimilation of the modal properties of the left plosive to phonemic properties of the right obstruent is typical. In Greek, as in most IE languages (but not in Indo-Iranian) there is no mechanism like Bartholomae's Law (cf. Sihler 1995: 200), hence this process is always dominated by the right obstruent.

Since Greek is well attested with numerous examples, we focused, again, on the productive examples, especially those of verbal derivation/flexion. The purely etymological examples are limited to well-known items with a wider Indo-European validity and background.

7.2.1 The clusters *labial* + *t/d^h/s*

Indo-European clusters of *Pt, *Ps, *Pd^h are fully preserved (IE *d^h becoming Gr. t^h); the left plosive is assimilated to the right obstruent both in voice and aspiration:

P + t = Gr. pt:

pr. δρέπτω, verb.adj. δρεπτός (cf. pr. δρέπω 'pluck'; < IE *√*drep-*; cf. Cz. *drápati* 'scratch', Sln. *dŕpati* 'tear'; cf. Pokorny IEW: 211; Frisk 1960: 417; Liddell/Scott 1996: 449; LIV^2: 128; Beekes 2016: 353);

pr. κλέπτω, pf. κέκλεπται, nom. κλέπτης (cf. ao. ἐκλάπην 'steal'; < IE *√*klep-*; cf. L. *clepō*, Goth. *hlifan* 'steal'; cf. Pokorny IEW: 604; Frisk 1960: 870–871; Liddell/Scott 1996: 958; LIV^2: 363–364; Beekes 2016: 713–714);

pf. τέτραπται, verb.adj. τρεπτός (cf. pr. τρέπω 'turn, direct'; < IE *√*trep-*; cf. Hitt. *teripzi* 'plow'; cf. Pokorny IEW: 1094; Frisk 1970: 923–925; Liddell/Scott 1996: 1813; LIV^2: 650; Beekes 2016: 1503–1504);

num. ἑπτά 'seven' (< IE **septm̥*; cf. OIA *saptá*, L. *septem* cf. Pokorny IEW: 909; Frisk 1960: 545; Liddell/Scott 1996: 677; Waanders 1992: 373, 380; Blažek 1999: 247; Beekes 2016: 446);

pf. γέγραπται, verb.adj. γραπτός (cf. pr. γράφω 'scratch, graze'; < IE *√*gerb^h-*; cf. OE *ceorfan* 'cut off'; cf. Pokorny IEW: 392; Frisk 1960: 324–325; Liddell/Scott 1996: 359–360; LIV^2: 187; Beekes 2016: 285–286);

pf. (κατέ-)στραπται, verb.adj. στρεπτ-ός (cf. pr. στρέφω 'turn about'; < IE *√*streb^h-*; cf. Pokorny IEW: 1025; Frisk 1970: 808–809; Liddell/Scott 1996: 915, 1653–1654; LIV^2: 603; Beekes 2016: 1413–1414);[164]

P + s = Gr. ps:

ao. ἔδρεψα, fut. Dor. δρεψεῦμαι (cf. pr. δρέπω 'pluck'; < IE *√*drep-*; cf. Cz. *drápati* 'scratch', Sln. *dŕpati* 'tear'; cf. Pokorny IEW: 211; Frisk 1960: 417; Liddell/Scott 1996: 449; LIV^2: 128; Beekes 2016: 353);

[164] Only in Greek, without cognates from other Indo-European languages.

ao. ἔκλεψα, fut. κλέψω (cf. ao. ἐκλάπην 'steal'; < IE *√*klep*-; cf. L. *clepō*, Goth. *hlifan* 'steal'; cf. Pokorny IEW: 604; Frisk 1960: 870–871; Liddell/Scott 1996: 958; LIV^2: 363–364; Beekes 2016: 713–714);

ao. ἔτρεψα, fut. τρέψω (cf. pr. τρέπω 'turn, direct'; < IE *√*trep-*; cf. Hitt. *teripzi* 'plow'; cf. Pokorny IEW: 1094; Frisk 1970: 923–925; Liddell/Scott 1996: 1813; LIV^2: 650; Beekes 2016: 1503–1504);

ao. ἔγραψα, fut. γράψομαι (cf. pr. γράφω 'scratch, graze'; < IE *√*gerb^h-*; cf. OE *ceorfan* 'cut off'; cf. Pokorny IEW: 392; Frisk 1960: 324–325; Liddell/Scott 1996: 359–360; LIV^2: 187; Beekes 2016: 285–286);

ao. ἔστρεψα, fut. στρέψω (cf. pr. στρέφω 'turn about'; < IE *√*streb^h-*; cf. Pokorny IEW: 1025; Frisk 1970: 808–809; Liddell/Scott 1996: 915, 1653–1654; LIV^2: 603; Beekes 2016: 1413–1414);

P + d^h = Gr. p^ht^h:

ao. ἐδρέφθην (cf. pr. δρέπω 'pluck'; < IE *√*drep-*; cf. Cz. *drápati* 'scratch', Sln. *dŕpati* 'tear'; cf. Pokorny IEW: 211; Frisk 1960: 417; Liddell/Scott 1996: 449; LIV^2: 128; Beekes 2016: 353);

ao. ps. ἐκλέφθην (cf. ao. ἐκλάπην 'steal'; < IE *√*klep*-; cf. L. *clepō*, Goth. *hlifan* 'steal'; cf. Pokorny IEW: 604; Frisk 1960: 870–871; Liddell/Scott 1996: 958; LIV^2: 363–364; Beekes 2016: 713–714);

ao. ps. τραφθείς (cf. pr. τρέπω 'turn, direct'; < IE *√*trep-*; cf. Hitt. *teripzi* 'plow'; cf. Pokorny IEW: 1094; Frisk 1970: 923–925; Liddell/Scott 1996: 1813; LIV^2: 650; Beekes 2016: 1503–1504);

pf. imp. γέγραφθω (cf. pr. γράφω 'scratch, graze'; < IE *√*gerb^h-*; cf. OE *ceorfan* 'cut off'; cf. Pokorny IEW: 392; Frisk 1960: 324–325; Liddell/Scott 1996: 359–360; LIV^2: 187; Beekes 2016: 285–286);

ao. ps. ἐστρέφθην (cf. pr. στρέφω 'turn about'; < IE *√*streb^h-*; cf. Pokorny IEW: 1025; Frisk 1970: 808–809; Liddell/Scott 1996: 915, 1653–1654; LIV^2: 603; Beekes 2016: 1413–1414);

7.2.2 The clusters *velar + t/d^h/s*

Indo-European clusters of **Kt*, **Ks*, **Kd^h* are fully preserved (IE **d^h* becoming Gr. *t^h*); the left plosive is assimilated to the right obstruent both in voice and aspiration:

K + t = Gr. kt:

verb.adj. ἑλκτέον, ἑλκτικός (cf. pr. ἕλκω 'drag, draw'; < IE *√*selk-*; cf. Toch. B *sälkāte* 'drag'; cf. Pokorny IEW: 901; Frisk 1960: 497–498; Liddell/Scott 1996: 534–535; LIV^2: 530–531; Beekes 2016: 412);

verb.adj. τηκτός, τηκτέον (cf. pr. τήκω 'melt'; < IE *√*teH$_2$k-*; cf. OCS *tają* 'melt'; cf. Pokorny IEW: 1053; Frisk 1970: 891; Liddell/Scott 1996: 1786–1787; LIV^2: 617;[165] Beekes 2016: 1477);

plqpf. ἔζευκτο (cf. pr. ζεύγνῡμι, ζεύγνῡσι 'yoke'; < IE *√*i̯eu̯g-* cf. OIA *yunákti* 'yoke', L. *iungō* 'bind'; cf. Pokorny IEW: 505–510; Frisk 1960: 609–610; Liddell/Scott 1996: 754; LIV^2: 316; NIL: 397–404; Beekes 2016: 497–498);

[165] Not attested outside Greek, LIV^2 (l.c.) has a variant with a final palatovelar as well.

verb.adj. τακτός (cf. ao. part. ps. ταγεὶς 'draw up, form, array'; < IE *√*tag*-; cf. OP *ham-ataxšatā* 'try to keep in order'; cf. Pokorny IEW: 1055; Frisk 1970: 845–846; Liddell/Scott 1996: 1759–1760, 1753; LIV^2: 615; Beekes 2016: 1444, 1454–1455);

pf. ἦρκται, verb.adj. ἀρκτέον (cf. pr. ἄρχω 'rule, begin'; < IE *√*reg^h*-; cf. MHG *regen* 'erect, irritate'; cf. Pokorny IEW: 854, 863; Frisk 1960: 159; Liddell/Scott 1996: 242, 254; LIV^2: 498; Beekes 2016: 145–146);

K + s = Gr. ks:

fut. ἕλξω (cf. pr. ἕλκω 'drag, draw'; < IE *√*selk*-; cf. Toch. B *sälkāte* 'drag'; cf. Pokorny IEW: 901; Frisk 1960: 497–498; Liddell/Scott 1996: 534–535; LIV^2: 530–531; Beekes 2016: 412);

ao. ἔτηξα, fut. τήξω (cf. pr. τήκω 'melt'; < IE *√*teH₂k*-; cf. OCS *tajǫ* 'melt'; cf. Pokorny IEW: 1053; Frisk 1970: 891; Liddell/Scott 1996: 1786–1787; LIV^2: 617;[166] Beekes 2016: 1477);

ao. ἔζευξα, fut. ζεύξω, nom. -ζυξ (cf. pr. ζεύγνῡμι, ζεύγνῡσι 'yoke'; < IE *√*i̯eu̯g*- cf. OIA *yunákti* 'yoke', L. *iungō* 'bind'; cf. Pokorny IEW: 505–510; Frisk 1960: 609–610; Liddell/Scott 1996: 754; LIV^2: 316; NIL: 397–404;Beekes 2016: 497–498);

ao. ἔταξα, fut. τάξω (cf. ao. part. ps. ταγεὶς 'draw up, form, array'; < IE *√*tag*-; cf. OP *ham-ataxšatā* 'try to keep in order'; cf. Pokorny IEW: 1055; Frisk 1970: 845–846; Liddell/Scott 1996: 1759–1760, 1753; LIV^2: 615; Beekes 2016: 1444, 1454–1455);

ao. ἦρξα, fut. ἄρξω (cf. pr. ἄρχω 'rule, begin'; < IE *√*reg^h*-; cf. MHG *regen* 'erect, irritate'; cf. Pokorny IEW: 854, 863; Frisk 1960: 159; Liddell/Scott 1996: 242, 254; LIV^2: 498; Beekes 2016: 145–146);

ao. inf. θρᾶξαι (cf. pr. θράσσω, Att. θράττω 'confuse'; < IE *√*d^{h}reH₂g^h*-; cf. OCS *-dražǫ* 'bewilder'; cf. Pokorny IEW: 251, 273; Frisk 1960: 679–670; Liddell/Scott 1996: 804; LIV^2: 154–155; Beekes 2016: 553);

K + d^h = Gr. k^{h}t^h:

fut. ps. ἑλχθήσομαι (cf. pr. ἕλκω 'drag, draw'; < IE *√*selk*-; cf. Toch. B *sälkāte* 'drag'; cf. Pokorny IEW: 901; Frisk 1960: 497–498; Liddell/Scott 1996: 534–535; LIV^2: 530–531; Beekes 2016: 412);

ao. ps. ἐτήχθην (cf. pr. τήκω 'melt'; < IE *√*teH₂k*-; cf. OCS *tajǫ* 'melt'; cf. Pokorny IEW: 1053; Frisk 1970: 891; Liddell/Scott 1996: 1786–1787; LIV^2: 617;[167] Beekes 2016: 1477);

ao. ps. ἐζεύχθην, fut. ps. ζευχθήσομαι (cf. pr. ζεύγνῡμι, ζεύγνῡσι 'yoke'; < IE *√*i̯eu̯g*- cf. OIA *yunákti* 'yoke', L. *iungō* 'bind'; cf. Pokorny IEW: 505–510; Frisk 1960: 609–610; Liddell/Scott 1996: 754; LIV^2: 316; Beekes 2016: 497–498);

ao. ps. ἐτάχθην, fut. ps. ταχθήσομαι (cf. ao. part. ps. ταγεὶς 'draw up, form, array'; < IE *√*tag*-; cf. OP *ham-ataxšatā* 'try to keep in order'; cf. Pokorny IEW: 1055; Frisk 1970: 845–846; Liddell/Scott 1996: 1759–1760, 1753; LIV^2: 615; Beekes 2016: 1444, 1454–1455);

ao. ps. ἤρχθην, ἀρχθῆναι (cf. pr. ἄρχω 'rule, begin'; < IE *√*reg^h*-; cf. MHG *regen* 'erect, irritate'; cf. Pokorny IEW: 854, 863; Frisk 1960: 159; Liddell/Scott 1996: 242, 254; LIV^2: 498; Beekes 2016: 145–146);

ao. ps. ἐθράχθη (cf. pr. θράσσω, Att. θράττω 'confuse'; < IE *√*d^{h}reH₂g^h*-; cf. OCS *-dražǫ* 'bewilder'; cf. Pokorny IEW: 251, 273; Frisk 1960: 679–670; Liddell/Scott 1996: 804; LIV^2: 154–155; Beekes 2016: 553);

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[166] Not attested outside Greek, LIV^2 (l.c.) has a variant with a final palatovelar as well.

[167] Not attested outside Greek, LIV^2 (l.c.) has a variant with a final palatovelar as well.

7.2.3 The clusters *palatovelar + t/d^h/s*

Since assumed IE palatovelars are indistinguishable in Greek from IE plain velars, the mechanism is the same as with Indo-European clusters of **Kt*, **Ks*, **Kd^h*:

Ḱ + t = Gr. kt:

pf. δέδεικται, pf.ps. δείδεκτο, verb.adj. δεικτέον (cf. pr. δείκνυμι 'show'; < IE *√*dei̯ḱ-*; cf. OIA *ádiṣṭa* 'show', L. *dīcō* 'say'; cf. Pokorny IEW: 188–189; Frisk 1960: 355–356; Liddell/Scott 1996: 373; LIV²: 108–109; Beekes 2016: 309);

pf. δέδηκται (cf. pr. δάκνω 'bite'; < IE *√*denḱ-*; cf. OIA *dáśati* 'bite'; cf. Pokorny IEW: 201; Frisk 1960: 343; Liddell/Scott 1996: 367; LIV²: 117–118; NIL: 82–83; Beekes 2016: 399);

pr. πεκτέω, nom. πεκτήρ (cf. pr. πέκω 'comb'; < IE *√*peḱ-*; cf. L. *pectō* 'comb, shear', Lith. *pešù* 'pluck'; cf. Pokorny IEW: 797; Frisk 1970: 492–493; Liddell/Scott 1996: 1356, 1432; LIV²: 467; Beekes 2016: 1164);

num. ὀκτώ 'eight' (< IE **oḱtṓ*; cf. OIA *aṣṭáu*, L. *octō*; cf. Pokorny IEW: 775; Frisk 1970: 374–375; Liddell/Scott 1996: 1213; Waanders 1992: 373; Blažek 1999: 247; Beekes 2016: 1066);

verb.adj. ἀκτέον, ἀκτή (cf. pr. ἄγω 'drive, carry, fetch'; < IE *√*H₂eǵ-*; cf. OIA *ájati* 'drive', Arm. *acem* 'lead'; cf. Pokorny IEW: 4–5; Frisk 1960: 18; Liddell/Scott 1996: 17–18, 58; LIV²: 255–256; NIL: 267–277; Beekes 2016: 18–19);

pf. λέλεκται, ao. λέκτο, verb.adj. λεκτός (cf. pr. λέγω 'pick up, choose, say'; < IE *√*leǵ-*; cf. L. *legō* 'pick up, read'; cf. Pokorny IEW: 658; Frisk 1970: 94–96; Liddell/Scott 1996: 1033–1034, 1037; LIV²: 397; Beekes 2016: 841);

nom. ἀγκτήρ (cf. pr. ἄγχω 'squeeze, hug'; < IE *√*H₂emǵ^h-*; cf. Hitt. *hamanki* 'tie up', L. *angō* 'restrict'; cf. Pokorny IEW: 42–43; Frisk 1960: 17–18; Liddell/Scott 1996: 10, 17; LIV²: 264–265; Beekes 2016: 18);

nom. λείκτης 'cunnilingus' (cf. pr. λείχω 'lick'; < IE *√*lei̯ǵ^h-*; cf. OIA *réḍhi*, OCS *ližǫ* 'lick'; cf. Pokorny IEW: 668; Frisk 1970: 102–103; Liddell/Scott 1996: 1035, 1037; LIV²: 404; Beekes 2016: 846–847);

verb.adj. ἑκτός, nom. ἕκτωρ (cf. pr. ἔχω 'have, posses'; < IE *√*seǵ^h-*; cf. OIA *sáhate* 'capture'; cf. Pokorny IEW: 888–889; Frisk 1960: 602–604; Liddell/Scott 1996: 523, 749–750; LIV²: 515–516; NIL: 600–604; Beekes 2016: 490–491);

Ḱ + s = Gr. ks;

ao. ἔδειξα, fut. δείξω (cf. pr. δείκνυμι 'show'; < IE *√*dei̯ḱ-*; cf. OIA *ádiṣṭa* 'show', L. *dīcō* 'say'; cf. Pokorny IEW: 188–189; Frisk 1960: 355–356; Liddell/Scott 1996: 373; LIV²: 108–109; Beekes 2016: 309);

ao. ἔδηξα, fut. δήξομαι (cf. pr. δάκνω 'bite'; < IE *√*denḱ-*; cf. OIA *dáśati* 'bite'; cf. Pokorny IEW: 201; Frisk 1960: 343; Liddell/Scott 1996: 367; LIV²: 117–118; NIL: 82–83;Beekes 2016: 399);

ao. ἔπεξα (cf. pr. πέκω 'comb'; < IE *√*peḱ-*; cf. L. *pectō* 'comb, shear', Lith. *pešù* 'pluck'; cf. Pokorny IEW: 797; Frisk 1970: 492–493; Liddell/Scott 1996: 1356, 1432; LIV²: 467; Beekes 2016: 1164);

nom. ἄξων 'axle', ἅμαξα 'wagon' (< IE **sm-H₂ḱs-iH₂-*; cf. OIA *akṣa-*, L. *axis*, OCS *osь*, OHG. *ahsa* 'axle'; cf. Pokorny 1959: 6; Frisk 1960: 85–86, 116; Liddell/Scott 1996: 172; NIL: 259–262; Beekes 2016: 81–82, 111);

num. ἕξ, Dor. Crete ϝέξ 'six' (< IE *sṷeḱs; cf. L. *sex*, Goth. *saihs*; cf. Pokorny IEW: 1044; Frisk 1960: 527; Waanders 1992: 372–673; Liddell/Scott 1996: 529; Blažek 1999: 236; Beekes 2016: 433–434);

ao. inf. ἄξαι, fut. ἄξω (cf. pr. ἄγω 'drive, carry, fetch'; < IE *√*H₂eǵ-*; cf. OIA *ájati* 'drive', Arm. *acem* 'lead'; cf. Pokorny IEW: 4–5; Frisk 1960: 18; Liddell/Scott 1996: 17–18, 58; LIV²: 255–256; NIL: 267–277; Beekes 2016: 18–19);

ao. ἔλεξα, fut. λέξω (cf. pr. λέγω 'pick up, choose, say'; < IE *√*leǵ-*; cf. L. *legō* 'pick up, read'; cf. Pokorny IEW: 658; Frisk 1970: 94–96; Liddell/Scott 1996: 1033–1034, 1037; LIV²: 397; Beekes 2016: 841);

ao. inf. ἄγξαι, fut. ἄγξω (cf. pr. ἄγχω 'squeeze, hug'; < IE *√*H₂emǵʰ-*; cf. Hitt. *hamanki* 'tie up', L. *angō* 'restrict'; cf. Pokorny IEW: 42–43; Frisk 1960: 17–18; Liddell/Scott 1996: 10, 17; LIV²: 264–265; Beekes 2016: 18);

aor. ἔλειξα (cf. pr. λείχω 'lick'; < IE *√*leịǵʰ-*; cf. OIA *réḍhi*, OCS *ližǫ* 'lick'; cf. Pokorny IEW: 668; Frisk 1970: 102–103; Liddell/Scott 1996: 1035, 1037; LIV²: 404; Beekes 2016: 846–847);

fut. ἕξω (cf. pr. ἔχω 'have, posses'; < IE *√*seǵʰ-*; cf. OIA *sáhate* 'capture'; cf. Pokorny IEW: 888–889; Frisk 1960: 602–604; Liddell/Scott 1996: 523, 749–750; LIV²: 515–516; NIL: 600–604; Beekes 2016: 490–491);

Ḱ + dʰ = Gr. kʰtʰ:

ao.ps. δειχθήσομαι (cf. pr. δείκνυμι 'show'; < IE *√*deịḱ-*; cf. OIA *ádiṣṭa* 'show', L. *dīcō* 'say'; cf. Pokorny IEW: 188–189; Frisk 1960: 355–356; Liddell/Scott 1996: 373; LIV²: 108–109; Beekes 2016: 309);

fut. ps. δηχθήσομαι, ao. ps. ἐδήχθην (cf. pr. δάκνω 'bite'; < IE *√*denḱ-*; cf. OIA *dáśati* 'bite'; cf. Pokorny IEW: 201; Frisk 1960: 343; Liddell/Scott 1996: 367; LIV²: 117–118; NIL: 82–83;Beekes 2016: 399);

ao. ps. ἐπέχθην (cf. pr. πέκω 'comb'; < IE *√*peḱ-*; cf. L. *pectō* 'comb, shear', Lith. *pešù* 'pluck'; cf. Pokorny IEW: 797; Frisk 1970: 492–493; Liddell/Scott 1996: 1356, 1432; LIV²: 467; Beekes 2016: 1164);

ao. ps. ἤχθην. ps. fut. ἀχθήσομαι (cf. pr. ἄγω 'drive, carry, fetch'; < IE *√*H₂eǵ-*; cf. OIA *ájati* 'drive', Arm. *acem* 'lead'; cf. Pokorny IEW: 4–5; Frisk 1960: 18; Liddell/Scott 1996: 17–18, 58; LIV²: 255–256; Beekes 2016: 18–19);

ao. ps. ἐλέχθην (cf. pr. λέγω 'pick up, choose, say'; < IE *√*leǵ-*; cf. L. *legō* 'pick up, read'; cf. Pokorny IEW: 658; Frisk 1970: 94–96; Liddell/Scott 1996: 1033–1034, 1037; LIV²: 397; Beekes 2016: 841);

ao. ps. part. ἐκλειχθέν (cf. pr. λείχω 'lick'; < IE *√*leịǵʰ-*; cf. OIA *réḍhi*, OCS *ližǫ* 'lick'; cf. Pokorny IEW: 668; Frisk 1970: 102–103; Liddell/Scott 1996: 1035, 1037; LIV²: 404; Beekes 2016: 846–847);

7.2.4 The clusters *labiovelar + t/dʰ/s*

The Indo-European labiovelars are realized either as labials or velars in the position before *t/tʰ/s-*. In the given contexts there is no realization as *t*, possible in other contexts. The outcome is *k* for an old labiovelar in the case of close contact of a labiovelar with *u* (cf. pr. ηὗκται, ao. εὐξάμην and pr. εὔχομαι < IE *√*H₂eụgᵘʰ-*, this change is Pre-Mycenaean, since Myc. *e-u-ke-to*; cf. Lejeune 1972: 44; Aura Jorro/Adrados 1985: 261–262; Sihler 1995: 156; Bartoněk 2003: 139):

$K^{u̯}$ + t = PGr. *$k^{u̯}$t > Gr. pt/kt:

pf. λέλειπτο (ep.), ao. ἔλειπτο (ep.), verb.adj. λειπτέον (cf. pr. λείπω 'leave'; < IE *√*lei̯k*$^{u̯}$-; cf. OIA *riṇákti*, L. *līquī* 'leave'; cf. Pokorny IEW: 669–670; Frisk 1970: 99–100; Liddell/Scott 1996: 1035–1036; LIV^2: 406–407; NIL: 600–604; Beekes 2016: 844–845);

pr. βλάπτω (cf. part. βλᾰβείς 'disable, hinder'; < IE *√*melk*$^{u̯}$-; cf. OIA *marcáyati* 'damage'; cf. Pokorny IEW: 737; Frisk 1960: 239–240; Liddell/Scott 1996: 317; LIV^2: 434–435; Beekes 2016: 217);

pf. πέπεπται (cf. pr. πέσσω 'ripen, cook'; < IE *√*pek*$^{u̯}$-; cf. OIA *pácati* 'cook, ripe', L. *coquō* 'cook', OCS *pekǫ* 'bake'; cf. Pokorny IEW: 798; Frisk 1970: 519–520; Liddell/Scott 1996: 1396; LIV^2: 468; NIL: 548–552; Beekes 2016: 1180–1181);

num. πέμπτος 'fifth' (< IE **penk*$^{u̯}$*to*-; cf. OIA *pakthá*-, L. *quīnctus* 'fifth'; cf. Pokorny IEW: 808; Frisk 1970: 506–507; Liddell/Scott 1996: 1359; Waanders 1992: 372, 375, 379; Blažek 1999: 221; Beekes 2016: 1172–1173);

pf. ἤμειπται, plpf. ἄμειπτο (cf. pr. ἀμείβω 'change'; < IE *√*H*$_2$*mei̯g*$^{u̯}$-; cf. L. *migrāre* 'migrate' (?); cf. Pokorny IEW: 713; Frisk 1960: 90; Liddell/Scott 1996: 79–80; LIV^2: 279; Beekes 2016: 85–86);

verb.adj. τριπτέον, τριπτήριον (cf. pr. τρίβω 'rub'; < IE *√*trei̯g*$^{u̯}$-; cf. Pokorny IEW: 1071; Frisk 1970: 930–931; Liddell/Scott 1996: 1817, 1822; LIV^2: 648; Beekes 2016: 1508–1509);[168]

ps. ηὗκται, verb.adj. εὐκταῖος (cf. pr. εὔχομαι 'pray, wish'; < IE *√*H*$_1$*u̯eg*$^{u̯h}$-; cf. OIA *óhate* 'speak solemnly', L. *uoueō* 'vow'; cf. Pokorny IEW: 348; Frisk 1960: 595–596; Liddell/Scott 1996: 719, 739; LIV^2: 253; Beekes 2016: 485–486);

$K^{u̯}$ + s = PGr. *$k^{u̯}$s > Gr. ps/ks:

ao. ἔλειψα, fut. λείψω (cf. pr. λείπω 'leave'; < IE *√*lei̯k*$^{u̯}$-; cf. OIA *riṇákti*, L. *līquī* 'leave'; cf. Pokorny IEW: 669–670; Frisk 1970: 99–100; Liddell/Scott 1996: 1035–1036; LIV^2: 406–407; NIL: 600–604; Beekes 2016: 844–845);

ao. ἔβλαψα, fut. βλάψω (cf. part. βλᾰβείς 'disable, hinder'; < IE *√*melk*$^{u̯}$-; cf. OIA *marcáyati* 'damage'; cf. Pokorny IEW: 737; Frisk 1960: 239–240; Liddell/Scott 1996: 317; LIV^2: 434–435; Beekes 2016: 217);ao, ἔπεψα, fut. πέψω (cf. pr. πέσσω 'ripen, cook'; < IE *√*pek*$^{u̯}$-; Beekes 2016: x);

ao. ἤμειψα, fut. ἀμείψα (cf. pr. ἀμείβω 'change'; < IE *√*H*$_2$*mei̯g*$^{u̯}$-; cf. L. *migrāre* 'migrate' (?); cf. Pokorny IEW: 713; Frisk 1960: 90; Liddell/Scott 1996: 79–80; LIV^2: 279; NIL: 548–552; Beekes 2016: 85–86);

ao. ἔτριψα, fut. τρίψω (cf. pr. τρίβω 'rub'; < IE *√*trei̯g*$^{u̯}$-; cf. Pokorny IEW: 1071; Frisk 1970: 930–931; Liddell/Scott 1996: 1817, 1822; LIV^2: 648; Beekes 2016: 1508–1509);

ao. εὐξάμην, fut. εὔξομαι (cf. pr. εὔχομαι 'pray, wish'; < IE *√*H*$_1$*u̯eg*$^{u̯h}$-; cf. OIA *óhate* 'speak solemnly', L. *uoueō* 'vow'; cf. Pokorny IEW: 348; Frisk 1960: 595–596; Liddell/Scott 1996: 719, 739; LIV^2: 253; Beekes 2016: 485–486);

$K^{u̯}$ + d^h = PGr. *$k^{u̯h}t^h$ > Gr. p^ht^h /k^ht^h:

[168] Not securely attested outside Greek.

ao. ps. ἐλείφθην (cf. pr. λείπω ‘leave’; < IE *√*lei̯k*^{u}-; cf. OIA *riṇákti*, L. *līquī* ‘leave’; cf. Pokorny IEW: 669–670; Frisk 1970: 99–100; Liddell/Scott 1996: 1035–1036; LIV^{2}: 406–407; NIL: 600–604; Beekes 2016: 844–845);

ao. ps. ἐβλάφθην (cf. part. βλᾰβείς ‘disable, hinder’; < IE *√*melk*^{u}-; cf. OIA *marcáyati* ‘damage’; cf. Pokorny IEW: 737; Frisk 1960: 239–240; Liddell/Scott 1996: 317; LIV^{2}: 434–435; Beekes 2016: 217);

ao, ps. ἐπέφθην, fut. ps. πεφθήσομαι (cf. pr. πέσσω ‘ripen, cook’; < IE *√*pek*^{u}-; cf. OIA *pácati* ‘cook, ripe’, L. *coquō* ‘cook’, OCS *peką* ‘bake’; cf. Pokorny IEW: 798; Frisk

ao. ps. ἠμείφθην, fut. ps. ἀμειφθήσεται (cf. pr. ἀμείβω ‘change’; < IE *√*H*$_{2}$*mei̯g*^{u}-; cf. L. *migrāre* ‘migrate’ (?); cf. Pokorny IEW: 713; Frisk 1960: 90; Liddell/Scott 1996: 79–80; LIV^{2}: 279; NIL: 548–552; Beekes 2016: 85–86);

ao. ps. ἐτρίφθην, fut. ps. τριφθήσομαι (cf. pr. τρίβω ‘rub’; < IE *√*trei̯g*^{u}-; cf. Pokorny IEW: 1071; Frisk 1970: 930–931; Liddell/Scott 1996: 1817, 1822; LIV^{2}: 648; Beekes 2016: 1508–1509);

pf. inf. ps. ηὖχθαι (cf. pr. εὔχομαι ‘pray, wish’; < IE *√*H*$_{1}$*u̯eg*^{uh}-; cf. OIA *óhate* ‘speak solemnly’, L. *uoueō* ‘vow’; cf. Pokorny IEW: 348; Frisk 1960: 595–596; Liddell/Scott 1996: 719, 739; LIV^{2}: 253; Beekes 2016: 485–486);

7.2.5 The clusters *dental* + *t*/*d*^{h}/*s*

The IE cluster of **Tt* is realized as Gr. *ss,* **Ts* as Gr. *0s,* **Td*^{h} as Gr. *st*^{h}:

T + t = Gr.st:

verb.adj. κεστός, κέστρος (cf. pr. κεντέω ‘prick, goad’; < IE *√*ḱent-*; cf. L. *sīts* ‘hunting spear’,[169] OHG *hantag* ‘pointed’; cf. Pokorny IEW: 567; Frisk 1960: 820–821; Liddell/Scott 1996: 939, 944; LIV^{2}: 326–327; Beekes 2016: 672–673);[170]

verb.adj. λιστός (cf. pr. λίτομαι Hom., aor. inf. λῐτέσθαι ‘beg, pray’; < IE *√*lei̯t-*; cf. Lith. *liečiù* ‘touch’ (?); cf. Pokorny IEW: 664; Frisk 1970: 130; Liddell/Scott 1996: 1054; LIV^{2}: 410–411; Beekes 2016: 866);

plqpf. ἐπέπαστο, verb.adj. παστός (cf. pr. πάσσω, Att. πάττω ‘sprinkle’; < IE *√(*s*)*ku̯eH*$_{2}$*t* -; cf. L. *quatiō* ‘shake, toss’, OHG *scutten* ‘pour, toss’; cf. Pokorny IEW: 632, 957–958; Frisk 1970: 478; Liddell/Scott 1996: 1346; LIV^{2}: 563; Beekes 2016: 1155–1156);

pf. ἴστε, ἴστω, verb.adj. ἰστέον (Boeot. ἴττω; cf. pf. οἶδα ‘know’; < IE *√*u̯ei̯d-*; cf. OIA *vindáti* ‘find’, L. *uīsō* ‘visit’; cf. Pokorny IEW: 1125–1127; Frisk 1970: 357; Liddell/Scott 1996: 483, 841; LIV^{2}: 665–667; NIL: 717–722; Beekes 2016: 577, 1053);

pf. πέπεισται, verb.adj. πειστέον (cf. pr. πείθω ‘persuade’; < IE *√*b*^{h}*ei̯d*^{h}-; cf. L. *fīdō* ‘trust’; cf. Pokorny IEW: 117; Frisk 1970: 487–488; Liddell/Scott 1996: 1353–1354, 1356; LIV^{2}: 71–72; NIL: 12–13; Beekes 2016: 1161–1162);

pf. πέπυσται (cf. pr. πεύθομαι, πυνθάνομαι ‘learn’; < IE *√*b*^{h}*eu̯d*^{h}-; cf. OIA *bódhati* ‘awake’, OCS *bljudą* ‘wake up’; cf. Pokorny IEW: 150–152; Frisk 1970: 625–626; Liddell/Scott 1996: 1398, 1554; LIV^{2}: 82–83; NIL: 36–37; Beekes 2016: 1258);

T + s = Gr. 0s:

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[169] If from **ḱnt-o-*.

[170] Not securely attested outside Greek.

ao. inf. κένσαι (cf. pr. κεντέω 'prick, goad'; < IE *√ḱent-; cf. L. *sīts* 'hunting spear',[171] OHG *hantag* 'pointed'; cf.Pokorny IEW: 567; Frisk 1960: 820–821; Liddell/Scott 1996: 939, 944; LIV^2: 326–327; Beekes 2016: 672–673);
ao. ἐλῐσάμην, λίσαι (cf. pr. λίτομαι Hom., aor. inf. λῐτέσθαι 'beg, pray'; < IE *√lei̯t-; cf. Lith. *liečiù* 'touch' (?); cf. Pokorny IEW: 664; Frisk 1970: 130; Liddell/Scott 1996: 1054; LIV^2: 410–411; Beekes 2016: 866);
ao. ἔπᾰσα, fut. πάσω (cf. pr. πάσσω, Att. πάττω 'sprinkle'; < IE *√(s)ku̯eH_2t -; cf. L. *quatiō* 'shake, toss', OHG *scutten* 'pour, toss'; cf. Pokorny IEW: 632, 957–958; Frisk 1970: 478; Liddell/Scott 1996: 1346; LIV^2: 563; Beekes 2016: 1155–1156);
ao. ἧσα, ἡσάμην (cf. pr. ἥδω, ἥδομαι 'enjoy'; < IE *√su̯eH_2d-; cf. OIA *svādate* 'make palatable', L. *suādeō* 'rate someone'; cf. Pokorny IEW: 1039–1040; Frisk 1960: 622–623; Liddell/Scott 1996: 764; LIV^2: 606–607; Beekes 2016: 509–510);
pf. ἴσασι (Boeot. ἴττω; cf. pf. οἶδα 'know'; < IE *√u̯ei̯d-; cf. OIA *vindáti* 'find', L. *uīsō* 'visit'; cf. Pokorny IEW: 1125–1127; Frisk 1970: 357; Liddell/Scott 1996: 483, 841; LIV^2: 665–667; NIL: 717–722; Beekes 2016: 577, 1053);
ao. ἔπεισα, fut. πείσω (cf. pr. πείθω 'persuade'; < IE *√b^{h}ei̯d^h-; cf. L. *fīdō* 'trust'; cf. Pokorny IEW: 117; Frisk 1970: 487–488; Liddell/Scott 1996: 1353–1354, 1356; LIV^2: 71–72; NIL: 12–13; Beekes 2016: 1161–1162);
fut. πεύσομαι (cf. pr. πεύθομαι, πυνθάνομαι 'learn'; < IE *√b^{h}eu̯d^h-; cf. OIA *bódhati* 'awake', OCS *bljudǫ* 'wake up'; cf. Pokorny IEW: 150–152; Frisk 1970: 625–626; Liddell/Scott 1996: 1398, 1554; LIV^2: 82–83; NIL: 36–37; Beekes 2016: 1258);

T + d^h = Gr. st^h:

ao. ps. ἐπάσθην (cf. pr. πάσσω, Att. πάττω 'sprinkle'; < IE *√(s)ku̯eH_2t -; cf. L. *quatiō* 'shake, toss', OHG *scutten* 'pour, toss'; cf. Pokorny IEW: 632, 957–958; Frisk 1970: 478; Liddell/Scott 1996: 1346; LIV^2: 563; Beekes 2016: 1155–1156);
pr. ἐσθίω, ps. ἐσθίομαι (cf. pr. ἔδω 'eat, devour'; < IE *√H_1ed-; cf. OIA *átti*, L. *edō* 'eat'; cf. Pokorny IEW: 287–289; Frisk 1960: 444–445; Liddell/Scott 1996: 478; LIV^2: 230–231; Beekes 2016: 375);
ao. ἥσθην, fut. ἡσθήσομαι (cf. pr. ἥδω, ἥδομαι 'enjoy'; < IE *√su̯eH_2d-; cf. OIA *svādate* 'make palatable', L. *suādeō* 'rate someone'; cf. Pokorny IEW: 1039–1040; Frisk 1960: 622–623; Liddell/Scott 1996: 764; LIV^2: 606–607; Beekes 2016: 509–510);
pf. ἴσθι ((Boeot. ἴττω; cf. pf. οἶδα 'know'; < IE *√u̯ei̯d-; cf. OIA *vindáti* 'find', L. *uīsō* 'visit'; cf. Pokorny IEW: 1125–1127; Frisk 1970: 357; Liddell/Scott 1996: 483, 841; LIV^2: 665–667; NIL: 717–722; Beekes 2016: 577, 1053);
pf. πέπεισϑε (cf. pr. πείθω 'persuade'; < IE *√b^{h}ei̯d^h-; cf. L. *fīdō* 'trust'; cf. Pokorny IEW: 117; Frisk 1970: 487–488; Liddell/Scott 1996: 1353–1354, 1356; LIV^2: 71–72; NIL: 12–13; Beekes 2016: 1161–1162);
pf. inf. πεπύσθαι (cf. pr. πεύθομαι, πυνθάνομαι 'learn'; < IE *√b^{h}eu̯d^h-; cf. OIA *bódhati* 'awake', OCS *bljudǫ* 'wake up'; cf. Pokorny IEW: 150–152; Frisk 1970: 625–626; Liddell/Scott 1996: 1398, 1554; LIV^2: 82–83; NIL: 36–37; Beekes 2016: 1258);

7.2.6 The clusters *sibilant* + *t/d^h/s*

The IE cluster of *st is preserved, IE cluster of *ss is simplified as *0si:*

[171] If from IE *ḱnt-o-*.

s + t = Gr. st:

pr. ἐστί, verb.adj. ἐστόν (cf. pr. ἐσμέν ‘be’; < IE *√*H_1es-*; cf. Hitt. *ēszi*, OIA *ásti*, L. *est* ‘be’; cf. Pokorny IEW: 340–341; Frisk 1960: 463; Liddell/Scott 1996: 487–489; LIV^2: 241–242; Beekes 2016: 389);

verb.adj. μύστης, μυστήριον (cf. pr. μύω ‘close’; < IE *√*meu̯s-*; cf. Pokorny IEW: 752; Frisk 1970: 279–280; Liddell/Scott 1996: 1156–1157; LIV^2: 444; Beekes 2016: 988);[172]

pr. ἵστημι (‘stand’; < IE *√*steH_2-*; cf. OIA *ástāt*, L. *sistō* ‘stand’; cf. Pokorny IEW: 1004–1008; Frisk 1960: 739; Liddell/Scott 1996: 841; LIV^2: 590–592; Beekes 2016: 601);

verb.adj. τρέστης (cf. pr. τρέω ‘flee, fear’; < IE *√*tres-*; cf. OIA *trásati* ‘tremble’, OCS *tręsǫ* ‘shake’; cf. Pokorny IEW: 1095; Frisk 1970: 929–930; Liddell/Scott 1996: 1813, 1815; LIV^2: 650–651; Beekes 2016: 1507–1508);

s + s = Gr. 0s:

fut. ἔσομαι, Aeol. ἔσσι[173] (cf. pr. ἐσμέν ‘be’; < IE *√*H_1es-*; cf. Hitt. *ēszi*, OIA *ásti*, L. *est* ‘be’; cf. Pokorny IEW: 340–341; Frisk 1960: 463; Liddell/Scott 1996: 487–489; LIV^2: 241–242; Beekes 2016: 389);

ao. ἔδησα, fut. δήσω (cf. pr. δέω ‘bind’; < IE *√*deu̯s-*; cf. Pokorny IEW: 219; Frisk 1960: 374–375; Liddell/Scott 1996: 383; LIV^2: 125; Beekes 2016: x);[174]

ao. ἔθραυσα, fut. θραύσω (cf. pr. θραύω, pf. τέθραυσμαι ‘break, shatter’; < IE *√*d^hreu̯s-*; cf. Goth. *driusan* ‘fall (down)’; cf. Pokorny IEW: 274–275; Frisk 1960: 680–681; Liddell/Scott 1996: 805; LIV^2: 157–158; Beekes 2016: 553);

ao. ἔμυσα, fut. μύσω (cf. pr. μύω ‘close’; < IE *√*meu̯s-*; cf. Pokorny IEW: 752; Frisk 1970: 279–280; Liddell/Scott 1996: 1156–1157; LIV^2: 444; Beekes 2016: 988);

ao. ἔτρεσα (cf. pr. τρέω ‘flee, fear’; < IE *√*tres-*; cf. OIA *trásati* ‘tremble’, OCS *tręsǫ* ‘shake’; cf. Pokorny IEW: 1095; Frisk 1970: 929–930; Liddell/Scott 1996: 1813, 1815; LIV^2: 650–651; Beekes 2016: 1507–1508);

Note: The ending 2nd pr. εἶ (= *es-si*) shows that the IE cluster of **ss* was simplified to **0s* before the loss of the intervocalic *-s-*. Aeol. ἔσσι, Ep., Dor. ἐσσί, Hom. Pi. ἐσί from the same Greek root √*es-* are morphological restorations. Similarly, Dor. fut. ἐσσῇ, σσοῦνται are morphologically restored.

s + d^h = Gr. st^h:

pf. inf. δεδέσθαι (cf. pr. δέω ‘bind’; < IE *√*deu̯s-*; cf. Pokorny IEW: 219; Frisk 1960: 374–375; Liddell/Scott 1996: 383; LIV^2: 125; Beekes 2016: x)

ao. ps. ἐθραύσθην, fut. ps. fut. θραυσθήσομαι (cf. pr. θραύω, pf. τέθραυσμαι ‘break, shatter’; < IE *√*d^hreu̯s-*; cf. Goth. *driusan* ‘fall (down)’; cf. Pokorny IEW: 274–275; Frisk 1960: 680–681; Liddell/Scott 1996: 805; LIV^2: 157–158; Beekes 2016: 553);

7.2.7 The overview of the Greek development

Classical Greek is a very conservative language, preserving all peripheral plosives as plosives (the old IE labiovelars realized either as labials or velars). The dentals are realized as sibilants in the *t*-context, lost in the *s*-context:

[172] Not attested outside Greek.
[173] This cluster is more probably a result of the re-archaization than a relict.
[174] Attested only in Greek, without IE cognates.

IE	Greek	t-	d^h-	s-
-k$^{u̯}$/g$^{u̯}$/g$^{u̯h}$	-p/b/p^h -k/g/k^h -t/d/t^h	*pt* *kt*	p^ht^h k^ht^h	*ps* *ks*
-k/g/g^h	-k/g/k^h	*kt*	k^ht^h	*ks*
-ḱ/ǵ/ǵ^h	-k/g/k^h	*kt*	k^ht^h	*ks*
-t/d/d^h	-t/d/t^h	*st*	st^h	*0s*
-p/b/b^h	-p/b/p^h	*pt*	p^ht^h	*ps*
-s	-s/0	*st*	st^h	*0s*

7.3 The Mycenaean clusters and their development

Mycenaean development differs from the Classical Greek in preserving the old labiovelars; otherwise it has, as far as limited data allow us to be sure, the same development.

For Mycenaean data, Aura Jorro/Adrados (1985; 1993) and Bartoněk 2003 will be used. With Bartoněk, if quoting the grammatical data, the quotation on a given page will be used, but when lemmata in the glossary are used, we will quote the given lemma (in the form Bartoněk 2007: Lxxx). Beekes (2016; 2016) will be quoted for Mycenaean when quoting the same data as Aura Jorro/Adrados and Bartoněk.

7.3.1 The clusters *labial* + *t/d^h/s* in Mycenaean

P + t = Myc. pt:

]e-na-ri-po-to (*enaliptos*) 'greased, polished, painted' (cf. Gr. ἐνάλειπτος, ἐναλείφω 'anoint with', ἀλείφω 'anoint'; < IE *√*lei̯p*- (?); cf. OIA *limpáti* 'smear', OCS *-lěpiti* 'glue'; cf. Pokorny IEW: 670–671; Frisk 1960: 67–68; Aura Jorro/Adrados 1985: 217; Liddell/Scott 1996: 62, 553; LIV^2: 408; Bartoněk 2003: L205; Beekes 2016: 64);

ra-pte (*r^{h}aptēr*) (cf. Gr. ῥάπ-της ' one who stitches, clothes-mender', ῥάπτω 'sew, stitch'; cf. OIA *várpas-* 'artifice'; cf. Pokorny IEW: 1156; Frisk 1970: 643; Aura Jorro/Adrados 1993: 221–223; Liddell/Scott 1996: 1565; LIV^2: 701; Bartoněk 2003: L698; Beekes 2016: 1275–1276);

P + s = Myc. ps:

di-pi-si-jo (*dipsios*) '?' (a dat. sg. ?) (Aura Jorro/Adrados 1993: 175–176; Bartoněk 2003: L162);

e-we-pe-se-so-me-na (*eu (h)epsēsomena*) fut. part. 'well cooked (?)' (cf. Gr. εὐέψητος, ' readily cooked'?; < IE *√*pek$^{u̯}$*-; cf. OIA *pácati* 'cook, ripe', L. *coquō* 'cook', OCS *pekǫ* 'bake'; cf. Pokorny IEW: 798; Frisk 1970: 519–520; Aura Jorro/Adrados 1993: 267 for other possible meanings; Liddell/Scott 1996: 712; LIV^2: 468; Bartoněk 2003: L282; Beekes 2016: 1180–1181);

P + t^h = Myc. p^{h}t^h:

di-pte-ra (*diphtherā*) (cf. Gr. διφθέρα'prepared hide, piece of leather' and probably Gr. δέφω 'soften'; < IE *√*dep^h*- (?); cf. Arm. *topʿem* 'beat', Pol. *deptać* 'step, tread'; cf.

Pokorny IEW: 203; Frisk 1960: 372–373, 400; Aura Jorro/Adrados 1993: 176–177; Liddell/Scott 1996: 382, 438; Bartoněk 2003: L164; Beekes 2016: 320, 341);[175]

7.3.2 The clusters *velar + t/d^h/s* in Mycenaean

K + t = Myc. kt:

wa-na-ka-te (*u̯anaktei*) (< PGr. *u̯anaks*; cf. Gr. ἄναξ 'ruler'; cf. Frisk 1960: 102–103; Aura Jorro/Adrados 1993: 400–402; Liddell/Scott 1996: 114; Bartoněk 2003: L837; NIL: 267–277; Beekes 2016: 98–99);[176]

K + s = Myc. ks:

ke-se-ne-wi-ja (*ksenu̯ia*) (< PGr. *ksenuu̯ii̯a*; cf. ξένιος 'friendly'; cf. Pokorny IEW: 453; Frisk 1970: 333–334; Aura Jorro/Adrados 1985: 353–354; Liddell/Scott 1996: 1188–1189; Bartoněk 2003: L379; Beekes 2016: 1034);[177]

wa-na-ka (*u̯anaks*) (< PGr. *u̯anaks*; cf. Gr. ἄναξ 'ruler'; Frisk 1960: 102–103; Aura Jorro/Adrados 1993: 400–402; Liddell/Scott 1996: 114; Bartoněk 2003: L837; NIL: 267–277; Beekes 2016: 98–99);

7.3.3 The clusters *palatovelar + t/d^h/s s* in Mycenaean

Ḱ + t = Myc. kt:

mi-ka-ta (*miktās*) 'mixer' (cf. Gr. μείγνυμι, μίγνυμι; < IE *√*mei̯ḱ*-; cf. L. *misceō*, OCS *měšǫ* 'mix'; cf. Pokorny IEW: 714; Frisk 1970: 192–193; Aura Jorro/Adrados 1985: 452–453; Liddell/Scott 1996: 1092; LIV²: 428–429; Bartoněk 2003: L477; Beekes 2016: 919–920);

pa-ke-te-re (*pǎ̄ktēres* ?) 'pin, plug' (cf. Gr. πήγνῡμι 'stick'; < IE *√*peH₂ǵ*-; cf. L. *pangō* 'fasten, fix'; cf. Pokorny IEW: 787; Frisk 1970: 525–526; Aura Jorro/Adrados 1993: 71; Liddell/Scott 1996: 1399; LIV²: 461; Bartoněk 2003: L560; Beekes 2016: 1184);

pe-ki-ti-ra₂ (*pektri̯ai*) (cf. Gr. πεκτέω, πέκω 'comb'; < IE *√*peḱ*-; cf. L. *pectō* 'comb, shear', Lith. *pešù* 'pluck'; cf. Pokorny IEW: 797; Frisk 1970: 492–493; Aura Jorro/Adrados 1993: 97; Liddell/Scott 1996: 1356, 1432; LIV²: 467; Bartoněk 2003: L589; Beekes 2016: 1164–1165);

Ḱ + s = Myc. ks:

a₃-ka-sa-ma (*aiksmans*) 'point of a spear/arrow' (cf. Gr. αἰχμή 'point of a spear'; < IE *√*H₂ei̯ḱ-s*(*m*)-; cf. L. *īcō* 'hit, wound', Pruss. *aysmis* 'roasting spit', OCS *igla* 'needle'; cf. Pokorny IEW: 15; Frisk 1960: 48; Aura Jorro/Adrados 1985: 132–133; Liddell/Scott 1996: 45; LIV²: 259; Bartoněk 2003: L121; Beekes 2016: 405–406);

de-ka-sa-to (*deksato*) (cf. Gr. δείκνυμι 'show'; < IE *√*dei̯ḱ*-; cf. OIA *ádiṣṭa* 'show', L. *dīcō* 'say'; cf. Pokorny IEW: 188–189; Frisk 1960: 355–356; Aura Jorro/Adrados 1985: 164; Liddell/Scott 1996: 373; LIV²: 108–109; Bartoněk 2003: L148; Beekes 2016: 309);

7.3.4 The clusters *labiovelar + t/d^h/s* in Mycenaean

The labiovelars are preserved in Mycenaean (or restored?):

[175] Could be from **dipstéra*, cf. Pokorny (l.c.)?
[176] Assumed to be a substrate word.
[177] Could be related to L. *hostis*, OCS *gostь*?

K^u + t = Myc. K^ut:

ke-ni-qe-te-we (*k^hernik^{u}tē$\underline{u}$es*) ‘basin’ (cf. Gr. χερνίπτομαι ‘wash (hands) (to purify)’; cf. OIA *anijam, ninikta* ‘wash’, OIr. *-nig* ‘wash’; cf. Pokorny IEW: 761; Frisk 1970: 319–320; Aura Jorro/Adrados 1985: 342; Liddell/Scott 1996: 1175–1176, 1988; LIV2: 450; Bartoněk 2003: L366; Beekes 2016: 1620–1621);

ra-qi-ti-ra$_2$ (*lak^{u}tri̯ai* ?) ‘take’ (cf. Gr. λαμβάνω ‘take’; < IE *√*sleH$_2$g^u-*; cf. Œ *læccean* ‘take’; cf. Pokorny IEW: 958; Frisk 1970: 77–78; Aura Jorro/Adrados 1993: 223–224; Liddell/Scott 1996: 1026–1027; LIV^2: 566; Bartoněk 2003: L700; Beekes 2016: 828–826);

K^u + s = Myc. K^us:

a$_3$-ti-jo-qo (*Aithiok^{u}s*) PN ‘Ait^{h}iok^{u}s’ (cf. Gr. αἰθίοψ ‘burnt-face, negro’, ὤψ ‘face, eye’, ὄσσομαι ‘see, presage’; < IE *√*H$_3$ek^u-*; cf. OIA *ī́kṣate* ‘see’; cf. Pokorny IEW: 775–777; Frisk 1970: 407–408, 436, 1154; Aura Jorro/Adrados 1985: 140; Liddell/Scott 1996: 37, 1262, 1282–1283; LIV^2: 297; Bartoněk 2003: 138; Beekes 2016: 36–37, 1094, 1118, 1684–1685);

mo-qo-so (*mok^{u}sos*) PN ‘Mopsos’ (cf. Gr. PN Μόψος-; Aura Jorro/Adrados 1985: 457);

K^u + t^h = Myc. $k^{uh}t^h$:

e-qi-ti-wo-e (*ek^{u}t^{h}i̯u̯o(h)e*) ‘destroyed’ (?) (cf. Gr. φθίνω ‘decay, waste’; < IE *√*d^{h}g^{uh}ei̯-*; (?)’ ; cf. OIA *kṣiṇāti* ‘destroy’, ON *dvena* ‘wane, destroy’; cf. Pokorny IEW: 487; Frisk 1970: 1014–1016; Liddell/Scott 1996: 1926; LIV^2: 150–152; Bartoněk 2003: L240; Beekes 2016: 1570–1571);

7.3.5 The clusters *dental* + *t/d^h/s s* in Mycenaean

T + t = Myc. st:[178]

e-pi-da-to (*epidastos* = *-d-t-*) (cf. Gr. δᾰτέομαι ‘divide’; < IE *√*dH$_1$t-sa-* (?); cf. OIA *dáyate* ‘divide’; cf. Pokorny IEW: 175–176; Frisk 1960: 351–352; Aura Jorro/Adrados 1985: 223; Liddell/Scott 1996: 370; LIV^2: 103–104; Bartoněk 2003: L216; Beekes 2016: 305–306);

T + s = Myc. 0s:

pa-si (*pansi* = **pant-si*) dat. pl. ‘all’ (cf. πᾶς, πᾶσα, πᾶν; < IE **pH$_2$-ent-*; cf. ; cf. Pokorny IEW: 593; Frisk 1970: x; Aura Jorro/Adrados 1985: 342; Liddell/Scott 1996: x; LIV2: x; Bartoněk 2003: L365; Beekes 2016: 1154–1155);

pi-we-ri-si (*Pi̯u̯erisi* = **-d-si*) dat. pl. ‘Pierides’ (cf. Gr. PN Πῑερίδες; Aura Jorro/Adrados 1993: 342; Liddell/Scott 1996: 1403; Bartoněk 2003: 145);

]o-da-sa-ṭọ (*das(s)ato*) ‘distribute, divide’ (cf. δᾰτέομαι, fut. δάσομαι; < IE *√*dH$_1$t-sa-* (?); cf. OIA *dáyate* ‘divide’; cf. Pokorny IEW: 175–176; Frisk 1960: 351–352; Frisk 1970: 126–127; Aura Jorro/Adrados 1993: 17, 252; Liddell/Scott 1996: 370, 1052; LIV^2: 103–104; Bartoněk 2003: L140; Beekes 2016: 305–306, 864);[179]

7.3.6 The clusters *sibilant* + *t/d^h/s* in Mycenaean

s + t = Myc. st:[180]

[178] Mycenaean script does not show more than *t-*, as in the case of the cluster of *st-*.

[179] The relation between ἐναλείφω and ἀλείφω is doubted, cf. especially Beekes (l.c.).

[180] A Mycenaean graphics does not show more than given *t+vowel* sign, as in the case of the cluster of *Tt-*.

ta-to-mo (*stat*^{h}*mos*) ‘weight, stall’ (cf. Gr. σταθμός ‘standing place, dwelling, balance, weight’; Gr. ἵστημι ‘stand’; < IE *√*steH*$_{2}$-; cf. OIA *ástāt*, L. *sistō* ‘stand’; cf. Pokorny IEW: 1007; ; Frisk 1960: 739; Frisk 1970: 775; Aura Jorro/Adrados 1993: 321; Liddell/Scott 1996: 841, 1632–1633; LIV^{2}: 590–592; Bartoněk 2003: L755; Beekes 2016: 601, 1388–1389);

s + s = Myc. 0s:

e-so-to (*es(s)ontoi*) 3rd pl. fut. ‘be’ (cf. Gr. ἐσσοῦνται; < IE *√*H*$_{1}$*es*-; cf. Hitt. *ēszi*, OIA *ásti*, L. *est* ‘be’; cf. Pokorny IEW: 340–341; Frisk 1960: 463; Aura Jorro/Adrados 1985: 203–204, 252; Liddell/Scott 1996: 487–489; LIV^{2}: 241–242; Bartoněk 2003: L184; Beekes 2016: 389);

7.3.7 The overview of the Mycenaean development

The reconstructed (and not directly attested) outcomes are in brackets; note that Mycenaean preserves labiovelars, usually with their labial value restored:

IE	Mycenaean	t-	d^{h}-	s-
-$k^{u̯}$/$g^{u̯}$/$g^{u̯h}$	-$k^{u̯}$/$g^{u̯}$/$k^{u̯h}$	$k^{u}t$	$k^{u}t^{h}$	$k^{u}s$
-k/g/g^{h}	-k/g/k^{h}	*kt*	($k^{h}t^{h}$)	*ks*
-ḱ/ǵ/$ǵ^{h}$	-k/g/k^{h}	*kt*	($k^{h}t^{h}$)	*ks*
-t/d/d^{h}	-t/d/t^{h}	*st*	(st^{h})	*0s*
-p/b/b^{h}	-p/b/p^{h}	*pt*	$p^{h}t^{h}$	*ps*
-s	-s/h	*st*	(st^{h})	*0s*

7.4 Trajectories of the Greek development

A typical feature of the Greek clusters of *plosive + t/s* is that only peripheral plosives are preserved either with *t*- or with *s*- (Bubenik 2017: 646), while the central (i.e., dental) plosives are sibilantized before *t*-/t^{h}- or wholly lost before *s*- (probably after a sibilantization).

The status of two aspirates clusters of $k^{h}t^{h}$, $p^{h}t^{h}$ <χϑ, φϑ> is questionable, the aspiration of the first plosive is often disputed. On the following lines, we assume the full assimilation of a left plosive both in voice and in aspiration, hence $k^{h}t^{h}$, $p^{h}t^{h}$ in full accordance to the standard orthography, though we cannot exclude the dialectical outcome without aspiration: kt^{h}, pt^{h}[181], since phonetically clusters of two aspirates in a single cluster are articulatory more complex than those with an only left aspirate. For comparison, OIA does not have the clusters of $k^{h}t^{h}$, $t^{h}t^{h}$, $p^{h}t^{h}$ but only kt^{h}, tt^{h}, pt^{h} (proposed by Brugmann 1885: 34–35; Brugmann 1890: 57; Brugmann 1900: 96; expressed later by Jannaris 1897: 58; Hirt 1912: 189; Brugmann/Thumb

181 The graphic κϑ and πϑ are attested in archaic inscriptions dialectally (Lejeune 1972: 69), limited to the South Aegean Islands and Crete (the “green variant” of Kirchhoff 1877). Note that the same dialects often use π and κ both for *p* and p^{h} and *k* and k^{h}.

1913: 112; Meillet/Vendryes 1924: 64; Schwyzer 1939: 210;[182] Lejeune 1952: 59; 1972: 68–69). However, as Allen has noted (Allen 1968: 24–26), such clusters are not impossible at all, cf. Georgian *p‘k‘*, *t‘k‘*, Arm. *t‘k‘*, Abaza *p‘q‘* (but note that all examples, on the other hand could be simply a case of a special *Sprachbund*-feature of the Caucasus). Rix (1992: 95) supports the two-aspirates solution, though he even accepts the variant kt^h, pt^h as well.

Note: Any reader who prefers $T + t^h = Tt^h$ should accordingly modify the development of clusters formed by IE $*d^h$-.

7.4.1 Development of the clusters *labial* + *t/dʰ/s*

Similarly to the velar series, the clusters of labial plosive + $t/d^h/s$ were affected only by the devoicing of the IE $*d^h$, otherwise the clusters are preserved, the left plosive is assimilated both in voice and aspiration to the right obstruent (cf. Meillet/Vendryes 1924: 53; Buck 1932: 144; Lejeune 1947: 28–59, 62–63; Lejeune 1972: 68–69, 73; Sihler 1995: 203):

P + **t** > **pt**

P + $\mathbf{d^h}$ > bd^h → p + t^h > $\mathbf{p^h t^h}$

P + **s** > **ps**

7.4.2 Development of the clusters (*palato*)*velar* + *t/tʰ/s*

Since there is no internal proof of the original distinction between reconstructed IE plain velars and palatovelars, we will treat both series as a single one.

Old IE velars (both plain and palate-) are realized as the velar *k* before *t/s*- and as the aspirate k^h before the aspirate t^h- (< $*d^h$), i.e., assimilated both in voice and aspiration according to the right obstruent (cf. Meillet/Vendryes 1924: 53, 63; Buck 1932: 145; Lejeune 1947: 28–59, 62–63; Lejeune 1972: 68, 72; Rix 1992: 94–95; Sihler 1995: 203–204):

K + **t** > **kt**

K + $\mathbf{d^h}$ > gd^h → Kt^h > $\mathbf{k^h t^h}$

K + **s** > **ks**

[182] Schwyzer assumes the full aspiration of the first plosive was present in the earlier phase, replaced by a dissimilated form later.

7.4.3 Development of the clusters *labiovelar* + *t/t^h/s*

The Mycenaean in general preserves old labiovelars (though they were assimilated as plain velars when in direct contact with *u*), as written above, even in clusters otherwise affected by the assimilation of the voice and aspiration.

In Classical Greek, the old labiovelars are assimilated as other plosives, in a distinctive way according to the given dialect. In contexts of *t/t^h/s*, the prevailing realization is that of *p* though *k*-variants are often to be met. The *p*-variant could be a result of a levelling (cf. Meillet/Vendryes 1924: 59–61; Buck 1932: 129; Sihler 1995: 164). Classical Greek tends to level one of the outputs of old labiovelars without regard to original contexts, though the different outputs were originally context-conditioned. Examples are limited to *p*-output, since *k*-output is limited to roots with preceding **u* (cf. Hirt 1912: 201–205; Brugmann/Thumb 1913: 137; Meillet/Vendryes 1924: 57–61; Lejeune 1947: 36; Lejeune 1972: 44; Aura Jorro/Adrados 1985: 261–262; Rix 1992: 85–88; Sihler 1995: 156; Bartoněk 2003: 139):

i. **K$^{u̯}$** + **t** > **k$^{u̯}$t**	(Mycenaean)
ii. **K$^{u̯}$** + **t** > Pt > **pt**	(Classical Greek)
i. **K$^{u̯}$** + **d^h** > g$^{u̯}$d^h → K$^{u̯}$t^h > **k$^{u̯h}$t^h**	(Mycenaean)
ii. **K$^{u̯}$** + **d^h** > Pt^h > **p^{h}t^h**	(Classical Greek)
i. **K$^{u̯}$** + **s** > **k$^{u̯}$s**	(Mycenaean)
ii. **K$^{u̯}$** + **s** > Ps > **ps**	(Classical Greek)

Note: νύξ, νυκτός 'night' could be an example of the old neutralization *K$^{u̯}$ +t > kt* (cf. Hit. *nekuz*), but this could be as well an example of an old Indo-European process, since L. *nox*, *noctis* has *k* through the whole paradigm, probably due to levelling (Lejeune 1947: 37; Lejeune 1975: 44; Sihler 1995: 230; Beekes 2016: 1027).

7.4.4 Development of the clusters *dental* + *t/d^h/s*

The classical trajectory is that of an affricate: the old **T* is affricated; later the affricate is sibilantized, and the cluster of **ss* is then simplified. The **affrication model** was developed for Indo-European languages by Kräuter (1877: 88)[183] and popularized by Brugmann (firstly 1880: 140–142, used since), Brugmann successfully applied it to Greek development and was widely accepted (cf. Brugmann 1885: 34;[184] Brugmann 1890: 57; Brugmann 1900: 96, 99–100; Hirt

[183] It is interesting that Kräuter speaks about affrication, but his *description* of the feature is that of a *spirantization*! Verner (1878: 341–342) has a critical evaluation of the idea.

[184] In this book, Brugmann uses the older version of the trajectory, assuming insertion of a spirant (*tÞt*), as he did in Brugmann (1880: 140–142).

1912: 193, 209, 239; Brugmann/Thumb 1913: 112; Buck 1932: 143–145; Sihler 1995: 201–202, 204).[185]

T + **t** > $t^s t$ > tst > **st**

T + $\mathbf{d^h}$ > $d^z d^h$ → $t^s t^h$ > tst^h > $\mathbf{st^h}$

T + **s** > $t^s s$ > tss > ss > **0s**[186]

Note: Rix (1992: 96) simply assumes the (direct?) assibilation of the first plosive.

Another possible trajectory is that of **spirantization**, assuming the spirantization instead of affrication, then sibilantization of the spirant (and its subsequent loss before *s*- due to simplification). This trajectory is a better solution for the cluster of *Ts* since it does not require a loss of *t* from the cluster *tss,* which would be easier to simplify to the original *ts*.

T + **t** > ϑt > **st**

T + $\mathbf{d^h}$ > δd^h → tt^h > ϑt^h > $\mathbf{st^h}$

T + **s** > ϑs > ss > **0s**

The status of clusters of *Td^h in both trajectories is questionable: did the affrication or the spirantization appear before the transition of *D^h > T^h or not? Since the change of a dental before an obstruent is attested in all IE languages (disputable in OIA), we prefer the older existence of it before the devoicing of old IE voiced aspirate, but technically, we can even construct trajectories with reversed ordering: the affricate trajectory: **T** + $\mathbf{d^h}$ > dd^h → T + t^h > $t^s t^h$ > tst^h > $\mathbf{st^h}$; the spirantization trajectory: **T** + $\mathbf{d^h}$ > dd^h → T + t^h > ϑt^h > $\mathbf{st^h}$.

7.4.5 Development of the clusters *sibilant* + *t*/d^h/*s*

Pre-Greek development is conservative. we can assume for the clusters **ss* an (already Indo-European) simplification of the cluster (Meillet/Vendryes 1924: 54). The cluster of sd^h was revalued due to the loss of voice of the aspirate (the old cluster being zd^h) (cf. Schwyzer 1939: 328; Meillet/Vendryes 1924: 52; Lejeune 1947: 99; Lejeune 1972: 117–118; Sihler 1995: 220):

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[185] Interestingly, neither Brugmann nor anyone else tries to detail the trajectory for *Ts* (cf. Brugmann 1885: 39; Brugmann 1890: 64; Brugmann 1900: 101).

[186] The simplification *ss* > *0s* is a standard in Attic, later Ionic, partially in Homeric; other dialects keep *ss* (cf. Sihler 1995: 204).

s + **t** > st

s + $\mathbf{d^h}$ > zd^h → s + t^h > $\mathbf{st^h}$

s + **s** > **0s**

7.5 Conclusion

The development of Greek is remarkably conservative.

The peripheral series are fully preserved in all three contexts (d^h-context being subjected to the analogical remodelling due to the Pre-Greek loss of voice though). The old labiovelars are restored before obstruents; only few traces of the old neutralization of the labial value of the labiovelars can be found in Mycenaean).

The dental series underwent an old fricativization process, ending in the sibilantization of a plosive in all three contexts. we prefer the spirantization trajectory of the two variants of the development, since it better explains the loss of a sibilant in the cluster of **Ts*: a simplification of the assumed intermediate **ϑs* to *ss* and later on *0s* seems to be a more plausible trajectory than the simplification of the $*t^s s$, which could probably only restore the old *ts*.

Similarly, IE clusters of **sT* and *ss* are preserved (the second degeminated in some of the dialects). The cluster of $*sd^h$ was remodelled, according to the change IE $*d^h$ > Gr. t^h, as were all other clusters within the d^h-context.

8 The development of the two-obstruent clusters from Indo-European into Italic languages

8.0 Italic languages

The Italic languages include many languages, initially covering the area of Apennine peninsula except Etruria and Apulia (and Greek settlements on Italian coast). The status of Venetian and Sicel is questionable and beyond the scope of this study (for a short overview cf. Wallace 2017: 317–319).

There are at least two sub-branches inside the Italic family: Latin (–Faliscan) branch and Sabellic (= Osco–Umbrian) branch, different in many aspects of our interest (for a complex overview of the differences between both sub-branches, cf. especially Rix: 2004: 147–172). We will examine both branches independently before trying to sketch the trajectories of the development of clusters of *plosive + t/s*.

8.1 Latin language

Latin is one of the most substantial languages for (not only) Comparative Indo-European linguistics, especially since it is well attested both in its grammar and lexicon.

It represents, almost alone, the whole sub-branch of the Italic languages (but Faliscan, closely related is poorly attested; cf. Baldi 1999: 123–125, on the Latin–Faliscan relationship cf. Baldi 1999: 170–171; an excellent modern overview is that by Stuart-Smith 2004: 54–64).

8.1.1 Latin and Indo-European

The typical features separating Latin obstruent system from that of Indo-European are:

i. the preservation of the three modal classes, reconstructed for the Indo-European protolanguage; the traditionally reconstructed voiced aspirates are realized either as voiceless fricatives or voiced plosives (see below);
ii. the preservation of the labiovelars, at least voiceless and voiced;
iii. the development of the IE cluster of **Tt* into a cluster of *ss*;
iv. the rhotacization of the intervocalic **s*.

The first feature is shared with Indo-Aryan, Armenian, Greek and Germanic, the second with Germanic, the third with other Italic languages and with Germanic and Celtic languages, the fourth with other Italic languages and with Germanic.

8.1.2 Latin clusters and their IE origins

The clusters of *plosive + t/s* are not subjected, as in most Indo-European languages outside the Indo-Iranian branch, to Bartholomae's Law (cf. Meiser 1998: 124); hence all clusters, without regard to the original voice or aspiration are realized as voiceless outcomes of their both segments.[187]

Note: A remarkable feature of Latin historical phonology is the lengthening of the vowel preceding a *-Ct-* cluster if the left plosive is a voiced unaspirated, known as **Lachmann's Law** (first formulated by Lachmann 1850; for the overviews of the literature, see Collinge 1985:105–114; Sukač 2013: 52–87). The examples on the law

[187] On the possible origin of suffixes *-d^{h}ro-/-d^{h}lo-* (vs *-tro-/-tlo-*) due to Bartholomae's Law, cf. Sihler (1995: 200–201).

are: *legit* vs *lēctus* 'read'; *edit* vs *ēsus* 'eat'; *agit* vs *āctus* 'drive, act'; *fragit* vs *frāctus* 'break'. Lachmann's Law was linked to Winter's Law and repeatedly interpreted and rejected (the existence of such a law was rejected especially by Kent 1928, who considers such outcomes a result of analogy processes, in many aspects similarly to de Saussure 1885). From other possible solutions we have to mention the glottalic explanation (cf. Baldi 1991; Kortland 1989; 1999; Schrijver 1991: 134–138; but rejected by Meiser 1998: 79–80); there are other different solutions based either on phonemic or morphemic analogy (most relevant are: Osthoff 1884: 112–113; Maniet 1956; Kuryłowicz 1968; Watkins 1968; Drinka 1991; Sihler 1995: 75–76; Jasanoff 2004).

Besides Latin, three modal classes are directly attested not only for Sabellic but also for Greek, Armenian, and Germanic, while traces of the triad can be found in Balto-Slavic (Winter's Law) etc. Old Indo-Aryan preserved not only three old modal classes but also had a fourth. Such a preservation is more the matter of the diachronic analysis than the synchronic reality of Latin or in other words: not present but traceable. A characteristic feature of the Latin development of the IE voiced aspirates is the often split of old voiced aspirates into context-given outcomes, typically in the *anlaut* on the one hand and in the *inlaut* on the other (for development of IE plosives into Latin cf. Meiser 1998: 97–104; Weiss 2009: 73–79, 149–150). However, in contexts of our interest, the processes and their outcomes are regular, which enable us to treat old IE voiced aspirates as a single modal class in our analysis.

Since Latin is a language with a large corpus of data and of the old grammarian tradition, we can focus especially on the productive examples of 'active' clusters, preferring verbal derivation and flexion (typically supines, passive particles perfecti, sigmatic perfects etc.), the non-productive ('etymological') examples being used more to illustrate the common IE examples of the clustering, notably numerals.

8.1.2.1 The clusters *labial + t/s*

The IE cluster of **Pt* is realized without any changes as L. *pt*, but as *0t* in the word-initial:

P + t = L. pt:

- sup. *aptum*, pr. *aptō*, ppp. *aptus* (cf. pr. *apō*, *-ere*, *apiō* 'fasten, bind'; < IE *√*H_1ep*-; cf. Hitt. *ēpzi* 'take, grab', YAv. *āpa* 'reach'; cf. Lewis/Short 1879: 137–139; WH II: 57–58; Pokorny IEW: 50–51; LIV^2: 237; de Vaan 2008: 47);
- sup. *cleptum* (cf. pr. *clepō*, *-ere* 'steal'; < IE *√*klep*-; cf. Gr. κλέπτω 'steal', Goth. *hlifan* 'steal'; cf. Lewis/Short 1879: x; WH I: 232; Pokorny IEW: 604; LIV^2: 363–364; de Vaan 2008: 120);
- sup. *serptum* (cf. pr. *serpō*, *-ere* 'crawl'; < IE *√*serp*-; cf. OIA *sárpati* 'creep, crawl', Gr. ἕρπω 'move slowly'; cf. Lewis/Short 1879: 1680–1681; WH II: 524; Pokorny IEW: 912; LIV^2: 536; de Vaan 2008: 558);
- sup. *nūptum*, ppp. *nuptus* (cf. pr. *nūbō*, *-ere* 'marry'; < IE *√*sneu̯b^h*-; cf. RuCS *snubiti* 'make couple'; cf. Lewis/Short 1879: 1222; WH I: 268; WH II: 183–184; Pokorny IEW: 977–978; LIV^2: 574; NIL: 499–504; de Vaan 2008: 417–418);
- sup. *scrīptum*, nom. *scrīptor* (cf. pr. *scrībō*, *-ere* 'write'; < IE *√*skrei̯b^h*-; cf. ON *hrífa* 'scratch, tear', Latv. *skrīpât* 'scratch, scribble, write down'; cf. Lewis/Short 1879:

1647–1648; WH II: 499; Pokorny IEW: 946–947; LIV^2: 562; de Vaan 2008: 546–547);

num. *septem* 'seven' (cf. OIA *saptá-*, Gr. ἑπτά; cf. Lewis/Short 1879: 1675; WH II: 517–518; Pokorny IEW: 909; Sihler 1995: 214–216; Coleman 1992: 248; Blažek 1999: 248; de Vaan 2008: 555);

sternuō 'sneeze' (if related to Gr. πτάρνυμαι, πταίρω 'sneeze', Arm. *pʾṙngam*, *pʾṙngem* 'squeeze', W. *ystrew* 'sneezing'; < IE *√*pster-*; cf. Lewis/Short 1879: 1758; WH I: 591; Pokorny IEW: 846–847; LIV^2: 494; de Vaan 2008: 587);

taceō, *-ēre* 'be silent' (if from IE *√*pteH*$_2$*k-* as states LIV^2 495; then related to Gr. πτώσσω 'shrink from', Arm. *tʿakʿeaw* 'hid himself', Goth. *Þahan* 'to keep secret', OHG *dagēn* 'be silent'; cf. Lewis/Short 1879: 1833; WH II: 641–642; Pokorny IEW: 1055; de Vaan 2008: 604–605);

Similarly, the IE cluster **Ps* is realized without any changes internally, as *0s* word-initially (cf. Meiser (1998: 113); Weiss (2009: 170):[188]

P + s = L. ps:

s-pf. *clepsī* (cf. pr. *clepō*, *-ere* 'steal'; < IE *√*klep-*; cf. Gr. κλέπτω 'steal', Goth. *hlifan* 'steal'; cf. Lewis/Short 1879: x; WH I: 232; Pokorny IEW: 604; LIV^2: 363–364; de Vaan 2008: 120);

s-pf. *serpsī* (cf. pr. *serpō*, *-ere* 'crawl'; < IE *√*serp-*; cf. OIA *sárpati* 'creep, crawl', Gr. ἕρπω 'move slowly'; cf. Lewis/Short 1879: 1680–1681; WH II: 524; Pokorny IEW: 912; LIV^2: 536; de Vaan 2008: 558);

s-pf. *nūpsī* (cf. pr. *nūbō*, *-ere* 'marry'; < IE *√*sneu̯b*^{h}-; cf. RuCS *snubiti* 'make couple'; cf. Lewis/Short 1879: 1222; WH I: 268; WH II: 183–184; Pokorny IEW: 977–978; LIV^2: 574; NIL: 499–504; de Vaan 2008: 417–418);

s-pf. *scrīpsī* (cf. pr. *scrībō*, *-ere* 'write'; < IE *√*skrei̯b*^{h}-; cf. ON *hrífa* 'scratch, tear', Latv. *skrīpât* 'scratch, scribble, write down'; cf. Lewis/Short 1879: 1647–1648; WH II: 499; Pokorny IEW: 946–947; LIV^2: 562; de Vaan 2008: 546–547);

nom. *sabulum* 'sand, gravel' (cf. ON *sandr*, Gr. ψάμμος; cf. Lewis/Short 1879: 1609; Stolz 1894: 297; Kent 1932b: 112; WH II: 458; Pokorny IEW: 145–146; Leumann 1977: 186; Meiser 1998: 113; NIL 45–46; de Vaan 2008: 531);

Note: In a limited number of cases, metathesis possibly appeared, cf. L. *crispus* 'curly', MW. *Crych*, Gallo-L. PN *Crixsus* (< IE **krip-so-*), cf. Meiser (1998: 127); Weiss (2009: 170), but de Vaan (2008: 145) prefers **cris-* (as in L. *crīnis* 'hair of the head', *crista* 'crest on the head of animal, plume').

8.1.2.2 The clusters *velar + t/s*

The velar cluster **Kt* is fully preserved, similarly to the cluster **Ks*, at least in the word-internal position. However, the word-initial cluster **#Ks-* results in *#0s-* only:

K + t = L. kt (<ct>):

sup. *ductum*, ppp. *ductus* (cf. pr. *dūcō*, *-ere* 'lead'; < *√*deu̯k-*; cf. OW. *-duch* 'lead, bring', Alb. *n-duk* 'pull'; cf. Lewis/Short 1879: 615–616; WH I: 377–378; Pokorny IEW: 220–221; LIV^2: 124; de Vaan 2008: 181);

[188] This process did not affect later borrowings from Greek.

sup. *iūnctum,* nom. *iunctiō* (cf. pr. *iungō, -ere* 'joint'; < *√*i̯eu̯g*-; cf. OIA *yunájmi* 'yoke', OCS *igo* 'yoke'; cf. Lewis/Short 1879: 1017; WH I: 726–730; Pokorny IEW: 508–510; LIV^2: 316; NIL: 397–404; de Vaan 2008: 314–315);

sup. *pictum,* ppp. *pictum,* nom. *pictor* (cf. pr. *pingō, -ere* 'paint'; < *√*pei̯g*-; cf. OIA *pěgъ* 'colourful'; cf. Lewis/Short 1879: 1378; WH II: 305–306; Pokorny IEW: 794; LIV^2: 464; NIL: 546–548; de Vaan 2008: 465–466);[189]

sup. *tectum,* nom. *tectio, tector* (cf. pr. *tegō, -ere* 'cover'; < IE *√(*s*)*teg*-; cf. Gr. στέγω 'cover, fend, contain', Lith. *stógas* 'roof'; cf. Lewis/Short 1879: 1845–1846; WH II: 654; Pokorny IEW: 1013–1014; LIV^2: 589; NIL: 634–636; de Vaan 2008: 608);

K + s = L. ks (<x>):

s-pf. *dūxī,* nom. *dux* (cf. pr. *dūcō, -ere* 'lead'; < *√*deu̯k*-; cf. OW. *-duch* 'lead, bring', Alb. *n-duk* 'pull'; cf. Lewis/Short 1879: 615–616; WH I: 244–245; Pokorny IEW: 220–221; LIV2: 124; de Vaan 2008: 181);

s-pf. *iūnxī* (cf. pr. *iungō, -ere* 'joint'; < *√*i̯eu̯g*-; cf. OIA *yunájmi* 'yoke', OCS *igo* 'yoke'; cf. Lewis/Short 1879: 1017; WH I: 726–730; Pokorny IEW: 508–510; LIV^2: 316; NIL: 546–548; de Vaan 2008: 314–315);

s-pf. *pīnxī pictor* (cf. pr. *pingō, -ere* 'paint'; < *√*pei̯g*-; cf. OIA *pěgъ* 'colourful'; cf. Lewis/Short 1879: 1378; WH II: 305–306; Pokorny IEW: 794; LIV^2: 464; NIL: 546–548; de Vaan 2008: 465–466);

pr. *texō, s*-pf. *tēxī* (cf. pr. *tegō, -ere* 'cover'; < IE *√(*s*)*teg*-; cf. Gr. στέγω 'cover, fend, contain', Lith. *stógas* 'roof'; cf. Lewis/Short 1879: 1845–1846; WH II: 654; Pokorny IEW: 1013–1014; LIV^2: 589; NIL: 634–636; de Vaan 2008: 608);

sentis 'thorn', *sentus* 'shrubby' (< *#√*k*(*e*)*s-n̥-ti/to*-; cf. Hitt. *kiszi* 'comb', Gr. ξαίνω 'scratch, comb', MIr. *eīr* 'comb', OCS *češǫ* 'comb'; cf. Lewis/Short 1879: 1673; Stolz 1894: 297; WH II: 516–517; Kent 1932b: 125; Pokorny IEW: 585; Meiser 1998: 113; LIV^2: 357);[190]

8.1.2.3 The clusters *palatovelar + t/s*

The outcome of the development of the palatovelar + *t* is same as for **Kt*(and **K^{u}t*):

Ḱ + t = L. kt (<ct>):

sup. *dictum* (cf. pr. *dīcō, -ere* 'say'; < IE *√*dei̯ḱ*-; cf. OIA *ádikṣi* 'point', Gr. δείκνυμι 'show'; cf. Lewis/Short 1879: 570–571; WH I: 348–349; Pokorny IEW: 188–189; LIV^2: 108–109; de Vaan 2008: 169–170);

sup. *spectrum,* nom. *spectrum* (cf. pr. *speciō, -ere* 'observe'; < IE *√*speḱ*-; cf. OIA *páśyati* 'see', Gr. σκέπτομαι 'look about something'; cf. Lewis/Short 1879: 1737; WH II: 570–571; Pokorny IEW: 984; LIV^2: 575–576; de Vaan 2008: 578–579);

sup. *lēctum* (cf. pr. *legō, -ere,* pf. *lēgī* 'choose, read'; < IE *√*leǵ*-; cf. Gr. λέγω 'pick up'; cf. Lewis/Short 1879: 1047–1048; WH I: 351–352, 397, 780; Pokorny IEW: 658; LIV^2: 397; de Vaan 2008: 332–333);

sup. *rēctum,* nom. *rector* 'guide' (cf. pr. *regō, -ere* 'rule'; < IE *√*H_3reǵ*-; cf. OIA *rā́jat* 'prevail', MW. *reag* 'stand up'; cf. Lewis/Short 1879: 1551–1553; WH I: 273, 415, 429–430; WH II: 426–427; Pokorny IEW: 854–857; LIV^2: 304–305; de Vaan 2008: 517–518);

[189] If reconstructed as **pei̯k*- (cf. LIV^2 l.c.), if related to OIA *piṁśati* "adorn', it should be reconstructed as *√*pe□ḱ*- (cf. Pokorny IEW l.c., LIV^2: 464–465).

[190] The cluster of #*Ks* is simplified on #*0s*-, cf. Meiser (1998: 113); Weiss (2009: 170).

sup. *fictum*, adj. *fictus* (cf. pr. *fingō, -ere* 'mold'; < IE **√d^{h}ei̯ǵ^h-*; cf. OIA *díhanti* 'stack up', Goth. *digan* 'form mould'; cf. Lewis/Short 1879: 750–751; WH I: 501–502; Pokorny IEW: 244–245; LIV^2: 140–141; NIL: 118–119; de Vaan 2008: 221–222);

sup. *tractum*, ppp. *tractus* (cf. pr. *trahō, -ere* 'pull'; < IE **√d^{h}reǵ^h-*; cf. Gr. τρέχω 'run', Goth. *-dragan* 'carry'; cf. Lewis/Short 1879: 1885–1886; WH II: 697–699; Pokorny IEW: 257, 273; LIV^2: 154; de Vaan 2008: 626–627);

sup. *uectum*, nom. *vector* (cf. pr. *uehō, -ere* 'carry'; < IE **√u̯eǵ^h-*; cf. OIA *váhati* 'cart, drive', OCS *vezǫ* 'drive'; cf. Lewis/Short 1879: 1962; WH II: 741–743; Pokorny IEW: 1118–1120; LIV^2: 661–662; de Vaan 2008: 658);

num. *octō* 'eight' (< IE **oḱtō*; cf. Goth. *ahtau*, Gr. ὀκτώ; cf. Lewis/Short 1879: 1254–1255; WH II: 199–200; Pokorny IEW: 775; Coleman 1992: 266; Blažek 1999: 266; de Vaan 2008: 424–425);

Similarly, the outcome of the development of the palatovelar + *s* is same as for **Ks* (and **K^{u}s*):

Ḱ + s = L. ks (<x>):

s-pf. *dīxī* (cf. pr. *dīcō, -ere* 'say'; < IE **√dei̯ḱ-*; cf. OIA *ádikṣi* 'point', Gr. δείκνυμι 'show'; cf. Lewis/Short 1879: 570–571; WH I: 348–349; Pokorny IEW: 188–189; LIV^2: 108–109; de Vaan 2008: 169–170);

s-pf. *spēxī* (cf. pr. *speciō, -ere* 'observe'; < IE **√speḱ-*; cf. OIA *páśyati* 'see', Gr. σκέπτομαι 'look about something'; cf. Lewis/Short 1879: 1737; WH II: 570–571; Pokorny IEW: 984; LIV^2: 575–576; de Vaan 2008: 578–579);

s-pf. *rēxī*, nom. *rēx* 'king' (cf. pr. *regō, -ere* 'rule'; < IE **√H$_3$reǵ-*; cf. OIA *rā́jat* 'prevail', MW *reag* 'stand up'; cf. Lewis/Short 1879: 1551–1553; WH I: 273, 415, 429–430; WH II: 426–427; Pokorny IEW: 854–857; LIV^2: 304–305; de Vaan 2008: 517–518);

s-pf. *finxī* (cf. pr. *fingō, -ere* 'mold'; < IE **√d^{h}ei̯ǵ^h-*; cf. OIA *díhanti* 'stack up', Goth. *digan* 'form mould'; cf. Lewis/Short 1879: 750–751; WH I: 501–502; Pokorny IEW: 244–245; LIV^2: 140–141; NIL: 118–119; de Vaan 2008: 221–222);

s-pf. *trāxī* (cf. pr. *trahō, -ere* 'pull'; < IE **√d^{h}reǵ^h-*; cf. Gr. τρέχω 'run', Goth. *-dragan* 'carry'; cf. Lewis/Short 1879: 1885–1886; WH II: 697–699; Pokorny IEW: 257, 273; LIV^2: 154; de Vaan 2008: 626–627);

s-pf. *uēxī* (cf. pr. *uehō, -ere* 'carry'; < IE **√u̯eǵ^h-*; cf. OIA *váhati*, OCS *vežǫ*; cf. Lewis/Short 1879: 1962; WH II: 741–743; Pokorny IEW: 1118–1120; LIV^2: 661–662; de Vaan 2008: 658);

num. *sex* 'six' (< IE **seḱs*; cf. Goth. *saihs*, Gr. ἕξ; cf. Lewis/Short 1879: 1687; WH II: 528–529; Pokorny IEW: 1044; Coleman 1992: 237; Blažek 1999: 237; de Vaan 2008: 560);

Note: L. *uōx* is an example of the neutralization of the labiovelar before *-s*, cf. OIA *vā́k*, Gr. ὄψ < IE **u̯ōk^u-s*. This neutralization was extended, by the analogy, to other cases of the paradigm (de Vaan 2008: 691–692); it even became a base for new derivations: *uocāre*, *uocālis*, *uocābulum*, etc.

8.1.2.4 The clusters *labiovelar + t/s*

Labiovelars lose their labial component when clustering with *t* or *s:*

K^u + t = L. kt (<ct>):

sup. *coctum*, adj. *coctus*, nom. *coctor* (cf. pr. *coquō, -ere* 'cook'; < **√pek^u-*; cf. OIA *pacati*, OCS *pečǫ* 'cook'; cf. Lewis/Short 1879: 468; WH I: 270–271; WH II: 338; Pokorny IEW: 798; LIV^2: 468–469; NIL: 548–552; de Vaan 2008: 134);

sup. *-lictum* (cf. pr. *-linquō, -ere* ‘abandon’; < *√*lei̯k$^{u̯}$*-; cf. OIA *riṇákti* ‘leave’, Gr. λείπω ‘leave, quit’; cf. Lewis/Short 1879: 1557–1558; WH I: 808–809; Pokorny IEW: 669–670; LIV^2: 406–408; de Vaan 2008: 344);

nom. *sector* (cf. pr. *sequor* ‘follow’; < *√*sek$^{u̯}$*-; cf. OIA *sácate* ‘follow’, Gr. ἕπομαι ‘follow’; cf. Lewis/Short 1879: 1677–1678; WH II: 519; Pokorny IEW: 896–897; LIV^2: 526–527; de Vaan 2008: 555–556);

sup. *-stīnctum* (cf. pr. *-stinguō, -ere* ‘quench’; < *√*steng$^{u̯}$*-; cf. Goth. *stigqn* ‘meet, adjoin’; cf. Lewis/Short 1879: 1760; WH I: 706–707; Pokorny IEW: 1016–1017; LIV^2: 596–597; de Vaan 2008: 588);

sup. *ūnctum* (cf. pr. *unguō, -ere* ‘anoint’; < *√*H$_2$eng$^{u̯}$*-; cf. OIA *anákti* ‘anoint, smear’, Arm. *awcanem* ‘anoint’; cf. Lewis/Short 1879: 1931; WH II: 819–820; Pokorny IEW: 779; LIV^2: 267; de Vaan 2008: 641–642);

pr. *nictō, nictor,* nom. *nictus* (cf. pr. *cōnīueō, -ere* ‘close the eyes’; < *√*knei̯g$^{u̯h}$*-; cf. OHG *nīgan* ‘bow, inclined’; cf. Lewis/Short 1879: 1206; WH I: 260; Pokorny IEW: 608; LIV^2: 410–411; Sihler 1995: 163; de Vaan 2008: 130), 410–411);

num. *quīnctus, quīntus* ‘fifth’ (< Italic **k$^{u̯}$enk$^{u̯}$to-* < IE **pn̥k$^{u̯}$to-*; cf. OIA *pakthá-*, Gr. πέμπτος; cf. Lewis/Short 1879: 1515; WH II: 407–408; Pokorny IEW: 808; Coleman 1992: 222; Blažek 1999: 221). De Vaan (2008: 509) assumes for *quīntus* the earlier spirantization and later loss of the spirant (*-nkt-* > *-nxt-* > *-nt-*), similarly to the spirantization of velars in Sabellic.

K$^{u̯}$ + s = L. ks (<x>):

s-pf. *cōxī* (cf. pr. *coquō, -ere* ‘cook’; < *√*pek$^{u̯}$*-; cf. OIA *pacati,* OCS *pečǫ* ‘cook’; cf. Lewis/Short 1879: 468; WH I: 270–271; WH II: 338; Pokorny IEW: 798; LIV^2: 468–469; NIL: 548–552; de Vaan 2008: 134);

s-pf. *-stīnxī* (cf. pr. *-stinguō, -ere* ‘quench’; < *√*steng$^{u̯}$*-; cf. Goth. *stigqn* ‘meet, adjoin’; cf. Lewis/Short 1879: 1760; WH I: 706–707; Pokorny IEW: 1016–1017; LIV^2: 596–597; de Vaan 2008: 588);

s-pf. *ūnxī* (cf. pr. *unguō, -ere* ‘anoint’; < *√*H$_2$eng$^{u̯}$*-; cf. OIA *anákti* ‘anoint, smear’, Arm. *awcanem* ‘anoint’; cf. Lewis/Short 1879: 1931; WH II: 819–820; Pokorny IEW: 779; LIV^2: 267; de Vaan 2008: 641–642);

s-pf. *cō-nīxī* (cf. pr. *cōnīueō, -ere* ‘close the eyes’; < *√*knei̯g$^{u̯h}$*-; cf. OHG *nīgan* ‘bow, inclined’; cf. Lewis/Short 1879: 1206; WH I: 260; Pokorny IEW: 608; LIV^2: 410–411; Sihler 1995: 163; de Vaan 2008: 130);

s-pf. *ninxit,* nom. *nix* (cf. pr. *ninguō, ninguit, -ere,* nom. g. sg. *nivis* ‘snow’; < *√*snei̯g$^{u̯h}$*-; cf. OIr. *snigid* ‘snow’, Goth. *snaiws* ‘snow’, OCS *sněgъ* ‘snow’; cf. Lewis/Short 1879: 1208; WH II: 169–170; Pokorny IEW: 974; LIV^2: 573; NIL 622–625; de Vaan 2008: 409–410);

Note: L. pr. *uīuō, -ere*, *s*-pf. *uīxī*, sup. *uīcturus* ‘live’, though from IE *√*g$^{u̯}$i̯eH$_3$*- (cf. Gr. βίος, OIA *jīva-*, OCS. *živъ* ‘life’), seems to be translated from a *u̯*-final to a labiovelar final and fits subsequently into the alternation pattern (cf. de Vaan 2008: 686).

8.1.2.5 The clusters *dental + t/s*

The cluster **Tt* is wholly sibilantized as *ss*:

T + t = L. (s)s:

sup. *messum,* nom. *messis* (cf. pr. *metō, -ere* ‘mow, reap’; < IE *√*met-*; cf. W. *medi* ‘mow, harvest’, OCS *metǫ, mesti* ‘throw, sweep’; cf. Lewis/Short 1879: 1140; WH II: 82–83; Pokorny IEW: 703–704; LIV^2: 442; de Vaan 2008: 377–378);

sup. *sēnsum* (cf. pr. *sentiō, -īre* 'feel'; < IE *√*sent-*; cf. OCS *sęštь* 'sensible, wise'; cf. Lewis/Short 1879: 1672–1678; WH II: 515–516; Pokorny IEW: 908; LIV²: 533; de Vaan 2008: 554);

sup. *ēsum*, inf. *esse* (besides *edere*), nom. *ēsor*, ppp. *ēsus* (cf. pr. *ēdō, -ere* 'eat'; < IE *√*H_1ed-*; cf. OIA *átti* 'eat', OLith. *edmi, esti* 'eat'; cf. Lewis/Short 1879: 626; WH I: 392–393; Pokorny IEW: 287–289; LIV²: 230–231; NIL: 208–210; de Vaan 2008: 185–186);

sup. *fūsum*, nom. *fūsiō* (cf. pr. *fundō, -ere* 'pour'; < IE *√*ǵʰeu̯d-*; cf. OIA *juhóti* 'pour, sacrifice', Goth. *guitan* 'pour'; cf. Lewis/Short 1879: 792–793; WH I: 563–564; Pokorny IEW: 447–448; LIV²: 179–180; de Vaan 2008: 249–250);

sup. *lūsum*, ppp. *lūsus* (cf. pr. *lūdō, -ere* 'play'; < IE *√*lei̯d-*; cf. Gr. λίζει 'play', OIA *lédmi* 'play'; cf. Lewis/Short 1879: 1083; WH I: 829; Pokorny IEW: 666; LIV²: 402–403; de Vaan 2008: 350–351);

sup. *suāsum*, nom. *suāsor* (cf. pr. *suādeō, -ēre* 'advice, recommend'; < IE *√*su̯eH_2d-*; cf. OIA *svádant* 'make savoury', Gr. ἡδύς 'pleasant'; cf. Lewis/Short 1879: 1770–1771; WH II: 483, 611–612; Pokorny IEW: 1039–1040; LIV²: 606–607; NIL: 670–672; de Vaan 2008: 594);

sup. *trūsum*, ppp. *trūsus* (cf. pr. *trūdō, -ere* 'thrust, push'; < IE *√*treu̯d-*; cf. OCS *trudъ* 'labour, work', OHG -*driozan* 'cause sorrow'; cf. Lewis/Short 1879: 1905; WH II: 710; Pokorny IEW: 1095–1096; LIV²: 651–652; de Vaan 2008: 630);

ppp. *fīsus sum* (cf. pr. *fīdō, -ere* 'trust'; < IE *√*bʰei̯dʰ-*; cf. Gr. πείθω 'persuade', Alb. *bē, besë* 'faith'; cf. Lewis/Short 1879: 747–748; WH I: 493–494; Pokorny IEW: 117; LIV²: 71; NIL: 12–13; de Vaan 2008: 218–219);

sup. *iussum* (cf. pr. *iubeō, -ēre* 'command'; < IE *√*Hi̯eu̯dʰ-*; cf. *yúdhyati* 'fight'; cf. Lewis/Short 1879: 1014; WH I: 724–725; Pokorny IEW: 511–512; LIV²: 225–226; de Vaan 2008: 312–313);

In reconstructed clusters of **dʰt*, the outcome is *st* attested in two examples: *aestus* 'heat, fervor', *aestās* 'summer (heat)' (< *H_2ei̯dʰ-*) (Stolz 1894: 326; Sihler 1995: 203; Meiser 1998: 127; Hill 2003: 243–247; de Vaan 2008: 28). The outcome is irregular, hence minor, and definitely not related to Bartholomae's Law (which, if operative in Pre-Italic, would yield a voiced outcome).

The same outcome is regular (since it is attested for all clusters of the same structure) for clusters of **Ttr* > *str*. Examples are: *rōstrum* 'snout, beak' (cf. *rōdō* 'graw' with *s*-pf *rōsī* and ppp. *rōsum*, both regular; cf. WH II: 439–440; Pokorny IEW: 854; Leumann 1977: 190; Meiser 1998: 124; de Vaan 2008: 526); similarly *fūstis* 'stick, rod' (cf. -*fūtāre* 'strike'; cf. OE *bēatan*, OHG *bozan* 'strike'; cf. WH I: 259–260, 573; Pokorny IEW: 112; Hill 2003: 229–238; de Vaan 2008: 253) and *cæstus* 'strip of leather' (related to *caedō* 'cut, hew, fell'; cf. WH I: 44, 129, 690; Pokorny IEW: 917; Untermann 2000: 364; Hill 2003: 229–238; de Vaan 2008: 79–80).

Note: The old process of sibilantization does not affect the (later) clusters resulting from *verbal prefix* + *verbal root*: *attineō* 'hold' (= *ad-teneō*), cf. Sihler (1995: 203), Baldi (1999: 293).

T + s = L. (s)s:

s-pf. *messuī* (cf. pr. *metō*, *-ere* ‘mow, reap’; < IE *√*met-*; cf. W. *medi* ‘mow, harvest’, OCS *metǫ*, *mesti* ‘throw, sweep’; cf. Lewis/Short 1879: 1140; WH II: 82–83; Pokorny IEW: 703–704; LIV^2: 442; de Vaan 2008: 377–378);

s-pf. *sēnsī* (cf. pr. *sentiō*, *-īre* ‘feel’; < IE *√*sent-*; cf. OCS *sęštъ* ‘sensible, wise’; cf. Lewis/Short 1879: 1672–1678; WH II: 515–516; Pokorny IEW: 908; LIV^2: 533; NIL: 208–220; de Vaan 2008: 554);

s-pf. *lūsī* (cf. pr. *lūdō*, *-ere* ‘play’; < IE *√*lei̯d-*; cf. Gr. λίζει ‘play’, OIA *lédmi* ‘play’; cf. Lewis/Short 1879: 1083; WH I: 829; Pokorny IEW: 666; LIV^2: 402–403; de Vaan 2008: 350–351);

s-pf. *suāsī* (cf. pr. *suādeō*, *-ēre* ‘advice, recommend’; < IE *√*su̯eH₂d-*; cf. OIA *svádant* ‘make savoury’, Gr. ἡδύς ‘pleasant’; cf. Lewis/Short 1879: 1770–1771; WH II: 483, 611–612; Pokorny IEW: 1039–1040; LIV^2: 606–607; NIL: 670–672; de Vaan 2008: 594);

s-pf. *trūsī* (cf. pr. *trūdō*, *-ere* ‘thrust, push’; < IE *√*treu̯d-*; cf. OCS *trudъ* ‘labour, work’, OHG *-driozan* ‘cause sorrow’; cf. Lewis/Short 1879: 1905; WH II: 710; Pokorny IEW: 1095–1096; LIV^2: 651–652; de Vaan 2008: 630);

s-pf. *iussī* (cf. pr. *iubeō*, *-ēre* ‘command’; < IE *√*Hi̯eu̯dʰ-*; cf. OIA *yúdhyati* ‘fight’; cf. Lewis/Short 1879: 1014; WH I: 724–725; Pokorny IEW: 511–512; LIV^2: 225–226; de Vaan 2008: 312–313);

s-pf. *uāsī* (cf. pr. *uādō*, *-ere* ‘go’; < IE *√*u̯eH₂dʰ-*; cf. ON *vaða* ‘wade’; cf. Lewis/Short 1879: 1951; WH II: 723–724; Pokorny IEW: 1109; LIV^2: 664; de Vaan 2008: 650);

Note: The process even afflicts secondary clusters like *possum* ‘can’ (< **potis sum*), cf. Meiser (1998: 116).

8.1.2.6 The clusters *sibilant + t/s*

Old Indo-European cluster **st* is fully preserved; Indo-European cluster **ss* is either preserved or simplified (usually according to rhythmicity rule):

s + t = L. st:

nom. *castus* ‘pure’ (cf. pr. *careō*, *-ēre* ‘lack’; < IE *√*ḱes-*; cf. OIA *śāsti* ‘order’; cf. Lewis/Short 1879: 291–292, 299; WH I: 167, 178; Pokorny IEW: 586; LIV^2: 329; de Vaan 2008: 92–93);

pr. *est* (cf. pr. *sum* ‘be ’; < IE *√*H₁es-*; cf. OIA *ásti*, OLith. *esti*, OCS *jestъ* ‘be’; cf. Lewis/Short 1879: 1797–1800; WH I: 263, 420; WH II: 628–629; Pokorny IEW: 340–341; LIV^2: 241–242; NIL: 235–238; de Vaan 2008: 599);

sup. *pistum* (beside *pīnsum*, *pīnsitum*), nom. *pistor* ‘baker’ (cf. pr. *pīnsō*, *-ere* ‘crush’; < IE *√*pei̯s-*; cf. OIA *pináṣṭi* ‘crush, grind’, RuCS *pъchati* ‘thrust, sprout’; cf. Lewis/Short 1879: 1878–1880; WH II: 302, 307–308; Pokorny IEW: 796; LIV^2: 466; de Vaan 2008: 466–467);

sup. *haustum* (cf. pr. *hauriō*, *-īre* ‘draw’; < IE *√*H₂eu̯s-*; cf. Gr. αὔω ‘get a light’, ON *ausa* ‘scoop’; cf. Lewis/Short 1879: 842–843; WH I: 637; Pokorny IEW: 90; LIV^2: 275–276; de Vaan 2008: 281);[191]

pr. *stō*, *sistō* (‘stand ’; < IE *√*steH₂-*; cf. OIA *ásthāt* ‘stand’, Lith. *stóti* ‘stand’; cf. Lewis/Short 1879: 1711–1712, 1762–1763; WH II: 584, 587, 597–598, 632; Pokorny IEW: 1004–1010; LIV^2: 590–592; NIL: 637–659; de Vaan 2008: 567, 589–590);

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[191] The initial *h-* in Latin is probably hypercorrect, l.c.

s + s = L. (0)s:

pr. *esi* (= **es-si*; cf. pr. *sum* ‘be ’; < IE *√H_1*es-*; cf. OIA *ásti*, OLith. *esti*, OCS *jestъ* ‘be’; cf. Lewis/Short 1879: 1797–1800; WH I: 263, 420; WH II: 628–629; Pokorny IEW: 340–341; LIV^2: 241–242; NIL: 235–238; de Vaan 2008: 599);

s-pf. *pīnsī* (cf. pr. *pīnsō, -ere* ‘crush’; < IE *√*pei̯s-*; cf. OIA *pináṣṭi* ‘crush, grind’, RuCS *pъchati* ‘thrust, sprout’; cf. Lewis/Short 1879: 1878–1880; WH II: 302, 307–308; Pokorny IEW: 796; LIV^2: 466; de Vaan 2008: 466–467);

s-pf. *hausī* (cf. pr. *hauriō, -īre* ‘draw’; < IE *√H_2*eu̯s-*; cf. Gr. αὔω ‘get a light’, ON *ausa* ‘scoop’; cf. Lewis/Short 1879: 842–843; WH I: 637; Pokorny IEW: 90; LIV^2: 275–276; de Vaan 2008: 281);

8.1.2.7 Overview of Latin development[192]

Latin development has two innovations: the first is the Common Indo-European transformation of the dentals in clusters of **Tt* and **Ts*; the second is old neutralization of labiovelars in both contexts:

IE	Latin	t-	s-
-k$^{u̯}$/g$^{u̯}$/g$^{u̯h}$	k$^{u̯}$/g$^{u̯}$(u̯)/u̯	*kt*	*ks*
-k/g/g^{h}	k/g/h	*kt*	*ks*
-ḱ/ǵ/ǵ^{h}	k/g/h	*kt*	*ks*
-t/d/d^{h}	t/d/d (b, f)	*ss*	*ss*
-p/b/b^{h}	p/b/f (b)	*pt*	*ps*
-s	s/r	*st*	*ss*

8.2 Sabellic languages

The Sabellic branch of Italic languages, though once widely used than the Latin-Faliscan branch, is worse attested than its counterpart. In this paper, data will be used from Oscan and Umbrian. Texts are attested either in native **alphabets** (adapted to a given language, principally similar to Etruscan and closely related to it) or in Greek ἀλφάβητος (only for Oscan), later Latin *script* was used for both languages (Baldi 1999: 129–132; 136–140; Stuart-Smith 2004: 78–79, 100–101; Pocetti 2017: 739).

Since both Oscan and Umbrian are relict languages (Oscan is attested in about 200 documents, Umbrian is attested in small glosses and especially in *Tabulae Iguvinae*), we have to use a minimal set of language data, though we can cover the main tendencies in the development of clusters of *plosive* + *t/s* (and *s* + *t/s*) even with attested data, albeit often very thinly (on the relationship between Oscan and Umbrian, cf. Baldi 1999: 174–176).

8.2.1 Sabellic and Indo-European

The typical features separating the Sabellic obstruent system from that of Indo-European are (listed are only those relevant for our field of interest):

i. the loss of labiovelars (in contrast to Latin) in all positions including *plosive* + *t/s* (for this more below), intervocalic in the way of merging with pure labials, cf. Os. **pís** vs L. *quis* ‘who’, Os. nom. pl. **bivus** vs L. *vīvus*, Um. **vufru** ‘votive’ (< IE **u̯og$^{u̯}$-ro-*) (Meiser 2017: 749);

[192] Valid only for the internal clusters.

ii. the transformation of old IE voiced aspirated plosives into voiceless spirants (Meiser 2017: 744);
iii. sibilantization of clusters of *Tt* as *ss*;
iv. spirantization/lenition of plosives before *t/s*;
v. degemination of *ss* (especially for metrical reasons).

Note: Though not the proper 'consonantal development', we should mention vowel syncope (Meiser 2017: 748), producing secondary clusters of different origins and (often even outcomes) that result from 'old clusters'. Some examples we will mention below.

The first feature is shared with Ancient Greek (but not with Mycenaean!) and with P-Celtic languages. The second feature is attested partially in Latin and Middle Greek. The third feature is shared with Latin, Celtic, and Germanic languages, while the spirantization of plosives is attested not only in Celtic and Germanic but even in Iranian, etc.

8.2.2 Sabellic clusters and their IE origins

There is no distinction between plain velars and palatovelars in all Italic languages (as there is none in all *centum*-languages), but we will distinguish both series for better Indo-European contextualisation. Beside old alternations, there are numerous secondary clusters, arising due to the syncope of vowels, often with a different outcome than those of the primary clusters. This distinction between primary and secondary clusters is very distinguishable.

8.2.2.1 The clusters *labial + t/s*

In Oscan, labiality is preserved. In Umbrian the labial fricative is delabialized:

P + t = (Sab. *φt), Os. *ft*, Um. (*h*)*t*):[193]

Os. *scriftas,* Um. *screhto, screihtor* 'written' (cf. L. *scrīptus*; < IE *√*skrei̯b*^{h}-; cf. ON *hrífa* 'scratch, tear', Latv. *skrīpât* 'scratch, scribble, write down'; cf. von Planta 1892: 425; Buck 1904: 78; Pokorny IEW: 946–947;Meiser 1986: 92; LIV^2: 562; Stuart-Smith 2004: 80, 113; de Vaan 2008: 546–547; Meiser 2017: 749);

Os. **ufteis**, **uhftis** 'voluntatis' (cf. L. *optiō*; < IE *√*H₃ep*- (?); cf. Hitt. *epp-*^{zi}*app-* 'take, grab'; cf. Buck 1904: 78; Pokorny IEW: 781; LIV^2: 299; Stuart-Smith 2004: 95; de Vaan 2008: 431–432);

Um. **setums** PN 'Septimus' (cf. L. *Septimus*; < IE **septm-*; cf. OIA *saptá-* 'seven', Gr. ἑπτά 'seven'; Pokorny IEW: 909; Coleman 1992: 248; Sihler 1995: 214–216; Blažek 1999: 248; de Vaan 2008: 555; Meiser 2017: 749);

Note: The secondary (having arisen due to syncopation) clusters in Umbrian seem to follow the same trajectory: Um. **hahtu, hatu**, *hatu* 'capito' (cf. Os. *hipid*; Buck 1904: 78; Untermann 2000: 316).

P + s = Sab. (*s*)*s*:

[193] This seems to be extended to secondary clusters, too: Um. *hahtu, hatu* "capito' (cf. L. *habeō*) (Buck 1904: 78).

Os. *osiin*[*ns*-, Um. **úpsim** '(lit.) to be against' (cf. L. *ob-sint*; < IE *√H_1*es*-; cf. OIA *ásti*, OLith. *esti*, OCS *jestъ* 'be'; cf. von Planta 1892: 427; Buck 1904: 78; Pokorny IEW: 340–341; Untermann 2000: 248; LIV^2: 241–242; de Vaan 2008: 599);

Os. **essuf**, *esuf*, Um. **esuf** 'himself; there' (cf. L. *ipse*; PItal. < **eps*(*o*)-*ōn-s* < IE **soso*; cf. von Planta 1892: 427; Buck 1904: 79; Pokorny IEW: 281–286; Untermann 2000: 235–236; de Vaan 2008: 308);

Um. *ostendu* 'should set up' (cf. L. *ostendere* 'show, reveal'; < IE *√(*s*)*tend*-; cf. OIA *tanóti* 'stretch', Gr. τείνω 'stretch, pull tight', Goth. *ufþanjan* 'extend'; cf. Pokorny IEW: 1065–1066; Meiser 1986: 169; Untermann 2000: 812–814; LIV^2: 626–628; de Vaan 2008: 612–613);

Note: The secondary (having arisen due to syncopation) clusters in Oscan are not subdued to this alternation, but those in Umbrian are: Os. **upsed**, **úpsannam** (cf. L. *fecit*), Um. *osatu*, *oseto* (from **opesā-*, cf. L. *operor*) (Buck 1904: 79; Meiser 1986: 169, 173).

8.2.2.2 The clusters *velar + t/s*

The IE cluster **Kt* is realized as *ht* (the *h* is often omitted). The outcomes are mixed with those of IE **Ḱt* (see below):

K + t = Sab. *ht*:

Os. **saahtúm**, Um. **sahta**, **satam**, *sahatam* 'sanctified, holy' (cf. L. *sanctum* 'holy'; < IE *√*s*H_2*nk-i*-; cf. Hitt. *šāklāi* 'custom, rites', Celtiberian *Sancilistara* 'money-fine' (?); cf. Buck 1904: 89; Pokorny IEW: 878; Untermann 2000: 640–643; Stuart-Smith 2004: 95; de Vaan 2008: 532);

Um. **uhtur** '(a title of an official?)' (cf. L. *auctor* 'seller, authoritative person'; < IE *√H_2*eu̯g*-; cf. OIA *ukṣáti* 'increase', Lith. *áugu* 'grow'; cf. Buck 1904: 89; Meiser 1986: 92; Pokorny IEW: 86–87; LIV^2: 84–85; Untermann 2000: 788–789; NIL: 328–332; de Vaan 2008: 61–62);

Um. **ahtisper, ahtimen** 'act'(cf. L. *actiō* 'activity'; < *√H_2*eg*-; cf. OIA *ájati* 'drive', Gr. ἄγω 'drive, lead, go'; cf. Pokorny IEW: 4–6; LIV^2: 255–256; Untermann 2000: 65–66; NIL: 267–277; de Vaan 2008: 30-31).

Note: The secondary clusters arising due syncopation are not affected by this process, cf. Um. **fiktu** 'form' (cf. L. *fingō*; < IE ***d^h*ei̯*$ǵ^h$*-e/o-*; cf. WH I: 501–502; Pokorny IEW: 244–245; LIV^2: 140–141; Stuart-Smith 2004: 112; ; de Vaan 2008: 221–222; Meiser 2017: 750). The secondary cluster from syncopated syllables could be realized in Umbrian as *it*, but not in Oscan: cf. Um. **aitu**, *aitu*, Os. *actud* (cf. L. *agit*); Os. *fac* Um. *feitu, fetu, feetu* (cf. L. *factum*). In such a case, the lenition process has outcome either a palatal approximant or zero due to the elision (cf. Buck 1904: 89).

There are no solid examples for the development of the IE cluster of *Ks*, though we assume the outcomes are same as for the IE cluster *Ḱs* (see below):

K + s = Sab. *0s*:

not attested

Note: The *k* is sometimes restored due to analogy: Os. μεδδειξ, *medixud* = **meddíss**, *meddis* '(L.) meddix (magistrate)' (from **med-dei̯ḱs*; von Planta 1892: 376; Buck 1904: 91; Untermann 2000: 456–459; de Vaan 2008: 169–170).

8.2.2.3 The clusters *palatovelar + t/s*

Old IE palatovelars merged fully with their plain velar counterparts. The cluster of *Ḱt* is then realized in the same way as *Kt*.

Ḱ + t = Sab. ht:

- Os. **ehtrad** ‘outside’ (cf. L. *extra*; < IE *H_1eǵ^h-s-; cf. OIr. *ess-* ‘out’, Gr. ἐξ ‘from’, OCS *iz* ‘out’; cf. Buck 1904: 89; Pokorny IEW: 292–293; Meiser 1986: 92; Untermann 2000: 202–203; Meiser 2017: 749; de Vaan 2008: 195–196);
- Os. **Úhtavis** PN (cf. L. *Octāvius*; < IE *ok̑to-; cf. Goth. *ahtau*, Gr. ὀκτώ; cf. von Planta 1892: 351; Buck 1904: 89; Pokorny IEW: 775; Meiser 1986: 92; Coleman 1992: 266; Blažek 1999: 266; Stuart-Smith 2004: 95; de Vaan 2008: 424–425);
- Um. **speturie** ‘spectoriae (augural)’ (cf. L *speciō, -ere* ‘observe’; < IE *√spek̑-; cf. OIA *páśyati* ‘see’, Gr. σκέπτομαι ‘look about something’; cf. Pokorny IEW: 984; LIV^2: 575–576; de Vaan 2008: 578–579; Meiser 2017: 749);
- Um. **rehte** ‘right’ (cf. L. *rēctā* ‘directly’; < IE *√H_3reǵ-; cf. OIA *rā́jat* ‘prevail’, MW *reag* ‘stand up’; cf. von Planta 1892: 352; Buck 1904: 89; Pokorny IEW: 854–857; Meiser 1986: 92; LIV^2: 304–305; Untermann 2000: 633; de Vaan 2008: 517–518);

The IE cluster *Ḱs* merged with the *Ks* cluster, as in all centum-languages, and as far as we can judge from the lack of data for *Ks* (see above). The outcomes for *Ḱs* are:

Ḱ + s = Sab. (h)s:

- Os. *sehsimbrịịs* ‘born in the sixth month’, **sehsík[** ‘?’ (cf. L. *sextārius* ‘measure of one-sixth’; < IE *√su̯ek̑s-; cf. Gr. ἕξ, Goth. *saihs* ‘six’; cf. Buck 1905: 91; Pokorny IEW: 1044; Coleman 1992: 237; Blažek 1999: 237; Untermann 2000: 91; de Vaan 2008: 560);
- Os. **destrst** (⇔ L. ‘dextra est’), Um. *desua*, *dersua* ‘right’, *destrame* ‘in the right’ (cf. L. *dexter* ‘right’; < IE *dek̑s-; cf. OIA *dákṣina-* ‘right’, Gr. δεξιά ‘right hand’; cf. von Planta 1892: 376; Buck 1904: 91; Pokorny 1959: 189–191; Untermann 2000: 169–170; de Vaan 2008: 168);

Note: Os. *sehsimbrịịs* still preserves the older cluster *hs*, Os. **destrst** represents -*k̑s-tr-.

8.2.2.4 The clusters *labiovelar + t/s*

The development of old labiovelars before *t* is based on few etymologies. It seems that labiovelars were delabialized before *t* as in Latin, as far as we can judge from very scarce examples, but surprisingly, the outcoming velar is not spirantized as in case of *Kt/Ḱt*, but in all examples quoted below, the clusters could be secondary, due to syncopation (cf. Buck 1904: 80; Meiser 1986: 179). Regardless, if secondary, the cluster-realization of the original labiovelar (otherwise fully labialized) as a velar is remarkable, being a result of an independent neutralization.

However, we lack reliable enough data to determine the outcome of IE *K^{u}t* data.

$K^u + t$ = Sab. kt (secondary?):

Um. **fiktu** 'figito' (< *$f\bar{\imath}k^u t\bar{o}d$; cf. L. *fīgō*; < IE *$d^h e\underset{\frown}{i}Hg^u$-; cf. Lith. *díegti* 'sting', Toch. B *tsäkaṃ* 'bite' (?); cf. Buck 1904: 95; Pokorny IEW: 243–244; Meiser 1986: 82; Untermann 2000: 284; LIV²: 142; de Vaan 2008: 219);

Um. *ninctu* 'ninguito'[194] (< *$nink^u t\bar{o}d$; cf. L. *ninguit* 'snow'; < *√$sne\underset{\frown}{i}g^{uh}$-; cf. OIr. *snigid* 'snow', Goth. *snaiws* 'snow', OCS *sněgъ* 'snow'; cf. Buck 1904: 95; Pokorny IEW: 974; Meiser 1986: 84–86; Untermann 2000: 497–498; LIV²: 573; de Vaan 2008: 409–410);

Os. *Púntiis* PN 'Quintius' (but Os. Πομπτιες, *pomtis*), Um. nom. pl. *puntes* 'quiniones' (i.e., a group of five priests) (< PSab. **ponkto-* 'five' < Italic *$k^u enk^u to$-; < IE *$penk^u$-*te*-; cf. OIA *pakthá-*, Gr. πέμπτος; cf. Buck 1904: 95; Pokorny IEW: 808; Meiser 1986: 89; Coleman 1992: 222; Blažek 1999: 221–222; Untermann 2000: 608). De Vaan (2008: 509) assumes for *quīntus* the earlier spirantization and later loss of the spirant (*-nkt-* > *-nxt-* > *-nt-*), similarly to the spirantization of velars in Sabellic. Similar development is valid in the case of Um. **anstintu** 'distinguito' (< *-$stink^u t\bar{o}d$; Buck 1904: 95; Meiser 1986: 82; Untermann 2000: 106).

The velar is lost due to the position inside the cluster. Similarly, the intermediate labiovelar (or more properly, its outcome) was lost in Um. **umtu** 'anoint' (< *$H_3 eng^u et\bar{o}d$; Meiser 1986: 80; Untermann 2000: 797–798). Such examples could represent an old neutralization $K^u t$ >*kt* > *ht* > *0t*.

Note: An atypical outcome like Os. **aftiím** 'unknown psyche/body part (?)' (< *√$H_3 eg^u$- 'see' ?; Meiser 1986: 90–91; Untermann 2000: 60) could be a result of a levelling (and a regular spirantization); abovementioned Os. Πομπτιες (to Os. *Púntiis*, *pomtis*) could be the same case (*π* could represent a spirant since in Greek *φ* had still the value of /p^h/).

For the development of the cluster of $K^u s$, we have at our disposal only Um. *suboco* 'invocation' (acc. sg.) and Um. *subocau* 'call' (both from **u̯ok-s*), analogically extended to other forms (as in Latin), though the cluster is *$k^u s$ in its origin (Meiser 1986: 90; Untermann 2000: 707–708). As in the case of IE $K^u t$, we lack data to demonstrate the Sabellic outcomes for IE $K^u s$ but we can assume the delabialization of the cluster, later probably spirantized and lenited as the clusters *Ks* and *Ḱs*.

8.2.2.5 The clusters *dental* + *t/s*

As in other IE languages (Latin, Germanic, Celtic), the IE cluster of *dental plosive* + *t* were transformed into *ss*:

T + t = Sab. (s)s:

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[194] Surprisingly without a loss of the intermediate phoneme, cf. below on Um. **anstintu**, Os. *Púntiis*, *pomtis*, Um. *puntes*, Um. **umtu**).

Os. Ϝερσορει '*Versori' (epithet of Iuppiter = *advertor*; cf. Um. *trahurfi* 'placed across', L. *versus*; < IE *√*u̯ert-to-*; cf. OIA *vr̥ttá-* 'turn', Pruss. *wīrst* 'become' ; cf. von Planta 1892: 419; Buck 1904: 86; Pokorny IEW: 1156–1158; Untermann 2000: 844–845; LIV^2: 691–692; de Vaan 2008: 666–667);

Um. *sesust* 'sederit' (cf. L. *sessus*; < IE *√*sed-t-*; cf. OIA *sattá-* 'sit', OCS *sěděti* 'sit'; cf. von Planta 1896: 335; Buck 1904: 86; Pokorny IEW: 884–887; Untermann 2000: 680–681; LIV^2: 513–515; NIL: 590–600; de Vaan 2008: 551–552)[195];

Um. *frosetom* 'fraudatum' (cf. OL. *fraussus*; < IE *√*dʰreu̯-t/dʰ-* (?); cf. OIA *dhrúti-* 'deception, error'; cf. Buck 1904: 86; Pokorny IEW: 277; LIV^2: 156; Untermann 2000: 300-301; de Vaan 2008: 240);

Os. *castrous*, Um. **kastruvuf**, *castruo* '(fenced) field' (?) (cf. L. *castrum* 'fort', *castrō* 'castrate'; < IE *√*ḱes-*; cf. OIA *śástra-* 'knife', Gr; cf. Buck 1904: 86; Pokorny IEW: 586; Untermann 2000: 374–375; LIV^2: 329–330; de Vaan 2008: 97–98);[196]

There are the secondary clusters, arising due to syncope, of two dentals, with the pattern *Tt* > *0t*: Um. **titu**, **tetu**, *ditu* 'should give' (< PSab. **déδatōd* < IE **di-dH₃-tod*); *preuendu* 'advertito' (< PSab. **prai̯-u̯endetōd* < IE *√*u̯endʰ-*) (cf. Meiser 1986: 180).

Similarly, the IE clusters of *Ts* are realized as 0s:

T + s = Sab. (s)s:

Um. **revestu** 'check' (= **re-u̯ei̯d-s-e-tōd*; cf. L. *re-vīsere* 'visit'; < IE *√*u̯ei̯d-s-*; cf. OIA *vittá-* 'find', Lith. *véizdi* 'look for'; cf. von Planta 1892: 390; Buck 1904: 85; Pokorny IEW: 1125–1127; Untermann 2000: 634–635, 854–855; LIV^2: 665–667; de Vaan 2008: 676);

Um. **Fise** 'deo Fidio', Os. **Fiísíais** '*Fisiis' (cf. L. *fīsus* 'trust'; < IE *√*bʰei̯dʰ-so-*, but often being considered from *√*bʰei̯dʰ-t-*; cf. von Planta 1892: 419; Buck 1904: 85; Pokorny IEW:117; Untermann 2000: 286; LIV^2: 71–72; Stuart-Smith 2004: 104, 113; de Vaan 2008: 218–219);

Note: The secondary clusters of *Ts*, arising due to syncope, are realized as **z** in the native alphabet but as *s* in Latin alphabet, cf. Os. **húrz** (cf. L. *hortus*), Um. **taçez**, *tases* (cf. L. *tacitus*), Os. **puz**, *pous*, Um. **puze**, *puse* 'ut' (< **put-s*) (von Planta 1892: 391; Buck 1904: 86; Meiser 1983: 173).

8.2.2.6 The clusters *sibilant + t/s*

The original cluster *st* is preserved in all cases:

s + t = Sab. st:

Os. **púst**, Um. *post* 'after, behind' (cf. L. *post*; < IE **pos-ti*; cf. Gr. Arc.-Cypr. πός 'at, to', Cz. *pozdě* 'late'; cf. Buck 1904: 73; Pokorny IEW: 841; Untermann 2000: 618–624; de Vaan 2008: 483);

Os. **staít**, Um. *stahu* 'stand' (cf. L. *stō* 'stand '; < IE *√*steH₂-*; cf. OIA *ásthāt* 'stand', Lith. *stóti* 'stand'; cf. Buck 1904: 73; Pokorny IEW: 1004–1010; Untermann 2000: 697–700; LIV^2: 590–592; NIL: 634–636; de Vaan 2008: 567, 589–590);

[195] But von Planta (1892: 390) considers it to be from **set-s-*!

[196] This is an example for the development of the cluster **Ttr*, resulting, as in Latin, in *str*.

Os. **est**, Um. **est**, *est* ‘be’ (L. *est*; < IE *√H_1*es*-; cf. OIA *ásti*, OLith. *esti*, OCS *jestъ* ‘be’; cf. von Planta 1892: 473; Buck 1904: 73; Pokorny IEW: 340–341; Untermann 2000: 245–247; LIV²: 241–242; NIL: 235–238; de Vaan 2008: 599);

The following single example of the development of the cluster of **ss* could be interpreted as a simplification of such a cluster as *0s* in Sabellic, assuming that Um. nom.sg. *meřs/mers*, is a *s*-stem followed by an -*as* of a nominative ending (i.e., -*s*-*s*-):

s + s = Sab. (s)s (?):[197]

Um. nom. sg. **meřs**, *mers* ‘law’ (*s*-stem, cf. d.-abl. pl. **mersus**; von Planta 1896: 71; Buck 1904: 130; Untermann 2000: 461–462).

8.2.2.7 Overview of Sabellic development

In the following table, only the primary clusters are listed. Note the spirantization of peripheral series. The sibilantization of dental clusters is shared with Latin, Celtic and Germanic languages:

IE	Sabellic	t-	s-
-kᵘ̯/gᵘ̯/gᵘ̯ʰ	-p/b/f	[*ht*]	[(*s*)*s*]
-k/g/gʰ	-k/g/h	*ht*	[(*s*)*s*]
-ḱ/ǵ/ǵʰ	-k/g/h	*ht*	(*s*)*s*
-t/d/dʰ	-t/d/f	(*s*)*s*	(*s*)*s*
-p/b/bʰ	-p/b/f	*ft/ht*	(*s*)*s*
-s	-s	*st*	(*s*)*s*

8.3 Trajectories of the Italic development

The development in both branches remarkably differs in the development of both peripheral series: Latin data show a remarkably conservative development of the peripheral series clusters, where old clusters are preserved. On the other hand, Sabellic data show a progressive development of spirantization/lenition, with this split between the closely related sub-branches mirroring that of Indo-Iranian. The labiovelar series has special development, which is neutralized as plain velars in Latin, while the Sabellic data are inconclusive.

Both sub-branches share the same development of the dental series, which has undergone a typical Indo-European development, here sibilantization of both clusters of **Tt* and **Ts* (as in Sabellic, Germanic, Celtic). Outcoming *ss* (of different origins) are often simplified as *0s* again in both sub-branches due to the moraic leveling.

[197] However, the simplification of two sibilant clusters on *0s* is known even from the secondary clusters resulting from IE **Ts*.

8.3.1 Development of clusters *labial* + *t*/*s*

For the development of the labial clusters with *t*-, Latin is once again a conservative language, preserving both plosives. The Sabellic development is more complex, different even for Oscan on the one side and Umbrian on the other, though we trace both developments to a common Sabellic source. First, the *Pt* cluster was spirantized, and the spirant is preserved as the labiodental spirant in Oscan (cf. Os. **scriftas,** but Um. **screihtor**, cf. L. *scrīptus*). In Umbrian, the spirant was delabialized and later debuccalized (the outcoming *h* is sometimes elided):

i. **P** + **t** > **pt**	(Latin)
ii. **P** + **t** > φt > **ft**	(Oscan)
iii. **P** + **t** > φt > xt > **ht**	(Umbrian)

Note: The Italic cluster of *#pt-* has another development in Latin: *#pt-* > *st-* (cf. L. *sternuō* 'sneeze', related to Gr. πταρ-μός, πταίρω, Arm. *p῾ṙngam*, *p῾ṙngem*; Stolz 1894: 297; Meiser 1998: 113; de Vaan 2008: 587), but note that in this case the cluster of**#pst-* is usually reconstructed (Schrijver 1995: 454; LIV^2 494–495). The L. *taceō*, *-ēre* 'be silent' is reconstructed to be from IE *√*pteH₂k-* (LIV^2 495; related to Gr. πτώσσω 'shrink from', Arm. *t῾ak῾eaw* 'hid himself', Goth. *Þahan* 'to keep secret', OHG *dagēn* 'be silent' (but against this etymology cf. de Vaan 2008: 604–605; Untermann 2000: 731–332 reconstructs from *√*tak*(*H₁*)-).

The IE cluster **Ps* is fully preserved in Latin when word-internal, but spirantized, debuccalized (and often simplified) in Sabellic:

i. **P** + **s** > **ps**	(Latin)
ii. **P** + **s** > φs > hs > **0s**	(Sabellic)

Note: The cluster *#ps-* has another development: *#ps-* > *0s-* (cf. L. *sabulum* 'sand, gravel'), otherwise known from Sabellic. For this analogy we presume that the initial labial was also spirantized, debuccalized and elided: ***#ps-*** > *#φs-* > *#hs.* > *#0s-* (cf. Weiss 2009: 170, who does not give details on the trajectory).

The development attested in L. *crispus* 'curly', where **ps* > L. *sp* is an example of an unproductive cluster, where the metathesis of a sibilant (for the articulatory reasons) is attested, as in L. *vespa* 'wasp' (cf. Prus. *wobse*, Œ *wæfs*, CS *(*v*)*osь* (Weiss 2009: 170).

Note: As with the cluster of *Ks*, there is an alternative trajectory for the Sabellic cluster, with a sibilantization instead of debuccalization: ***Ps*** > *φs* > *ss* > ***0s***.

8.3.2 Development of the clusters *velar* + *t*/*s*

The developments of the cluster **Kt* are remarkably different : Latin preserved an original cluster, Sabellic clusters underwent a spirantization, followed by the debuccalization, the outcoming *h* is sometimes elided):

i. **K** + **t** > **kt**	(Latin)
ii. **K** + **t** > xt > **ht** (/> 0t)	(Sabellic)

Note: The velar (of any origin) is lost in clusters of *Rks* (R = any liquid): L. *fortis* 'strong, robust' (< OL. *forctis*); L. *ultus* 'revenge' (< **ulkto-*, cf. *ulcīscor*) (Meiser 1998: 123; de Vaan 2008: 236–237, 363–637).

Similarly, the IE cluster of **Ks* is realized in Latin as *ks* in the *inlaut* (cf. Meiser 1998: 116; Weiss 2009: 170). For the Sabellic development of the cluster of *Ks,* we can model the trajectory based on spirantization in the first phase, the spirant being later debuccalized and elided:

i. **K** + **s** > **ks** (Latin)
ii. **K** + **s** > xs > hs > **0s** (Sabellic)

Note: But for the word-initial cluster *Ks* in Latin we have to state a more complex development, similar to that of Sabellic, with a spirantization, debuccalization and elision: *#**Ks**- > #xs- > #hs- > #0s-*; cf. L. *sentis* 'thorn', *sentus* 'shrubby' (< **ksn̥-ti/to-*; cf. Gr. ξαίνω; Meiser 1998: 113).

Note: The alternative trajectory for the Sabellic languages differs in its middle phase, the spirant sibilantized and later elided: ***Ks*** *> xs > ss > 0s*.

8.3.3 Development of the clusters *palatovelar* + *t/s*

The palatovelar IE clusters of **Ḱt* and **Ḱs* are realized in Latin in precisely the same way as IE clusters of **Kt* and **Ks* (and *$K^{u}t$, *$K^{u}s$, cf. above), i.e, as *kt* and *ks* (cf. Meiser 1998: 116, 124–125; Weiss 2009: 170–171), the trajectories are hence the same. The same is valid for Sabellic languages.

8.3.4 Development of the clusters *labiovelar* + *t/s*

The development of the labiovelar series differs remarkably in both sub-branches: Latin preserved them, while in Sabellic they were lost, merged with labials.

Note: The labiovelar is regularly neutralized before labial vowels *o/u* (Sommer 1914: 187; Meiser 1998: 124–125; Baldi 1999: 278), cf. L. *colō* 'inhabit', OIA *cárati* 'move', Gr. πέλομαι, Doric τέλομαι 'become' < IE *√*ku̯elH₁*- (de Vaan 2008: 125); L. *oculus* 'eye', Gr. ὤψ, OCS *oko* < IE **H₃eKu̯*- (de Vaan 2009: 425).

The Latin labiovelars are neutralized before *t*-, which is probably an ancient Indo-European feature (cf. Meiser 1998: 116, 124–125). The development is hence the same as with plain velars (and assumed Indo-European palatovelars). The Sabellic development could not be reconstructed: the attested outcomes *kt* are, with the highest probability, secondary, since they are not spirantized. In clusters of -$Nk^{u}t$- the labiovelar is lost regularly, hence the proposed trajectory is more *constructed* than *reconstructed*:

i. $\mathbf{K^{u}}$ + **t** > **kt** (Latin)
ii. $\mathbf{K^{u}}$+ **t** > kt > xt > **ht** (Sabellic)

Similar ancient neutralization of a labiovelar is attested for the IE cluster of *$K^{u}s$ in Latin (cf. Meiser 1998: 116, 124–125; Weiss 2009: 170). Again, we lack enough Sabellic data to reconstruct the proper trajectory.

i. $\mathbf{K}^{\text{u̯}}$ **+ s > s** (Latin)
ii. $\mathbf{K}^{\text{u̯}}$**+ s** > ks > xs > hs > (**s**)**s** (?) (Sabellic)

8.3.5 Development of clusters *dental* + *t*/*s*

The outcomes of the Italic development, in general, exclude any possibility of considering *ss* an outcome of intermediate stage *st* (as in Balto-Slavic or Iranian), since the outcome of IE **st* is preserved as Latin *st* (see below). Hence, we have to reconstruct a trajectory not coming though an *st*-stage at all. The outcome *ss* is the same as for the IE clusters **Ts* and (as much as we dare say from scarce data) for IE **ss*.

The traditional trajectory assumed for the development of IE clusters of **Tt* was broadened especially under Brugmann's influence (first Brugmann 1880: 140–142, used since), though initially, the idea was by Kräuter (1877: 88)· This model assumes the affrication of the left plosive, followed by dissimilation (the **affrication trajectory**), merging at the same point with the development of clusters of *ss*/*Ts*. For Latin, it was proposed by Brugmann (1885: 183; 1890: 305); the affrication trajectory is already used by Stolz (1894: 315); later Leumann (1977: 197), Meiser (1998: 124), Görtzen (1998: 386–390), Baldi (1999: 287) or Weiss (2008: 173), for the Indo-European context cf. especially Szemerényi (1996: 103).

i. **T** + **t** > t^st > tss > (**s**)**s** (Italic)

Note: Meisser (1986: 36; 1998: 123–124) reconstructs: ***Tt*** > *$t^s t$* > *ts* > ***ss***; ***Ts*** > ***ss*** (accepted by Kümmel 2007: 376).

Inside the affrication trajectory, the minor development *Tt*(*r*) to L. *st*(*r*) could be modelled as: *TT*(*r*) > *$t^s t$*(*r*) > *st*(*r*), with *t*- restored, i.e. not within a sound law (von Planta 1892: 419–424; Buck 1904: 86–87; Leumann 1977: 197–198; Sihler 1995: 201–203; Meisser 1998: 124–125; Hill 2003: 226; Weiss 2009: 174), sinc ethe first element of the presumed affricate is lost.

Note: It is worth of notion that clusters of *plosive + s + plosive* are often simplified as *s + plosive*, as attested with: *suscipiō* 'take up' (*subs-capiō*), *sustineō* 'support' (*subs-teneō*), though otherwise the cluster is preserved: *subscrībō* 'write beneath' (Baldi 1999: 297). Examples of the loss of the first plosive in a cluster could be counter-examples against the affrication trajectory. Clear examples of the loss of the internal syllable but the sibilantization of the final dental are given by Stoltz (1894: 317), Leumann (1977: 197–198, 203), Sihler (1995: 198) or Meiser (1998: 117): L. *lustrō* 'make light', *illūstris* (= *in-lou̯k-stri-*) 'illustrious' vs *lūceō* 'shine' (with examples for clusters with final *p* or *k*, Meiser (1998: 117) states that *textus* and *extra* are results of the analogical restoration, not the old outcomes).[198]

[198] As a counter-example could serve nom. *dexter* "right', PN *Sextius*, not speaking about prefixed words (cf. Leumann 1977: 202–204; Sihler 1995: 198–199).

A different variant of the affrication model was proposed by Kent (1932a: 23; 1932b: 117–118), who proposes that the second dental plosive (of the suffix) was lost and the cluster became both merged with **Ts* and subsequently sibilantized with it:

i. **T** + **t** > t^st > tss > (**s**)**s** (Italic)

We propose an alternative trajectory (the **spirantization trajectory**), based on assumed spirantization, instead of affrication of the left dental, and later spirantization of the whole cluster and its sibilantization. The first to propose such a strategy for Latin was de Saussure (1877: 375)[199], followed by Cocchia (1883: 16–58) and Bartholomae (1887: 83), critically to this cf. Brugmann (1885: 183); Walde (1897: 487–492):

i. **T** + **t** > ϑt > ϑϑ > (**s**)**s** (Italic)

Within the spirantization trajectory, the aforementioned cases of the development **Tt*(*r*) > *st*(*r*) could be regularly modelled as: *Ttr* > *ϑtr* > *str*, with a spirant sibilantized regularly, analogically for **Tt* > *ϑt* > *st* as a minor development, which is phonetically entirely acceptable. It is a process parallel to the above-mentioned regular major development in the development of the first plosive, the second being preserved, since it is not spirantized before *r* (but cf. Hill 2003: 247; who attributes the different distribution of *ss/st* to the syllabic structure of a given word).

Similarly, the development of the cluster of **Ts* can follow either the affrication trajectory, with the affrication and simplification of the cluster, as with all such geminate clusters of various origins, it could be degeminated, especially after a long vowel (cf. Meiser 1998: 116; Baldi 1999: 287):

i. **T** + **s** > t^ss > tss > ts > (**s**)**s** (Italic)

A variant model by Kent (1932a: 23; 1932b: 117–118) fits within the proposed general features.

Furthermore, the alternative spirantization trajectory differs in the first stages by a spirantization first, followed by a sibilantization of the spirant, later often degeminated:

i. **T** + **s** > ϑs > (**s**)**s** (Italic)

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[199] De Saussure speaks of the development of -*d*+*t*- but there are no reasons do not apply it on all dental clusters.

8.3.6 Development of the clusters *sibilant + t/s*

The original IE clusters *st* are preserved both in Latin and in Sabellic; hence the trajectory is straightforward:

i. **S + t > st** (Italic)

For the IE cluster **ss* we also assume a simplification due to the degemination as *0s* for all Italic languages. In the case of the L. pr. *es* 'thou art' the simplification could be considered to be already Indo-European (cf. Kent 1932b: 127; Weiss 2009: 171). All attested clusters *ss* are of a later development: L. *esse*, *essem* etc. are morphemic restorations given by analogy. The later sequence *ss* of any origin is either preserved or degeminated according to different phonemic conditions, especially if following a long vowel (cf. Kent 1932b: 131–132; Baldi 1999: 287):

i. **S + s > (s)s** (Italic)

8.4 Conclusion and final remarks

Confronting the Sabellic and Latin data we see that the development of the clusters with dentals and clusters with sibilants are shared (not only within Italic but often outside, in the wider IE family), while the development of the peripheral series remarkably differ inside the family, Sabellic having the progressive, Latin the conservative attitude.

The dental clusters **Tt* and **Ts* are uniformly realized as Italic *ss* (as in Germanic and Celtic). Of both possible fricativization strategies, we prefer that of spirantization (as proposed by de Saussure and Cocchia) over affricativization (as developed by Kräuter and Brugmann) for the following reason: the affricativization trajectory of the **Ts* cluster assumes the intermediate $t^{s}s$, which is very improbable to be simplified as *ss*, but the intermediate *ϑs* cluster could be easily assimilated to *ss*. For the development of the **Tt* clusters, both trajectories are similarly probable. The spirantization trajectory can easily explain the development of the clusters of **Ttr*, resulting in Italic *str*: if the first plosive were affricativized, the structure of the cluster would be even more complex (*tstr*!), but within the spirantization trajectory the development is simpler: the left plosive is fricativized, the second is preserved as plosive before *r*, and the first is later regularly sibilantized (*ϑtr >str*).

The Sabellic languages used the spirantization/lenition trajectory even for the development of the peripheral series. That this gradual strategy is working is clear from Umbrian, where the Oscan *ft* is realized as *ht*, i.e., after the debuccalization of the spirant as a laryngeal approximant. Latin (besides the old Indo-European neutralization of the labial value of the labiovelars in both examined contexts) is without any process of this type (Italian later followed the trajectory of the gemination with the same clusters).

The cluster *st* is fully preserved; the cluster *ss* is usually degeminated, usually contextually driven (after long vowels, due to consonantal context forming a moraic length, etc.).

9 The development of the two-obstruent clusters from Indo-European into Celtic

9.0 Celtic languages and their branches

Within the Celtic language group at least three different sub-branches are distinguished:

i. the *Continental languages* (Gaulish, Celtiberian, Galatian etc.), attested only as relict inscriptions, quotations and proper names; all dead about 500 AD;

ii. *Brythonic languages* (Welsh, Cornish, Breton), with huge documentation since their Middle phase and (except Cornish) living languages until our days; all descending from Brittonic language, diverging since 500 AD;

iii. *Goidelic languages* (Irish, Scottish Gaelic, Manx), also with numerous documentation since its Middle phase and living languages (except Manx), all were descending from Irish Gaelic about 1000 AD.

Note: The second and third group are often considered sub-branches of *Insular Celtic*.

On the classification and mutual relationship between Celtic sub-branches, cf. Blažek 2009; Vath/Ziegler 2017: 1169–1170; MacAulay 1992: 1–8; McCone 1996: 67–104; Schijver 2007; Sims-Williams 2007; Sims-Williams 2017: 352.

Note: It was proposed many times (and also many times rejected) that Celtic languages form a branch inside the broader Italo-Celtic branch. From the point of the examined material, such idea is acceptable, but this specific and wider question (since affecting more fields of interests than just clusters of plosives and sibilants) is left aside (for further reading, cf. Watkins 1966; Schmidt 1991 as examples of the ʻnegative' approach, Kortlandt 1981; Eska 2010; Weiss 2012; as examples of the ʻpositive' approach).

9.1 Celtic and Indo-European

The typical features separating the Celtic obstruent system from that of Indo-European are:

i. the typical Common Celtic loss of IE **p*;
ii. the later loss of labiovelars, which are replaced either by labials (*P*-Celtic) or a velar (*Q*-Celtic);
iii. the merging of IE voiced plosives with voiced aspirated plosives[200];
iv. the sibilantization of **Tt* clusters;
v. spirantization of plosives in clusters of *peripheral plosive + t/s-*;
vi. the tendency of *s* either became *h* or disappear;
vii. the extensive processes of lenition and mutations (especially in Insular Celtic languages).

The first feature is a unique Celtic phenomenon (Armenian and Germanic *p* were subjected to a shift, but we cannot speak about a shift in Celtic); labiovelars are otherwise preserved in Latin (but not in other Italic languages) and Germanic, but the merging with labials is known from Sabellic, and Greek (beside merging with dentals or velars). The Continental languages and oldest attested forms of Goidelic have labiovelars preserved. The merging of the second and the third modal class are known from Baltic, Slavic, Iranian languages, so the Celtic process is an example of parallel development (a *drift*). The sibilantization of the IE **Tt* is a common IE

[200] Interesting feature of this development is IE *g^{u} > PCelt. *b* vs. IE *g^{uh} > PCelt. g^{u} (Cowgill 1980; Sims-Williams 1981; Sims-Williams 2007: 128; Sims-Williams 2017: 363 but contrary view has McCone 1996: 38–42, who argues for the merging of both IE phonemes before the delabialization of labiovelars).

process (Old Indo-Aryan being the particular case), and the outcome *ss* is attested even in both sub-branches of Italic and in Germanic (another case of a drift or an area development?). The spirantization of the peripheral plosives in clusters is known from Iranian, Sabellic and Slavic; the Celtic development is specific in merging of all fricatives in a single one, either Brythonic *i̯* or Goidelic *x*: the Continental fricative is also *x*, which represents the original state. The loss of *s* is known from Iranian and Greek, and again such processes are examples of independent drifts, not of a dialect continuum.

Both living sub-branches underwent deep and numerous phonemic and morphemic development; hence we will limit ourselves to etymological examples. Both living sub-branches are dealt with independently; the Continental languages will be represented by Gaulish (examples taken mainly from epigraphic sources and literary quotations either in Latin or Greek).

9.2 Brythonic clusters and their IE origins

A special feature of the Brythonic development, related to our objects of study, is the merge of old labiovelars with labials (as in Sabellic). Common Celtic *x* (of different origins) > *i̯* (cf. Sims-Williams 2017: 365).

9.2.1 The clusters *labial + t/s*

Similarly to all peripheral plosives in the contexts *t/s-*, the outcome of the labial plosive is a palatal approximant; the outcome of **Ps* is *x*:

P + t = Bryth. i̯t:

MW. *seith*, W. *saith*; OCorn. *syth*, MCorn. *seyth*, OBr. *seith*, MBr. *seiz* (< PCelt. **sextam* < IE **septem*; cf. OIA *saptá-*, L. *septem* ʽseven’; cf. Pokorny IEW: 909; GPC III: 3170; Greene 1992: 510, 515, 540; Blažek 1999: 248; Deshayes 2003: 648; Matasović 2009: 332);

MW. *nith*, Corn. *noith*, OBr. *nith*, MBr. *nyz* ʽniece’ (PCelt. **neftī*; < IE **neptiH₂*; cf. L. *neptis*, OHG *nift* ʽniece’; cf. Pokorny IEW: 764; GPC III: 2584; Deshayes 2003: 538; NIL 520–524; Matasović 2009: 286);

W. *caeth* ʽbond, captive’, OCorn. *caid* ʽcaptivus’, MBr. *quaez*, NBr. *keaz* ʽunlucky, poor’ (< PCelt. **kaxto-*; < IE *√*keH₂p-*; cf. L. *captus*, ON *haptr* ʽcaptus’; cf. Pokorny IEW: 527; GPC I: 384–385; LIV^2: 344–345; Deshayes 2003: 583; Matasović 2009: 197);

P + s = Bryth. x:

MW. *crych*, MBr. *crech* ʽcurly’ (if < PCelt. **kaxto-* with a metathesis < IE **kris-po-*; cf. L. *crispus, crispō* ʽcurly’; cf. Pedersen 1913 I: 75; Lewis/Pedersen 1937: 19; Pokorny IEW: 937–938; GPC I: 619; Deshayes 2003: 429; Matasović 2009: 226);

MW. *uch*, Corn. *ugh*, OBr. *uh*, Br. *uc’h* ʽabove, over’ (< PCelt. **ouxso* < IE **H₂eu̯p-so*; cf. Gr. ὕψῐ), W. *uchel*, Corn. *huhel*, OBr. *uchel*, *uhel* ʽhigh’ (< PCelt.**ouxselo-* < IE *

H_2e̯upselo-; cf. Pedersen 1909: 75; Lewis/Pedersen 1937: 19; Pokorny IEW: 1107; GPC IV: 3692–3693; Deshayes 2003: 755; Matasović 2009: 303);

9.2.2 The clusters *velar+ t/s*

Plain velar plosives are lenited as *i̯* before *t-*, the cluster of **Ks* is realized as *x*:

K + t = Bryth.i̯t:

MW. *mwyth* ʽluxury, ease, pleasure’ (< PCelt. **muxto-*; < IE **√meu̯k-t-*; cf. L. *mūcor* ʽmould’, Gr. μύξᾰ ʽmucus’; cf. Pokorny IEW: 744–745; de Bernardo Stempel 1999: 438; GPC III: 2525; LIV^2: 443–444; Matasović 2009: 282);

K + s = Bryth. x:

MW. *trech* ʽstronger’, Corn. *tragh* ʽvictorious’, MBr. *vrech* ʽvictory’ (< PCelt. **trex-so*; < IE **treg-*; cf. OE *Þragjan* ʽcourage’, ON *Þrekr* ʽstrength’; cf. Pokorny IEW: 1090; Schrijver 1995: 136; de Bernardo Stempel 1999: 252, 258, 389; GPC IV: 3571; Deshayes 2003: 739; Matasović 2009: 389–390);

9. 2.3 The clusters *palatovelar + t/s*

Since there is no distinction between assumed IE plain and palatovelar plosives, Celtic being a *centum*-language, the outcome of **Ḱt* is equal to that of **Kt* and **Ḱs* to that of **Ks*:

Ḱ + t = Bryth.i̯t:

OW. *oith*, MW. *wyth*, Corn. *eath*, OBr. *eith*, MBr. *eiz* ʽeight’ (< PCelt. **oxtū* < IE **oḱtō*; cf. L. *octō,* Goth. *ahtau*; cf. Lewis/Pedersen 1937: 41; Pokorny IEW: 775; GPC III: 3746; Greene 1992: 510–511, 540; Blažek 1999: 266; Schrijver 1995: 350; Deshayes 2003: 212; Matasović 2009: 304);

MW. *amaeth* ʽploughman, tiller’, OBr. *ambaith* (< PCelt. **ambi-aktos*; < IE **√H_2eǵ-*; cf. Pokorny IEW: 4; LIV^2: 255–256; Schumacher 2007: 189–193; NIL 267–267; Matasović 2009: 32);

OW. *rhaith*, MW. *reyth* ʽlaw, sermon, jury, verdict’, Br. *reiz* ʽorder, law, right’ (< PCelt. **rextu-* < IE **√H_3reǵ-*; cf. L. *rēctus*, Goth. *raihts*; cf. Lewis/Pedersen 1937: 42; Pokorny IEW: 854–857; GPC III: 3033; Bernardo Stempel 1999: 291; LIV^2: 304; Schumacher 2007: 530–534; Deshayes 2003: 619; Matasović 2009: 310–311);

MW. *gweith* ʽwork, act; time, -times’, OCorn. *gueid,* MCorn. *gweth, gwyth* ʽ-times’, OBr. *gueid* ʽtime’, MBr. *gwez, gweach* ʽ-times’ (< PCelt. **u̯extā*; < IE **√u̯eǵ^h-*; cf. L. *vector, vectis* ʽcarry’, OCS *vezti* ʽcarry’; cf. Pokorny IEW: 1118–1120; GPC II: 1563; LIV^2: 661–662; Deshayes 2003: 309; Matasović 2009: 419–420);

MW. *lled-brith* ʽcharm’, OBr. *brith* ʽincantation’ (< PCelt. **brixtu/o-*; < IE **√b^{h}erǵ^h-*; cf. OIA *brahmán-*, ON *bragr*; cf. Pokorny IEW: 139; Delamarre 2003: 90; NIL 30–34; Matasović 2009: 79–80);[201]

Ḱ + s = Bryth. x:

MW. *echel,* MBr. *ahel* ʽaxis’ (< PCelt. **axsilā*; < IE **H_2eḱs-*; cf. OIA *ákṣa-*, L. *axis* ʽaxle’; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 6; GPC I: 1160; Deshayes 2003: 53; NIL 259–262; Matasović 2009: 50);

[201] The connection to the reconstructed IE root is disputed (cf. l.c.).

MW. *deheu, dehau* ʻto the right, to the south’, OCorn. *dehow, dyghow,* OBret. *dehou* (< PCelt. **dexs(o)u̯o-* < IE **deḱsu̯o*; cf. Gr. Gr. δεξῐτερός ʻon the right hand or side’, L. *dexter*; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 190; GPC I: 999; Deshayes 2003: 174; Matasović 2009: 97);

MW. *chwe(ch*), Corn. *whe*(*gh*), MBr. *huech*, Br. *c’houec’h* ʻsix’ (< PCelt. **su̯exs* < IE **su̯eḱs;* cf. Gr. ἕξ, L. *sex* ʻsix’; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 1044; GPC I: 864; Greene 1992: 510–511, 515, 539–540; Blažek 1999: 237; Deshayes 2003: 164; Delamarre 2003: 285–286; Matasović 2009: 364);

MW. *ech*, *eh*, OBret. *ech* ʻout of, from’ (< PCelt. **exs-* < IE **H_1esǵs-*; cf. L. *ex*, Lith. *iš*; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 292; Pokorny 1969: 24; GPC I: 1160; Delamarre 2003: 169; Matasović 2009: 119);

MW. *nych* ʻpainʻ (< PCelt. *nexso-* < IE **neḱ-*; cf. OIA *naṣṭá-* ʻbe lost’, L. *necō* ʻkill, say’; cf. Pokorny IEW: 762; GPC I: 49; GPC III: 2602; de Bernardo Stempel 1999: 97; Deshayes 2003: 65, 534; Matasović 2009: 37–38, 39, 290);

9.2.4 The clusters *labiovelar + t/s*

In Brythonic, the old IE labiovelars have merged with labials in all contexts; hence all outcomes are equal to those of labiovelars in the same contexts. In fact, due to the development of plosives before *t-/s-*, the outcomes are the same for all peripheral plosives:

Kᵘ̯ + t = Bryth. i̯t:

OW. *he-noid* ʻtonight’, MW. *peu-noeth* ʻevery night’, Corn. *haneth*, MBr. *hanoez* ʻtonight’, (PCelt. **noxt-* < IE **nokᵘ̯-t-* ; cf. L. *nox, noctis,* Goth. *nahts*; cf. Lewis/Pedersen 1937: 41; Pokorny IEW: 762–763; GPC III: 2790; LIV²: 449; de Bernardo Stempel 1999: 36; Delamarre 2003 : 237; NIL 504–513; Matasović 2009: 293–294);

MW. *gwaethl* ʻdispute’ (< PCelt. **u̯oxtlo-* ; < IE **u̯okᵘ̯-*; cf. OIA *vā́k-*, L. *uōx* ʻvoice’; cf. Pokorny IEW: 1135–1136; GPC II: 1552; de Bernardo Stempel 1999: 229; LIV² 673–674; Matasović 2009: 428–429);

OW. *noid*, MW. *noeth*, Corn. *noyth, noeth*, OBr. *noit*, MBr. *noaz* ʻnaked’ (< PCelt. **noxto-* < IE **nogᵘ̯to-*; cf. Goth. *naqaÞs*, OHG *nackut, nachut* ʻnaked’; cf. Pokorny IEW: 769; GPC III: 2592; de Bernardo Stempel 1999: 440; Deshayes 2003: 539; NIL 513–515; Matasović 2009: 294) ;

Kᵘ̯ + s = Bryth. x:

W. *ych* ʻox’ (< PCelt. **uxso-* < IE **√u̯egᵘ̯-*; cf. OIA *ukṣan-* ʻbull’, OHG *ohso* ʻox’; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 1118; GPC III: 3749; LIV² 602–603; Deshayes 2003: 544; NIL 368–370; Matasović 2009: 400–401);

MW. *techu*, Corn. *têgh*, MBr. *tec'hed* ʻflee’ (< IE **√tekᵘ̯-*; cf. OIA *takti* ʻshoots away’, OCS *tĕchъ* ʻrun’; cf. Pedersen 1913: 639; Pokorny IEW: 1059–1160; LIV² 620–621; Deshayes 2003 : 717; Schumacher 2007: 629–631; Matasović 2009: 377);

9.2.5 The clusters *dental + t/s*

In both sub-branches of Celtic languages, as in Italic and Germanic, the outcome of the IE cluster **Tt* is *ss*, often simplified to *0s*, and the same outcome is valid for IE cluster **Ts*:

T + t = Bryth. 0s:

W. *ys* 'he eats' (< PCelt. **ed-ti* < IE *√*H₁ed-*; cf. OIA *átti*; cf. Pokorny IEW: 287; LIV^2: 230–321; GPC IV: 3821; Schumacher 2007: 377–380; Matasović 2009: 113);

W. *gwys* 'knowledge', MBr. *gous* 'would be known' (< IE **u̯id-to-s*; cf. L. *uīsus* 'seen', OIA *vitti-* 'know'; cf. Jackson 1953: 531; Pokorny IEW: 1125–1127; GPC II: 1745, 1752; Schrijver 1995: 404; LIV^2: 665–667; Hill 2003: 257; Schumacher 2007: 664–669, 690–701; NIL 717–722; Matasović 2009: 407–408; 422–423);

MW. *moes* 'custom, habit', MBr. *boas* (< PCelt. **banssu-*; < IE *√*b^{h}end^h-*; cf. OIA *bándhati* 'bind', Goth. *bindan* 'bind'; cf. Pokorny IEW: 127; GPC III: 2476; LIV^2: 75; Hill 2003: 258; Deshayes 2003: 117; Matasović 2009: 55);

OW. *guecrissou*, MW. *crys* 'girdle, shirt', OCorn. *kreis* 'camisia', MBr. *cres* 'shirt' (< PCelt. **kris-su-* < IE **kr̥d^h-tu.*; cf. Ru. *čérez* 'girdle'; cf. Lewis/Pedersen 1937: 21; Pokorny IEW: 279; de Bernardo Stempel 1999: 262, 574; Deshayes 2003: 431; Matasović 2009: 225);

T + s = 0s:

W. *is* 'lower' (< PCelt. **fissu* < IE **ped-su* (loc. pl.); OIA *pad-*, L. *pēs* 'foot'; cf. Lewis/Pedersen 1937: 21; Pokorny IEW: 790–792; GPC II: 2031; NIL 520–540; Matasović 2009: 131);

OW. *nes, nesaf*, Corn. *nes, nessa*, MBr. *nes, nessaff* 'close' (< PCelt. **nesso-* < IE **Hned-skō*; cf. Os. *nessimas* 'proximae', OHG *nezzi* 'net'; cf. Lewis/Pedersen 1937: 21; Pokorny IEW: 758; GPC III: 2573; McCone 1996: 48; Deshayes 2003: 535; Matasović 2009: 289–290);[202]

9.2.6 The clusters *sibilant + t/s*

A general feature of the Celtic development, present also in Brythonic, is the loss of the plosive in **sC* clusters (cf. Stifter 2017: 68). The outcome of IE cluster **ss* is not securely identifiable (cf. Pedersen 1909: 75; Lewis/Pedersen 1937: 18):

S + t = ss:[203]

OW. *serenn*, MW. *ser, syr*, OCorn. *steren*, MBr. *sterenn* 'star' (< PCelt. **sterā-* < IE **H₂stēr-*; cf. Gr. ἀστήρ 'star', L. *stella* 'star'; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 1128; GPC III: 3226; de Bernardo Stempel 1999: 47; Delamarre 2003: 282; NIL 348–354; Matasović 2009: 355);

MW. *assen*, Corn. *asen* 'rib' (< PCelt. **astn(ii̯)o-* < IE **H₂ostH₁-*; cf. Hitt. *hastāi-*, OIA *ásthi-*, L. *os, ossis*; cf. Pokorny IEW: 783; GPC I: 219, 1198; de Bernardo Stempel 1999: 368; Schrijver 1995: 53–54; Matasović 2009: 44–45);

OW. PN *Con-bresel*, Corn. *bresel*, MBr. *brezel, bresel* 'war' (< PCelt. **brestā* < IE **b^{h}res-t-*; cf. OHG *brestan*; cf. Pokorny IEW: 166–167; Deshayes 2003: 135; Matasović 2009: 76–77);[204]

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202 Matasović (l.c.) assume either *√*Hned-t-* or *√*Hned-s-*, NIL (590–600) relates to IE *√*sed-*.

203 Schrijver (1995: 406) argues that there are instances when *-st-* is preserved in Brythonic (cf. for list of items, cf. Schrijver 1995: 410-413). Since some examples are dubious and other could be results of an analogy, but definitely not the results of a sound law, we do not repeat his list here.

204 According to Pokorny IEW and LIV^2, (l.c.) the root is *√*b^{h}rei̯-*, enlarged by *-s*. The cognates then are: L. *friō* "break, crumble", RuCS *briti* "shave, cut".

MW. *bys*, OCorn. *bis, bes*, Bret. *biz, bis* ʻfinger’ (< PCelt. **bisti-* ʻfinger’ < IE **g^uis-ti-*; cf. ON. *kvistr-* ʻbranch’, Alb. *gisht* ʻfinger’; cf. Pokorny IEW: 481; GPC I: 367; Deshayes 2003: 111; Matasović 2009: 66–67);

9.2.7 Overview of Brythonic development

In the overview are the regular outcomes of IE clusters in reconstructed Brythonic. The outcome of the IE cluster **ss*, since not directly attested, is reconstructed by analogy and in brackets.

IE	**Brythonic**	t-	s-
-k̯ᵘ/g̯ᵘ/g̯ᵘʰ	-p/b	*i̯t*	*x*
-k/g/gʰ	-k/g	*i̯t*	*x*
-ḱ/ǵ/ǵʰ	-k/g	*i̯t*	*x*
-t/d/dʰ	-t/d	*0s*	*0s*
-p/b/bʰ	-0/b	*i̯t*	*0x*
-s	-s	*0s*	(*0s*)

9.3 Goidelic clusters and their IE origins

In contrast to Brythonic, Goidelic preserved old labiovelars for a longer period but finally merged them with plain velars (this development is typical otherwise for *satəm*-languages, but it is also partially attested in Greek). Again, in contrast to Brythonic, old *x* (a result of a spirantization before a plosive) is preserved (cf. Sims-Williams 2017: 366), Goidelic hence being generally more conservative in the development of the consonantal clusters than Brythonic languages.

9.3.1 The clusters *labial* + *t/s*

IE labials are realized as *x* before *t-* and as *s* before *s-*, similarly to all velar plosives:

P + t = Goid. xt:

Ir. *secht* *^N* ʻseven’ *seiz* (< PCelt. **sextam* < IE **septem*; cf. OIA *saptá-*, L. *septem* ʻseven’; cf. Pokorny IEW: 909; LEIA S-66; Greene 1992: 510, 515, 540; Blažek 1999: 248; Matasović 2009: 332);

OIr. *necht* ʻniece’ (PCelt. **neftī* < IE **neptiH₂*; cf. L. *neptis*, OHG *nift* ʻniece’; cf. Pokorny IEW: 764; LEIA N-15; NIL: 520–524; Matasović 2009: 286);

OIr. *cacht* ʻfemale slave’, Ir. *cath* ʻservant’ (< PCelt. **kaxto-* < IE *√*keH₂p-*; cf. L. *captus*, ON *haptr* ʻcaptus’; cf. Pokorny IEW: 527; LEIA C-261; LIV²: 344–345; Matasović 2009: 197);

P + s = Goid. 0s:

OIr. *úas, ōs* ʻabove, over’ (< PCelt. **ouxso* < IE **H₂eu̯p-so*; cf. Gr. ὕψι), OIr. *ūasal* ʻhigh’ (< PCelt.**ouxselo-* < IE * *H₂eu̯pselo-*; cf. Pedersen 1909: 75; Lewis/Pedersen 1937: 19; Pokorny IEW: 1107; Matasović 2009: 303);

9.3.2 The clusters *velar + t/s*

Plain velar plosives are lenited as *x* before *t-*; the cluster of **Ks* is realized as *0s*:

K + t = Goid. xt:

MIr. *rucht* ʽtunic, mantle' (< PCelt. **rouk-tu*; < IE *√*Hreu̯k-*;[205] cf. W. *rhuch* ʽfilm, pellicle, jerkin, coat'; cf. Pokorny IEW: 867; LEIA R-50; Matasović 2009: 317–318);

OIr. *ucht* ʽbreast' (< PCelt. **fextu* < IE **pektu-*; cf. OIA *pákṣa-* ʽshoulder', L. *pectus* ʽbreast'; cf. Pokorny IEW: 792; LEIA U-14–15; de Vaan 2008: 453; Matasović 2009: 130);

MIr. *mocht* ʽsoft, tender' (< PCelt. **muxto-* < IE **meu̯kt-t* cf. L. *mūcor* ʽmould', Gr. μύξᾰ ʽmucus'; cf. Pokorny IEW: 744–745; LEIA M-58;de Bernardo Stempel 1999: 438; LIV²: 443–444; Matasović 2009: 282);

K + s = Goid. ss:

OIr. *tress* ʽfight' (< PCelt. **tregso*; < IE *√*treg-*; cf. OE *Þragjan* ʽcourage', ON *Þrekr* ʽstrength'; cf. Pokorny IEW: 1090; LEIA T-136; Schrijver 1995: 136; de Bernardo Stempel 1999: 252, 258, 389; Matasović 2009: 389–390);

9.3.3 The clusters *palatovelar + t/s*

Since the palatavelar plosives clusters of *Ḱt* have merged with plain velars, they are lenized as *x* before *t*; the cluster of **Ks* is realized as *0s,* as in the case with plain velars, labiovelars and labials:

Ḱ + t = Goid. xt:

OIr. *écht* ʽslaughterʽ (< PCelt. **anxtu-* < IE **neḱ-tu-*; cf. OIA *naśyati* ʽbe lost', L. *necō* ʽkill, say'; cf. Pokorny IEW: 762; LEIA N-11; de Bernardo Stempel 1999: 97; Matasović 2009: 37–38, 39, 290–291);

Ir. *ocht* ᴺ ʽeight' (< PCelt. **oxtū* < IE **oḱtō*; cf. L. *octō,* Goth. *ahtau*; cf. Lewis/Pedersen 1937: 41; Pokorny IEW: 775; LEIA O-7; Greene 1992: 510–511, 540; Blažek 1999: 266; Matasović 2009: 304);

OIr. *recht* ʽlaw' (< PCelt. **rextu-* < IE *√*H₃reǵ-*; cf. L. *rēctus*, Goth. *raihts*; cf. Lewis/Pedersen 1937: 42; Pokorny IEW: 854–857; LEIA R-12; Bernardo Stempel 1999: 291; LIV²: 304; Schumacher 2007: 530–534; Matasović 2009: 310–311);

OIr. *bricht* ʽmagical formula' (< PCelt. **brixtu/o-* < IE *√*bʰerǵʰ-*; cf. OIA *brahmán-*, ON *bragr*; cf. Pokorny IEW: 139; LEIA B-89; Delamarre 2003: 90; NIL 30–34; Matasović 2009: 79–80);

OIr. *fecht* ʽtravel, time, -times' (< PCelt. **u̯extā*; < IE *√*u̯eǵʰ-*; cf. L. *vector*, *vectis* ʽcarry', OCS *vezti* ʽcarry'; cf. Pokorny IEW: 1118–1120; LIV²: 661–662; Matasović 2009: 419–420);

Ḱ + s = Goid. ss:

MIr. *aiss* ʽback'[206] (< PCelt. **axsilā*; < IE **H₂eḱs-*; cf. OIA *ákṣa-*, L. *axis* ʽaxle'; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 6; LEIA A-50; Greene 1992: 510–511, 515, 539–540; NIL 259–262; Matasović 2009: 50);

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[205] Pokorny (l.c.) reconstructs **reu̯ǵ-*.

[206] Cf. Matasović (2009: 50) on the semantic motivation.

OIr. *dess* ʽto the right, to the south’ (< PCelt. **dexs*(*o*)*u̯o*- < IE **deḱsu̯o*; cf. Gr. δεξῐτερός ʽright hand’; L. *dexter*; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 190; LEIA D-61–62; Matasović 2009: 97);
OIr. *sesser* ʽsix men’[207] (< PCelt. **su̯exs* < IE **su̯eḱs*; cf. Gr. ἕξ ʽsix’, L. *sex* ʽsix’; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 1044; LEIA S-59; Blažek 1999: 237; Delamarre 2003: 285–286; Matasović 2009: 364);
OIr. *ess*-, *ass*- ʽout of, from’ (< PCelt. **exs*- < IE **H₁esǵs*-; cf. L. *ex,* Lith. *iš*; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 292; Pokorny 1969: 24; Delamarre 2003: 169; Matasović 2009: 119);
OIr. *ness* ʽwoundʽ (< PCelt. **nexso*- < IE **neḱ*-; cf. OIA *naṣṭá*- ʽbe lost’, L. *necō* ʽkill, say’; cf. Pokorny IEW: 762; LEIA N-11; de Bernardo Stempel 1999: 97; Matasović 2009: 37–38, 39, 290);

9.3.4 The clusters *labiovelar + t/s*

As all peripheral plosives are, labiovelars are realized as *x* in the context of *t*- and as a sibilant before *s*-:

Kᵘ + t = Goid. xt:
Ir. *in-nocht* ʽtonight’ (< PCelt. **noxt*- < IE **nokᵘt*- ; cf. L. *nox, noctis*, Goth. *nahts*; Lewis/Pedersen 1937: 41; Pokorny IEW: 762–763; LEIA N-19; LIV²: 449; NIL: 504–513; Matasović 2009: 293–294) ;
Ir. *nocht* ʽnaked’ < PCelt. **noxto*- < IE **nogᵘto*-; cf. Goth. *naqaÞs*, OHG *nackut, nachut*; Pokorny IEW: 769; LEIA N-19; de Bernardo Stempel 1999: 440; NIL: 513–515; Matasović 2009: 294) ;
Ir. *snecht*(*a*)*e* ʽrains’ (with *t*-suffix, cf. Gr. νῐφετὸς ʽfalling snow, snowstorm’, L. *nix* < IE **snei̯gᵘʰtos*; cf. Pokorny IEW: 974; LEIA S-153; LIV²: 573; Schumacher 2007: 597–598; NIL: 622–623; Matasović 2009: 349)

Kᵘ + s = Goid. ss:
Ir. *oss* ʽstag, cow’ (< **uxso*- < **ukᵘsō* < *√*u̯egᵘ*-; cf. OIA *ukṣan*- ʽbull’, OHG *ohso* ʽox’; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 1118; LEIA O-34; LIV² 602–603; NIL: 368–370; Matasović 2009: 400–401);
OIr. *no-tes* ʽflee’ (< IE *√*tekᵘ*-; cf. OIA *takti* ʽshoots away’, OCS *těchъ* ʽrun’; cf. Pedersen 1913: 639; Pokorny IEW: 1059–1160; LEIA T-40; LIV² 620–621; Schumacher 2007: 629–631; Matasović 2009: 377);

9.3.5 The clusters *dental + t/s*

Both IE clusters of **Tt* and **Ts* are realized as Goidelic *ss*:

T + t = Goid. ss:
Ir. *fiuss* ʽknowledge’ (< IE **u̯id-to-s*; cf. L. *uīsus* ʽseen’, OIA *vitti*-; cf. Pokorny IEW: 1126; Schrijver 1995: 404; LIV²: 665–667; Hill 2003: 258; Schumacher 2007: 664–669, 690–701; NIL 717–722; Matasović 2009: 407–408; 422–423);
OIr. *bés* (< PCelt. **banssu*-; < IE *√*bʰendʰ*-; cf. OIA *bándhati* ʽbind’, Goth. *bindan* ʽbind’; cf. Pokorny IEW: 127; LEIA B-43; LIV²: 75; Hill 2003: 257; Matasović 2009: 55);

[207] Note that *-er* < *fer* < **u̯īros*; Blažek (1999: 237).

Ir. *cri*(*u*)*ss* ʽgirdle’ (< PCelt. **kris-su-* < IE **kr̥d*^{h}*-tu.*; cf. Ru. *čérez* ʽgirdle’; cf. Lewis/Pedersen 1937: 21; Pokorny IEW: 279; LEIA C-238–239; de Bernardo Stempel 1999: 262, 574; Matasović 2009: 225);

OIr, *mess* ʽjudgement’ (< IE **med-tu-*; cf. MW. *meddu* ʽpossess, rule’, L. *modus* ʽmeasure’, Goth. *mitan* ʽmeasure’; cf. Pokorny IEW: 705–706; LEIA M-48–49; Lambert 1994: 44; LIV^2: 423; Hill 2003: 257; Delamarre 2003: 223; Schumacher 2007: 478–483; NIL: 463–465; Matasović 2009: 261);

T + s = Goid. ss:

OIr. *ís* ʽbelow, under’ (< PCelt. **fissu* < IE **ped-su* (loc. pl.); OIA *pad-*, L. *pēs* ʽfoot’; cf. Lewis/Pedersen 1937: 21; Pokorny IEW: 790–792; de Bernardo Stempel 1999: 31; NIL 520–540; Matasović 2009: 131);

Ir. *nessa, nessam* ʽnearer, nearest’ (< PCelt. **nesso-* < IE **Hned-skō*; cf. Os. *nessimas* ʽproximae’, OHG *nezzi* ʽnet’; cf. Lewis/Pedersen 1937: 21; Pokorny IEW: 758; LEIA N-12; McCone 1996: 48; Matasović 2009: 289–290);[208]

Ir. *īss* ʽwill eat’ (< **i-ed-s-*; < IE *√*H_1ed-*; cf. OIA *atsyáti*; cf. Pokorny IEW: 287; LIV^2: 230; Schumacher 2007: 377–380; Matasović 2009: 113);

9.3.6 The clusters *sibilant+ t/s*

The IE cluster of **sT* is realized as *ss* (or simplified as *0s*) (as generally clusters of **sC* are; cf. Stifter 2017: 68), there is probably only one “secure” outcome of the IE cluster **ss* again (cf. Pedersen 1909: 75; Lewis/Pedersen 1937: 18):

S + t = Goid. (s)s:

OIr. *ser* ʽstar’ (< PCelt. **sterā-* < IE **H_2stēr*; cf. L. *stella*; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 1128; LEIA S-90; de Bernardo Stempel 1999: 47; Delamarre 2003: 282; NIL 348–354; Matasović 2009: 355);

OIr. *bres* ʽfight, combat’, PN *Bres-*(*u*)*al* (< PCelt. **brestā* < IE **b*^{h}*res-t-*; cf. OHG *brestan*; cf. Pokorny IEW: 166–167; LEIA B-86; Matasović 2009: 76–77);[209]

OIr. *asna, esna* ʽrib’ (< PCelt. **astn*(*ii̯*)*o-* < IE **H_2ostH_1-*; cf. Hitt. *hastāi-*, OIA *ásthi-*, L. *os, ossis* ʽbone’; cf. Pokorny IEW: 783; de Bernardo Stempel 1999: 368; Schrijver 1995: 53–54; Matasović 2009: 44–45);

MIr. *bissig ega* (dat.pl.) ʽicicle’ (< PCelt. **bisti-* ʽfinger’ < IE **g*^{u}*is-ti-*; cf. ON. *kvistr-* ʽbranch’, Alb. *gisht* ʽfinger’; cf. Pokorny IEW: 481; LEIA B-53; Delamarre 2003: 76; Matasović 2009: 66–67);

S + s = Goid. ss:

OIr. *céiss* ʽlike to create’ (< **keis-*; < IE *√*kēi̯*(*s*)-; cf. Gr. κίω ʽgo away’ L. *cieō* ʽput in motion’; cf. Pedersen 1913: 490–491; Pokorny IEW: 538–539; Schumacher 2007: 391–393);

[208] Matasović (l.c.) assume either *√*Hned-t-* or *√*Hned-s-*, NIL (590–600) relates to IE *√*sed-*.

[209] According to Pokorny IEW and LIV^2, (l.c.) the root is *√*b*^{h}*rei̯-*, enlarged by -*s*, the cognates then are: L. *friō* “break, crumble”, RuCS *briti* “shave, cut”.

9.3.7 The overview of the Goidelic development

The IE peripheral clusters tend to form a cluster of *xt* in the *t*-contexts. The clusters of **Tt* and all clusters formed in the sibilant context are realized as *ss*:

IE	**Goidelic**	t-	s-
-kᵘ̯/gᵘ̯/gᵘ̯ʰ	k/b/g	*xt*	*ss*
-k/g/gʰ	k/g	*xt*	*ss*
-ḱ/ǵ/ǵʰ	k/g	*xt*	*ss*
-t/d/dʰ	t/d	*ss*	*ss*
-p/b/bʰ	0/b	*xt*	*ss*
-s	s	*ss*	*ss*

9.4 Gaulish clusters and their IE origins

Gaulish development has more archaic features that than Insular languages, preserving spirants before **s*. Since we have only a limited data pool to work with, our examples are usually onomastic.

Only attested cluster are listed, sources are quoted continuously:

9.4.1 The clusters *labial* + *t/s*

The labial clusters develop in exactly the same way as velar clusters in the same context:

P + t = Gal. xt:

Gal.(–L.) *Pagus Sextan-mandu*[*us*] (CIL XIII 3149) (< PCelt. **sextam* < IE **septem*; cf. L. *septem* ʽseven'; cf. Pokorny IEW: 909; Evans 1967: 223; Lambert 1994: 44; Greene 1992: 510, 515, 540; Blažek 1999: 248; Matasović 2009: 332);

Gal. PN *Caxtos* (< PCelt. **kaxto-* < IE *√*keH₂p*-; cf. L. *captus*, ON *haptr* ʽcaptus'; cf. Pokorny IEW: 527; Delamarre 2003: 112; LIV²: 344–345; Matasović 2009: 197);

P + s = Gal. xs:

Gal. PN *Crixus*, *Crixsus* (< PCelt. **kaxto-* after a metathesis < IE **kris-po*-; cf. L. *crispus, crispō*; cf. Pedersen 1909: 75; Lewis/Pedersen 1937: 19; Evans 1967: 398, 445; Delamarre 2003: 130; Matasović 2009: 226);

Gal. TN Οὔξελον, *Uxello-dūnum*, *Uxama* (< PCelt.**ouxselo* < IE **oupselo*-; cf. Pedersen 1909: 75; Lewis/Pedersen 1937: 19; Pokorny IEW: 1107; Lambert 1994: 44; Delamarre 2003: 330);

9.4.2 The clusters *velar* + *t/s*

The IE cluster of **Ks* is realized as Gaulish *x*, the cluster of **Kt* is not attested, and outcomes are the same for IE clusters of **Ḱt* and **Ḱs*:

K + s = Gal. x:

Gal. PN *Trexius*, *Trexa*, *Trenus* (< PCelt. **trexso*-; < IE **treg*-; cf. OE *Þraka* ʽcourage', ON *Þrekr* ʽstrength'; cf. Pokorny IEW: 1090; de Bernardo Stempel 1999: 252, 258, 389; Delamarre 2003: 301; Matasović 2009: 389–390);

9.4.3 The clusters *palatovelar* + *t/s*

The old IE palatovelars merged with old plain velars. The outcome of a **Ḱt* cluster is *xt*, and of **Ḱs* is *xs*:

Ḱ + t = Gal. xt:

Gal. *oxtumetos* ʽeight' (< PCelt. **oxtū-m-* < IE **oḱto-*; cf. L. *octō,* Goth. *ahtau* ʽeight'; cf. Lewis/Pedersen 1937: 41; Pokorny IEW: 775; Greene 1992: 510–511, 540; Blažek 1999: 266; Delamarre 2003: 304; Matasović 2009: 304);

Gal.(–L.) *ambactus* ʽservant' (< PCelt. **ambi-aktos* < IE *√H_2*eǵ-*; cf. Pokorny IEW: 4; Evans 1967: 128, 135–136; LIV²: 255–256; Delamarre 2003: 40; Schumacher 2007: 189–193; NIL 267–267; Matasović 2009: 32);

Gal. PN *Rextu-genus* (< PCelt. **rextu-* < IE *√H_3*reǵ-*; cf. L. *rēctum*, Goth. *raihts* ʽright'; cf. Lewis/Pedersen 1937: 42; Pokorny IEW: 854–857; Evans 1967: 109; Bernardo Stempel 1999: 291; Delamarre 2003: 255; LIV²: 304; Schumacher 2007: 530–534; Matasović 2009: 310–311);

Gal. *brixtia* (Chamalières) (< PCelt. **brixtu/o-* < IE *√*bʰerǵʰ-*; cf. OIA *brahmán-*, ON *bragr*; cf. Delamarre 2003: 90; Matasović 2009: 79–80);

Gal. PN *Vectirix*, *Vecturius* (< PCelt. **u̯extā*; < IE *√*u̯eǵʰ-*; cf. L. *vector, vectis* ʽcarry', OCS *vezti* ʽcarry'; cf. Pokorny IEW: 1118–1120; Evans 1967: 281; Delamarre 2003: 309; LIV²: 661–662; Matasović 2009: 419);

Ḱ + s = Gal. xs:

Ga. (La Graufesenque) *suexos* ʽsixth' (< **su̯eḱsos* < IE **su̯eḱs*; cf. Gr. ἕξ, L. *sex* ʽsix'; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 1044; Greene 1992: 510–511, 515, 539–540; Blažek 1999: 237; Delamarre 2003: 285–286; Matasović 2009: 364);

Gall. PN *Dexsiua* (< PCelt. **dexs(o)u̯o-* < IE **deḱsu̯o-*; cf. Gr. δεξῐτερός ʽright hand'; L. *dexter*; Lewis/Pedersen 1937: 20; Pokorny IEW: 190; de Bernardo Stempel 1999: 212, Delamarre 2003: 143; Matasović 2009: 97);

Gal. *ex-* (< PCelt. **exs-* < IE *H_1*esǵs-*; cf. L. *ex,* Lith. *iš*; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 292; Evans 1967: 398; Pokorny 1969: 24; Delamarre 2003: 169; Matasović 2009: 119);

9.4.4 The clusters *labiovelar* + *t/s*

There are no secure data on the development of IE labiovelars in contexts of *t/s-*.

9.4.5 The clusters *dental* + *t/s*

Both clusters **Tt* and **Ts* are often realized in ʽtau gallicum', usually considered to be a dental affricate (but also a dental fricative, cf. Evans 1967: 398), here marked always as *đ.* Note that the same symbol could express **st*.

Note: The phonemic nature of ʽtau gallicum' is assumed either as a dental affricate, fricative or sibilant (cf. Dottin 1920: 48; Weisgerber 1935: 317; Schmidt 1957: 101; Evans 1967: 419) or a lenited *t* (Eska 1998: 120–125).

T + t = Gal. đđ/ss:

Gal. PN *Međđu-gnatus*, *Međđi-gnatius*, Μεθθιλος, *Meθilos*, *Messillus*, *Medsillus* (< IE **med-tu-*; cf. MW. *meddu* ʽpossess, rule', L. *modus* ʽmeasure'; cf. Pokorny IEW: 705–706; Evans 1967: 293, 367–368, 411, Lambert 1994: 44; LIV²: 423; Delamarre 2003: 223; Schumacher 2007: 478–483; Matasović 2009: 261);

Gal. PN *Meliđđus, Meliđđius*, *Melissus* etc. (< IE **mélit-t-*; cf. G. μέλῐ, Goth. *miliÞ* , W. *melys* ʽsoft'; cf. Pokorny IEW: 723–724; Evans 1967: 115, 293, 297; Delamarre 2003: 224; Matasović 2009: 263);

T + s = Gal. đđ/ss:

Gal. *neđđamon* ʽnext' (gen. pl., Banassac) ʽproximorum' (< PCelt. **nesso-* < IE **Hned-skō*; cf. Os. *nessimas* ʽproximae', OHG *nezzi* ʽnet'; cf. Lewis/Pedersen 1937: 21; Pokorny IEW: 758; McCone 1996: 48; Delamarre 2003: 233; Hill 2003 : 254–256; Matasović 2009: 289);[210]

9.4.6 The clusters *sibilant* + *t/s*

[210] Matasović (l.c.) assume either *√*Hned-t-* or *√*Hned-s-*, NIL (590– 600) relates to IE *√*sed-*.

The IE cluster *st* is realized either as a sibilant *s*, or alternately with *đ*, i.e. 'tau gallicum'. There are no secure examples of the IE cluster *ss*, just as there are none in both Insular branches (cf. Pedersen 1909: 75; Lewis/Pedersen 1937: 18):

S + t = Gal. ss/đđ:

Gal. TN *Sirona, Đirona*, *Thirona*, *Dirona* (< PCelt. **sterā-* < IE *H_2*stēr*; cf. Gr. ἀστήρ 'star', L. *stella*; cf. Lewis/Pedersen 1937: 20; Pokorny IEW: 1128; Evans 1967: 412–414, 419; de Bernardo Stempel 1999: 47; Delamarre 2003: 282; NIL 348–354; Matasović 2009: 355);

Gal.(-Germ). PN *Bissula Bissus*, *Bisso*, *Bisius*, *Bessius* (< PCelt. **bisti-* 'finger' < IE *g^u*is-ti-*; cf. ON. *kvistr-* 'branch', Alb. *gisht* 'finger'; cf. Pokorny IEW: 481; Delamarre 2003: 76; Matasović 2009: 66);

9.4.7 Overview of the Gaulish development

The outcome in the following table is, due to the lack of data, only partially attested, outcomes based on the analogy are in brackets:

IE	Gaulish	t-	s-
-k^u/g^u/g^{uh}	p/b	(*xt*)	(*xs*)
-k/g/g^h	k/g	*xt*	*xs*
-ḱ/ǵ/$ǵ^h$	k/g	*xt*	*xs*
-t/d/d^h	t/d	*đđ/ss*	*đđ/ss*
-p/b/b^h	0/b	*xt*	*xs*
-s	s	*đđ/ss*	?

9.5 Trajectories of the development

Celtic development can be classified, according to its inputs and the context, into three (sub-)blocks. The first is that of **Tt* and **Ts*: both blocks were subjected to the old Common Indo-European process, here leading, as in Italic and Germanic, towards *ss* in Goidelic and Brythonic (but with much interesting outcome in Continental Celtic, see below). Another block is that of all peripheral plosives, which underwent a wide spirantization and lenition of the left plosive to a fricative or approximant before *t-*, but which has led towards the simplification of clusters with *s-*. The last block contains IE cluster **st* (since the output of the IE cluster **ss* is not securely attested in Celtic), resulting in Insular languages in a sibilant, but with the same interesting outcome in Continental Celtic.

9.5.1 Development of clusters *labial + t/s*

The development of the labial series mirrors that of all velar series; we assume a spirantization (as a bilabial spirant, later probably shifted to labiodental spirant), and the loss of labiality. In Brythonic, the spirant became a palatal approximant (as with all peripheral series), while in the other two sub-branches the outcome is a velar spirant.

The cluster of **Pt* underwent the same spirantization (attested in Gaulish), with both spirants later assimilated either as *x* (in Brythonic) or *ss* (in Goidelic), perfectly mirroring the development known from velar clusters (cf. Thurneysen 1909: 138; Pedersen 1909: 93, 117; Lewis/Pedersen 1937: 43–44; Jackson 1953: 529, 535-540; McCone 1996: 43–44; Schumacher 2004: 129; Kümmel 2007: 387–389; Stifter 2017: 1191):

i. **P** + **t** > φt > (ft > ht >) **i̯t** (Brythonic)
ii. **P** + **t** > φt > (ft >) **xt** (Goidelic)
iii. **P** + **t** > φt > (ft >) **xt** (Continental)

i. **P** + **s** > φs > xx > **0x** (Brythonic)
ii. **P** + **s** > φs > **ss** (Goidelic)
iii. **P** + **s** > φs > **xs** (Continental)

9.5.2 Development of cluster *velar* (and *palatovelar*) + *t/s*

The development of the plain velars and palatovelars can be reconstructed as follows: with a spirantization of a velar in its first phase, both before *t* and *s*, this state is preserved in Continental Celtic in its fullness. Both Insular branches have more advanced development of the clusters with *s*-, where both fricatives merged either as *x* (in Brythonic) or as *ss* (in Goidelic). The Brythonic spirant was lenited to *i̯* before *t*- (with an intermediate stage *ht*?; cf. Thurneysen 1909: 133–134; Pedersen 1909: 77–78; Lewis/Pedersen 1937: 43–44; Jackson 1953: 404-411, 535-540; McCone 1996: 43–44; Kümmel 2007: 387–389):

i. **K** + **t** > xt > (ht >) **i̯t** (Brythonic)
ii. **K** + **t** > **xt** (Goidelic)
iii. **K** + **t** > **xt** (Continental)

i. **K** + **s** > xs > xx > **0x** (Brythonic)
ii. **K** + **s** > xs > **ss** (Goidelic)
iii. **K** + **s** > **xs** (Continental)

9.5.3 Development of clusters *labiovelar* + *t/s*

Since the lack of Continental Celtic data and both outputs of the development of clusters with a left-standing labiovelar in Insular Celtic[211] give us no hint to presume that Proto-Celtic clusters had already lost their labiality in the neutralization position before *t/s* (as they did in Latin)[212] or that labiality was preserved, we will, for simplicity omit the question of labiality present here, using a model essentially the same as for plain velars (Thurneysen 1909: 134–135; Pedersen 1909: 77-78, 129–130; Jackson 1953: 535-540; McCone 1996: 43–44):

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[211] Since in both sub-branches of the Insular Celtic the outcome is the same for velars, labiovelars or labials.

[212] For the neutralization of labiality before *t/s*-; cf. Lewis/Pedersen 1937: 43–44; Kümmel 2007: 387.

i. **K^{u}** + **t** > xt > (ht >) **i̯t** (Brythonic)
ii. **K^{u}** + **t** > **xt** (Goidelic)
(iii. **K^{u}** + **t** > **xt** (Continental))

i. **K^{u}** + **s** > xs > xx > **0x** (Brythonic)
ii. **K^{u}** + **s** > xs > **ss** (Goidelic)
(iii. **K^{u}** + **s** > **xs** (Continental))

9.5.4 Development of clusters *dental + t/s*

The processes affecting the dental series clusters are the oldest layer of the development of clusters, since we meet the same processes in Germanic and Italic and very similar in all other Indo-European languages (beside Indic).

An interesting development is that attested in Gaulish, where **Tt* > *đđ/ss*. (cf. Vendryès 1908: 53; Evans 1967: 410–420; Lambert 1994: 44; Görtzen 1997: 394–399; Delamarre 1999: 223; McCone 1996: 48; Sims-Williams 2017: 364), the precise phonetic value of *đđ* is either a dental affricate or a spirant (cf. Evans 1967: 398). There is no reason to doubt its geminate nature, and its alternation with *ss,* numerously attested, is either a sign of the problem of expressing a given sound in the alphabet used or its unstable and dialectally different phonetic nature. However, both possibilities could be valid at the same time.

Both Insular languages have the same outcome *ss*, and it is worthy of notice that either in Continental or Insular languages clusters of **Tt/Ts/st* always have the same singular outcome.[213]

For the cluster **Tt*, its trajectory is usually modelled using the **affricate** model, popularized by Brugmann (first 1880: 140–142, used since), though initially the idea was by Kräuter (1877: 88), who assumed the affrication of the first plosive, followed by the assimilation of the second plosive and later simplification of both affricates as two sibilants. For the clusters of **Ts* the process could be modelled as affricativizaon and the assimilation of the affricate to a sibilant. The Continental Celtic forms with ʽtau gallicum' could be assumed to be examples of preserved affricates:

i. **T** + **t** > t^{s}t > tsts > **ss** (Insular)
ii. **T** + **t** > t^{s}t > tsts > **đđ/ss**[214] (Continental)

i. **T** + **s** > t^{s}s > tsts > **ss** (Insular)
ii. **T** + **t** > t^{s}s > tsts > **đđ/ss**[15] (Continental)

[213] It should be noted that Jackson (1953: 709) and Sims-Williams (2007: 338–339) argue that *Ts* was preserved as an affricate in Old welsh and Ogamic Irish.
[214] Here *đđ* marks two dental affricates.

Note: Pedersen (1909: 136 and later) assumes that *Tt > t^st > *st* > *ss*, this trajectory seems to be overcomplicated; however, the very same idea was supported by Jackson (1953: 529), similarly Hill (2003: 310) assumes that *Tt realized first as Proto-Celtic **st*, i.e. similarly to the development in Iranian, Baltic, Slavic, Greek.

The affricate model hardly explains the sibilantization of both clusters, especially that of **Ts*: if such a cluster were affricated, the simple phonetic solution would be the merging of both sibilants (*Tss* > *ts*), i.e., resulting in the original cluster again. The phonetic value of *đđ* is unknown, and its affricate value is derived from the Brugmann's model, not otherwise, hence as a self-evident proof it is useless).

We propose an alternative model, which was first proposed for Italic by de Saussure (1877), Cocchia (1883: 16–58) and Bartholomae (1887), who assumed that IE **Tt* > Italic *ϑϑ* (similarly Walde 1897: 503 for IE *d^ht[215]). Since Celtic (and Germanic and Italic) share the same features of the process, we dare to apply it in the Celtic **spirantization model**, assuming the spirantization of the left dental plosive and the assimilation of the right plosive to it, similarly the spirantization of the (left) dental plosive before *s*. All dental plosives merged later with *s*; hence both clusters have a singular input *ss* in Insular Celtic. The Continental geminate *đđ* is an old cluster of two dental spirants *ϑϑ*, its alternation with *ss* preserved in Gaulish data (it is possible that *ϑs* also gave *ϑϑ*):

i. **T** + **t** > ϑt > ϑϑ > **ss** (Insular)
ii. **T** + **t** > ϑt > ϑϑ > **đđ/ss**[216] (Continental)

i. **T** + **s** > ϑs > ϑϑ (?) > **ss** (Insular)
ii. **T** + **t** > ϑs > ϑϑ > **đđ/ss**[16] (Continental)

9.5.5 Development of clusters *sibilant + t/s*

We have mentioned above that even **st* clusters are realized in the same way as clusters of **Tt* and **Ts* (cf. Vendryès 1908: 53; Jackson 1953: 527, 530; Hill 2003: 291–306), i.e. as sibilant clusters in Insular Celtic and often as a 'tau gallicum' cluster of *đđ/ss* in Continental Celtic (in the word-initial, only *đ/s* are present). The assimilation of *Vst* as *Vss* appeared in Insular Celtic *en bloc* (McCone 1997: 33).

Lewis / Pedersen (1937: 20) assume the affrication of **st* to **ts* and relate this directly to the 'tau gallicum', Celt. **ts* being realized as *s* in Insular (cf. Sims-Williams 2007: 339). The trajectory could be modelled as:

i. **s** + **t** > ts > **ss** (Insular)
ii. **s** + **t** > ts > **đđ/ss** (Continental)

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[215] Note that Walde assumes that IE voiced aspirates were in fact voiced spirants.
[216] Here *đđ* marks two dental spirants *ϑϑ*.

Again, we assume that the spirantization trajectory is more appropriate, assuming that the right dental plosive was spirantized and later assimilated to *s*; in Gallic, both obstruents are assimilated as *đđ/ss*:

i. **s** + **t** > sϑ > ϑϑ > **ss** (Insular)
ii. **s** + **t** > ϑs > ϑϑ > **đđ/ss** (Continental)

For this development, we see a parallel in the development of all clusters of *s* + *plosive* in Celtic. IE *#*sp*- gives Goidelic #*s*- (lenited to #*f*) and Brythonic *#*f*- (Lewis/Pedersen 1937: 18; Stifter 2017: 1190), cf. Ir. *seir* ʽheel' (acc. du. *di pherid*), MW. *ffer* ʽancle', OCorn. *fer* from IE *$sperH_1$-o- (cf. OIA *sphuráti* ʽkick' Gr. σφῠρόν ʽankle'; Lewis/Pedersen 1937: 18; Matasović 2009: 333); OIr *sine* ʽteat' (cf. ON *speni* ʽnipple'; < PCelt. **sfenịo*-; Lewis/Pedersen 1937: 18; Matasović 2009: 333); MIr. *sond* ʽstake, beam', OW. *finn*, MW. *fonn* ʽstick, staff' (cf. L. *sponda* ʽbedstead, bed', OE *spōn* ʽsliver, shaving' Gr. σφήν ʽwedge'; < IE *spH_2en-; Lewis/Pedersen 1937: 18; Matasović 2009: 334). Though in the internal position we can assume the metathesis *-*sp*- > -*ps*- (cf. MW. *crych*, MBr. *crech* ʽcurly', Gal. PN *Crixus, Crixsus* (< PCelt. **kaxto*- after a metathesis < IE **kris-po*-; cf. L. *crispus, crispō*; Pedersen 1909: 75; Lewis/Pedersen 1937: 19; Evans 1967: 398, 445; Delamarre 2003: 130; Matasović 2009: 226). Since the reflexes of *#*sp*- and *-*ps*- remarkably differ, they could hardly be outputs of a single input, resulting from the metathesis of *sp* > *ps*. This is, however, improbable in an *anlaut*, since it is harder to pronounce, though such a metathesis is proposed by Lewis/Pedersen (1937: 18). Since the position of IE **p* was remarkably weak in Proto-Celtic, we assume a spirantization of its clusters of *#*sp*- as *#*sφ*- or (later on) *#*sf*- (Thurneysen 1909: 140; Jackson 1953: 529-531; cf. also reconstructed forms in Matasović 2009: 332–335) – we assume a similar lenition for the IE clusters of *#*st*- as well: *#*st*- > *#*sϑ*-.

However, the clusters of *#*sK*- (where *K* marks any voiceless velar plosive[217]) were subjected only partially (in Welsh, there is often a prosthetic vowel; cf. Jackson 1953: 527): preserved in: OIr. *scáth* ʽshadow', MW. *isgaud, cy-sgawd*, OCorn. *scod*, Br. *skeud* (< *Celt. *skāto*- < IE *$skeH_3t$-, cf. Gr. σκότος ʽdarkness, gloom', Goth. *skadus* ʽshadow'; cf. Pedersen 1909: 75; Lewis/Pedersen 1937: 19; de Bernardo Stempel 1999: 324, 528; Kümmel 2007: 388–389; Matasović 2009: 340); OIr. *scian* ʽknife', MBr. *squieaff, squeigaff* ʽcut' (< *Celt. *skiị-o*-

[217] List of clusters *#sk^u- as given by Pedersen (1909: 75); Lewis/Pedersen (1937: 20) is not persuasive, as it not the list of possible etymologies in Matasović (2009: 338–339), hence we have to limit ourselves on clusters *#*sk*-/*#*sḱ*- (on Insular development cf. Jackson 1953: 534–535).

< IE *sḱei̯-, cf. L. *sacéna, scēna* ʽdolabra pontificalis', OIc. *skeggia* ʽaxe'; cf. Lewis/Pedersen 1937: 15, 19; Schrijver 1995: 107; de Bernardo Stempel 1999: 254; Matasović 2009: 343) but lost in Brythonic: Ir. *scend-* ʽspring', W. *cy-chwynn-af* ʽI start' (but also MW. *ysgeinnyaw* ʽdisperse' with **sk-* preserved!) (< *Celt. *skando-* < IE **skend*, cf. OIA *skándati*, L. *scando*; cf. Lewis/Pedersen 1937: 19; Matasović 2009: 339); Ir. *scéith* ʽact of vomiting', MW. *chwydu*, Corn. *huedzha*, MBr. *huedaff* (< *Celt. *skii̯-o-* < IE **sḱei̯-d*, cf. Lith. *skíesti* ʽto have diarrhoea', OIc. *skeggia* ʽaxe'; cf. Lewis/Pedersen 1937: 19; Matasović 2009: 343). The spirantization of plosives after **s* appeared then first for **st-*, later it was applied to **sp-*, and the clusters of **sK-* were affected last and only partially in Brythonic, but not in Goidelic.

9.6 Conclusion and final remarks

The oldest development affected the dentals in both contexts, as in all Indo-European languages (OIA being a false exception). Usually, this change is explained using the affricate trajectory; however we prefer, for the reasons listed above, the spirantization trajectory, assuming **Tt* > *ϑt* > *ϑϑ* > *ss*, which is supported by the existence of the ʽtau gallicum', still documenting the intermediate state. Similarly, for **Ts* we model the trajectory: **Ts* > *ϑs* > *ss*, and a very similar trajectory is possible even for **st-* (> *sϑ* > *ss*), with the spirantization of plosives after **s* is well attested for **sp-* as well.

The later development of peripheral plosives before **t/s* fits into a range of spirantization/lenition: peripheral plosives were spirantized, later lenited as *h* (attested in Goidelic) or as a palatal approximant *i̯* (in Brythonic).

The development of the cluster of **st* has been already described few lines above, the cluster of **ss* is not securely attested, hence its possible development is left aside.

10 The development of the two-obstruent clusters from Indo-European into Germanic

10.0 Germanic languages and their branches

Germanic is first attested, beside glosses and short runic inscriptions, since the Christianization of given Germanic nation, by the Gothic language (late 4th century), later by Old English (since mid-late 7th century), by Old High German (mid 8th century), Old Saxon (first half of 9th century), Old Norse and Old Frisian (since 11th century) (Bousquette/Salmos 2017: 387).

Gothic represents the *East Germanic* branch, Old English, Old High German, Old Saxon and Old Frisian represent *West Germanic* branch, Old Norse the *North Germanic*. Details of the relationship between branches are beyond the scope of this study (cf. Prokosch 1939: 21–34; Krahe/Meid 1969: 10–40; Nedoma 2017:875–888).

10.1 Germanic and Indo-European

The typical features separating the Germanic obstruent system from that of Indo-European, relevant for this study, are:

i. the Germanic shift of plosives (*erste Lautverschiebung*; Rask/Grimm's Law[218], with Verner's Law modifying its outcomes) (followed by a later similar shift within Old High German), with a spirantization of the IE voiceless non-aspirate; devoicing of the IE voiced plosives, and deaspirantion/spirantization of the IE voiced aspirated plosives;
ii. preservation of the Indo-European modal opposition of three classes within the limits of the consonantal shift;
iii. preservation of old labiovelars in its older stages[219].

A similar shift is well known from Armenian (it but hardly could be anything more than a common drift, not the sign of a single phenomenon), and the loss of **p* in Celtic could be a result of a similar process. Labiovelars are attested in Latin inside the Italic languages and from archaic Celtic languages – a remarkable feature is a later split of old labiovelars into velars and labials; the process is known best from Greek (cf. Prokosch 1939: 71–74; Stiles 2017: 895).

10.2 Germanic clusters and their IE origins

(Rask–)Grimm´s Law did not affect voiceless stops following another obstruent (cf. Braune/Heidermanns 2004: 73; Ringe 2006: 97), hence IE **t-* is fully preserved in clusters of *plosive* or *s* + *t*, i.e., in the clusters of our interest.

The primary language of our analysis will be Gothic; other language data will be used when necessary, otherwise as supporting material. Beside etymological examples, we will use

[218] Since the first scholar describing the principle was Rask, we will use his name to mark the law itself. However, since popular knowledge connects this rule with Grimm, who used it in the second edition of his *Deutsche Grammatik* and since there is no chance to disconnect this false authorship, we will use Grimm's name as a second part of the compound name.

[219] Labiovelars are however later lost in the development of later phases of Germanic languages (cf. Markey1980 for a short overview of the Germanic development of labiovelars).

given productive clusters from the Gothic derivation/flexion to demonstrate the synchronic form and value of described processes.

10.2.1 Clusters *plain velar + t/s* in Germanic

The plain velars are hard to reconstruct from the Germanic data, being merged with the reconstructed IE palatovelars in all their outcomes:

K + t = Germ. ht:

Goth. prt. *mahta* 'have power, be able', nom. *mahts*, OHG, OS *math*, OE *meaht*, *might* 'power' (< PGerm. **mahta*; < IE *√*mag*^{h}-; cf. OIA *maghá-* 'power', OCS *mogǫ*, *mošti*; cf. Pokorny IEW: 695; Streitberg 1974: 114; Lehmann 1986: 239–240; LIV^{2}: 422; Kroonen 2013: 347; D. G. Miller 2019: 30);

Goth. *gasahts* 'rebuke' (< PGerm. **ga-sahti-*; < IE *√*seH₂g-*; cf. Gr. ἡγέομαι, L. *sāgus* 'prophetic, prescient', OIr. *saigid* 'try to reach'; cf. Pokorny IEW: 876–877; Lehmann 1986: 292–293; LIV^{2}: 520; Kroonen 2013: 423)

K + s = Germ. hs:

OHG, OS *sahs*, OE *seax* 'knife', ON *sax* 'short sword; scissors' (< PGerm. **sahsa-*; < IE *√*sekH-*; cf. L. *secō*, OCS *sěkǫ* 'cut'; cf. Pokorny IEW: 895–896; LIV^{2}: 524–525; Kroonen 2013: 421);

Goth. *maihstus*, OHG *mist* 'dung, manure' (< PGerm. **mihstu-* < IE *√*H₃mig*^{h}*-so-*[220]; cf. OIA *méhati*, *mīḍhá-* 'urinate', Gr. ὀμείχω 'urinate', L. *meiō*, *mixi*, *mictum* 'pee'; cf. Pokorny IEW: 713; Lehmann 1986: 241; LIV^{2}: 301–302; NIL: 384–385; Kroonen 2013: 369);

10.2.2 Clusters *palatovelar + t/s* in Germanic

The reconstructed palatovelars have the same outcomes as plain velars:

Ḱ + t = Germ. ht:

Goth. *ahtau* 'eight' (< PGerm. **ohtōu* < IE **oḱtō*; cf. OIA *aṣṭáu*, L. *octō* 'eight'; cf. Pokorny IEW: 775; Lehmann 1986: 12; Ross/Berns 1992: 602–609, 618; Blažek 1999: 266; Ringe 2006: 96; Kroonen 2013: 6-7);

Goth. *raíhts*, OE, OS, OHG *reht* 'right' (cf. < IE *√*H₃reǵ-*; OIA *rā́ṣṭi* 'rule', L. pr. *regō*, *-ere* 'rule'; sup. *rēctum*, nom. *rector* 'guide'; cf. Pokorny IEW: 856; Krahe/Meid 1969: 109; Lehmann 1986: 281; LIV^{2}: 304–305; Kroonen 2013: 408);

Goth. *waihts*, ON *véttr* 'thing', OS *with* 'something' (< IE *√*u̯eǵ*^{h}*-ti-*; cf. OCS *veštь* 'thing; cf. Pokorny IEW: 1136; Lehmann 1986: 388–389; Kroonen 2013: 578);[221]

Ḱ + s = Germ. hs:

Goth. *saíhs*, OE *siex* 'six' (< PGerm. **sehs* < IE **su̯eḱs*; cf. Gr. ἕξ, L. *sex*; cf. Pokorny IEW: 1044; Lehmann 1986: 290–291; Ross/Berns 1992: 585, 617, 628–629; Blažek 1999: 237; Ringe 2006: 96; Kroonen 2013: 431);

Goth. *taíhswa*, OHG *zeso*, *zesawēr* 'right (-hand)' (< PGerm. **tehswaz* < IE **deḱsu̯o*; cf. Gr. δεξιός 'on the right hand or side', L. *dexter* 'right'; cf. Pokorny IEW: 190; Lehmann 1986: 338–339; Ringe 2006: 97; Kroonen 2013: 512);

[220] Pokorny (1966: 713) reconstructs *mei̯ǵ*^{h}-.

[221] Pokorny (l.c.) reconstructs IE *√*u̯ek*^{u}*-ti-*; i.e., the deverbative noun from √*u̯ek*^{u}- (cf. L. *vōx* etc.).

OHG *ahsa* ‘axle’ (< PGerm. **ahsō* < IE **H_2eḱs*-; cf. OIA *ákṣa*- L. *axis*; cf. Pokorny IEW: 6; NIL: 259–262; Kroonen 2013: 6);

10.2.3 Clusters *labiovelar + t/s* in Germanic

The labiovelars were neutralized before *t/s*, as is attested in Latin, but this development was often corrupted by analogy (cf. Ringe 2006: 95). The plosive was spirantized before *t*:

$K^{u̯}$ + t = Germ. ht:

Goth. *nahts*, OHG *naht* ‘night’ (< IE **nók$^{u̯}$t*- ~ *nék$^{u̯}$t*-; cf. Hitt. *nekuz* ‘evening time’, Gr. νύξ, νυκτός, L. *nox, noctis*; cf. Pokorny IEW: 762–763; Streitberg 1974: 114; Lehmann 1986: 262; LIV^2: 449; Ringe 2006: 93, 97; NIL: 504–513; Kroonen 2013: 381)

Goth. *leiht*, OE *lēoht*, OS *liht*- ‘light’ (< Germ. *liht(i̯)a*- < IE **leg^{uh}-t*-; cf. L. *levis* ‘light’, MW. *líei* ‘less’, OCS *lьgъkъ* ‘light’; cf. Pokorny IEW: 660–661; Streitberg 1974: 111; Lehmann 1986: 229–230; Kroonen 2013: 338–339);

Note: Labiovelar is sometimes restored before *t*- due to analogy, cf. Goth. pt. *sahvt* (analogy to *saihvan* ‘see’) (Streitberg 1974: 111; Lehmann 1986: 291; Braune/Heidermanns 2004: 70), but cf. OS *siht*, OHG *siht* with the old neutralization.

$K^{u̯}$ + t = Germ. ft:

Goth. *fimfta-táihunda* ‘fifteenth’, OHG *fimfto, fingto*, OS *fifto* ‘fifth’ (< IE **penk$^{u̯}$t*- cf. OIA *paṅktí* ‘number five’, Gr. πέμπτος ‘fifth’; cf. Prokosch 1939: 287; Pokorny IEW: 808; Lehmann 1986: 117; Ross/Berns 1992: 584–585, 600, 616–617, 628; Blažek 1999: 223–224; Kroonen 2013: 140–141);[222]

$K^{u̯}$ + s = Germ. hs:

Goth. gen. pl. *aúhsne*, OE *oxa* ‘ox’ (< PGerm. **uhso*- < IE **uk$^{u̯}$-sō* < *√*u̯eg$^{u̯}$-so*-; cf. OIA *ukṣan*-, OHG *ohso*; cf. Pokorny IEW: 1118; Lehmann 86 49; LIV^2: 602–603; Ringe 2006: 97; NIL: 368–370; Kroonen 2013: 558);

Note: Labiovelars were also neutralized in *auslaut*, cf. Goth. *nih* ‘und nicht’ (cf. L. *neque*), but the labiovelar is restored in Goth. *nêhv* ‘nahe’ (cf. Lehmann 1986: 265–266; Braune/Heidermanns 2004: 70) as it is in .Goth. *sahv/saíhv* analogy to *saihvan* ‘sehen’.

10.2.4 Clusters *dental + t/s* in Germanic

The IE clusters of *Tt* are realized, similarly to Italic or Celtic, as *ss*, as are clusters of *Ts*:

T + t = Germ. ss:

Goth. *unwiss* ‘uncertain’ (cf. Goth. *unwita* ‘fool’), OE *gewiss* ‘certain’ (< PGerm. *(*ga*)*waissaz*; < IE *√*u̯id-to*-; cf. OIA pf. *véda*, Gr. pf. οἶδα ‘know’; cf. Prokosch 1939: 85; Pokorny IEW: 1125–1127; Lehmann 1986: 406–407; LIV^2: 665–667; Ringe 2006: 87; Kroonen 2013: 588);

Goth. *gawiss* ‘joint’ (< PGerm. *(*ga*)*wissiz*; < IE *√*u̯ed^h-ti*-; cf. OIA *vádhram* ‘leather strap’, W. *gwedd* ‘yoke’; cf. Pokorny IEW: 1116–1117; Krahe/Meid 1969: 110; Lehmann 1986: 153–154; LIV^2: 660; Ringe 2006: 87; Kroonen 2013: 577);

OE, ON *sess* ‘seat’ (< PGerm. **sessaz*; < IE *√*sed-to*-; cf. L. *sedēre*; cf. Prokosch 1939: 85; Pokorny IEW: 884–887; LIV^2: 513; Ringe 2006: 87; NIL: 560–600; Kroonen 2013: 433);

[222] The numeral “five” is irregular even in its cardinal form: Goth. *fimf*, OE, OS *fif*, OHG *fimf/finf*, though the last plosive is reconstructed as *-*k$^{u̯}$* (cf. L. *quinque*, Gr. πέντε, OIA pañca-, Lith. penkì), hence the ft of the ordinals could be a result of a transition due to the analogy with an ordinal form.

Note: In some cases, the cluster of **Tt* is realized as *st*, due to analogy, cf. Goth. preterits, *waist* (*wait*), *haihaist* (*haitan*), *qast* (*qiÞan*), *warst* (*waírÞan*), *ufsnaist* (**sneiÞan*), cf. Bammesberger 1986: 95; Braune/Heidermanns 2004: 73, 75; Hill 2003: 78—217; D. G. Miller 2019: 30), though Kögel (1879; similarly Brugmann 1880: 132–133 and later editions) assumes the phonetic explanation due to the original position of accent.

T + s = Germ. ss:

Goth. *missō* 'mutually', ON *ý-miss* 'alternately' (< IE **√mit^h-sto-* ?; cf. OIA adv. *mithas* 'mutually'; cf. Prokosch 1939: 85; Pokorny IEW: 715; Lehmann 1986: 257);

ON *eisa* 'embers' (< IE **√Hǝts/Hǝd^{h}s* ?-; cf. Gr. αἶθος 'burning heat, fire'; cf. Prokosch 1939: 85; Pokorny IEW: 11–12; Kroonen 2013: 14);

Goth. *us-stagg* imp. (hapax legomenon) 'ἐξελε (pluck out)' (von Grienberger 1900: 233–234; Brugmann 1913: 180; Brugmann 1913/1914: 284–285 reconstruct **uz-staggan* < IE **√steg^h-*, cf. Pokorny IEW: 1014–1015; Lehmann 1986: 380, 383; LIV^2: 589; Kroonen 2013: 480);

10.2.5 Clusters *labial* + *t/s* in Germanic

In Gothic, in productive clusters *f* regularly replaces any IE labial plosive before *t*, a similar process is attested in other Germanic languages in the same contexts.

P + t = Germ. ft:

Goth. *gaskafts* 'create', *ufar-skafts* 'first fruits' (cf. pt. part. *gaskapans*; ON *scapa*; < IE **√(s)keH-p*; cf. Gr. σκῆπτρον 'stick', L. *scāpus* 'shaft'; cf. Braune/Heidermanns 2004: 63; Lehmann 1986:[223] 148–149; Kroonen 2013: 440);

Goth. *haftam* 'the married, laden with, subject to', OE *hæft*, ON *haptr* 'captive, prisoner' (< IE **√keH$_2$p-*; cf. Gr. κάπτω 'gulp down'; L. *captus* 'taken'; cf. Pokorny IEW: 527; Streitberg 1974: 114; LIV^2: 344–345; Lehmann 1986: 168; Ringe 2006: 96; Kroonen 2013: 198);

OE *nift* 'niece, granddaughter', ON *nift* 'female relative, sister', OHG *nift* 'niece' (< PGerm. *neftī-* < IE **nept-iH$_2$*; cf. OIA *naptī́*, YAv. *napti* 'niece'; cf. Pokorny IEW: 764; Streitberg 1974: 114; NIL: 520–524; Kroonen 2013: 558);

Note: The Germanic cluster of **ft* is often lenited as *ht* in Old Saxon: *kraht* vs *kraft* 'kraft', *eht* vs *eft* 'wieder', *ohto* vs *ofto* 'oft' (cf. Gallée 1993: 164). Similar lenition is known from Celtic and Sabellic.

P + s = Germ. fs:

OE *wæfs*, *wæps*, *wæsp*, OHG *wefsa*, *wafsa*, *waspa* 'wasp' (< IE **u̯ob^{h}seH$_2$*; concurrent clusters either without spirantization or metathesis; cf, Lith. *vapsvà*, OCS *osa* 'wasp'; cf. Pokorny IEW: 1179);

Goth. *wulfs*, ON *ulfr* 'wolf' (< IE **u̯l̥k^{u}o-*; secondary cluster; labial irregular replacement of IE labiovelar; cf. Pokorny IEW: 1178–1179; Kroonen 2013: 598);

Goth. *af-stassais* (*bokos*) 'notice of divorce' (< IE *H$_2$epo-* + **√steH$_2$-*; hapax legomenon, an ad hoc calque; cf. Lehmann 1986: 7);[224]

10.2.6 Clusters *sibilant* + *t/s* in Germanic

The IE cluster of **st* is preserved in Germanic:

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[223] Cf. *l.c.* for the very complicated semantic explanation!

[224] Lehmann (1969: l.c.) lists five more similar forms with the prefix *af-*.

S + t = Germ. st:

Goth. *staírno*, OE *steorra* ʽstar’ (< PGerm. **sternan-* < IE **H_2stēr-*; cf. Gr. ἀστήρ ‘star’, L. *stella* ‘star’; cf. Pokorny IEW: 1128; Lehmann 1986: 322; Ringe 2006: 97; NIL: 348–354; Kroonen 2013: 495);

Goth., OHG pr. *ist* 3rd sg. ‘be’ (< PGerm. **isti* < IE **H_1es-ti*; cf. OIA *ásti*, Gr. ἐστί, L. *est*, OLith. *esti*, OCS *jestъ* ‘be’; cf. Pokorny IEW: 340–341; Lehmann 1986: 205; LIV^2: 241–242; Braune/Heidermanns 2004: 170; Ringe 2006: 97; Kroonen 2013: 170);

Goth. *gast*, OE *giest* ʽguest’ (< PGerm. **gastiz* < IE **H_2ostH_1-*; cf. L. *hostis* ‘enemy’, OCS *gostь* ‘guest’; cf. Pokorny IEW: 783; Lehmann 1986: 151; Ringe 2006: 97; NIL: 173; Kroonen 2013: 170);

The following example of IE **ss > 0s* is probably already Indo-European. There are no persuasive examples for Germanic clusters of *ss* arising from IE **ss*, so due to analogy we can expect *ss* to be preserved (or compensatory shorted after a long vowel):

S + s = Germ. ss:

Goth. pr. 2nd sg. *is* ʽbe’ (IE **H_2es-si*; cf. OIA *ási*, Gr. Aeol. ἔσσι,[225] L. *es*, OLith. *esi*, OCS *jesi* ‘be’; cf. Pokorny IEW: 340–341; Lehmann 1986: 205; LIV^2: 241–242; Braune/Heidermanns 2004: 170; Ringe 2006: 97; Kroonen 2013: 170);

10.2.7 Overview of Germanic development

Germanic development (represented here by Gothic) has a typical sibilantization of both dental clusters into *ss*; the velar and labial clusters are replaced by spirant clusters; sibilant clusters are preserved:

IE	**Gothic**	t-	s-
-ḱ/ǵ/ǵ^h	-x/k/g	*ht*	*hs*
-k/g/g^h	-x/k/g	*ht*	*hs*
-k$^{u̯}$/g$^{u̯}$/g$^{u̯h}$	-x$^{u̯}$/k$^{u̯}$/g$^{u̯}$	*ht*	*hs*
-t/d/d^h	-Þ/t/d	*ss*	*ss*
-p/b/b^h	-f/p/b	*ft*	*fs*
-s	s/z	*st*	(*ss*)

10.3 Trajectories of the Germanic development

The development of the Indo-European clusters of *plosive + t/s* and *s + t/s* into Germanic can be split into several sub-blocks, based either on the contexts (*t*-context, *s*-context), or on the series involved.

The oldest layer is the development of the dental series, resulting in both contexts in *s*, similarly to the development in Italic and Celtic (more appropriately: in Insular Celtic). Such

[225] This cluster is more probably a result of the re-archaization than a relict.

development is connected to the analogous process *Tt > st, known from Iranian (but not from Indic), Slavic, Baltic and Greek.

A younger development is that of all peripheral (grave) series, i.e., of plain velars (including palatovelars), labiovelars and labials, leading towards spirantization of the plosive before *t/s*, again, such development has its counterpart in the development of Sabellic, Celtic, Iranian and Slavic. The outcomes of this spirantization were same as those reconstructed as outcomes of Rask-Grimm's Law, i.e. *x*, (x^u), *φ* (cf. Ringe 2006: 93–94).

The block of sibilants is relatively stable, as it is in all IE languages outside Celtic.

10.3.1 Development of clusters *labial* + *t/s*

Labials, as all peripheral series in Germanic languages, were spirantized in both contexts, and later debuccalized. As the first step, we assume spirantization of the bilabial spirant, later shifted to a labiodental spirant (cf. Streitberg 1974: 114; Görtzen 1998: 441; Ringe 2006: 219):

P + **t** > pt > φt > **ft** (Germanic)

P + **s** > ps > φs> **fs** (Germanic)

Note: The above mentioned Old Saxon development of IE **Pt* > OS *ht* (parallel to the Standard Germanic **ft*, also known from Old Saxon) is further lenition, parallel to that known from Celtic and Sabellic (cf. Gallée 1993: 164), its trajectory is:

P + **t** > pt > φt > **ft** (/> **ht**) (Old Saxon)

10.3.2 Development of clusters *velar* and *palatovelar* + *t/s*

Since there is no distinction between reconstructed plain- and palatovelar series in all *centum*-languages, the development of both series will be dealt with as a single one.

All peripheral series in Germanic languages were spirantized in both contexts, in the case of the (palato)velars we assume spirantization and later debuccalization (cf. Streitberg 1974: 114; Görtzen 1998: 441; Ringe 2006: 219):

K + **t** > kt > xt > **ht** (Germanic)

K + **s** > ks > xs > **hs** (Germanic)

10.3.3 Development of clusters *labiovelar* + *t/s*

The labiovelar series was regularly neutralized before *t/s*, as it is in Latin, but the analogy process corrupted the system. Since the labial marker is regularly neutralized, the output is a plain velar and follows the same trajectory as all velars, with spirantization and debuccalization (cf. Streitberg 1974: 114; Voyles 1992: 44–45; Ringe 2006: 219; Kümmel 2007: 391):

K$^{\text{u̯}}$ + **t** > kt > xt > **ht** (Germanic)

K$^{\text{u̯}}$ + **s** > ks > xs > **hs** (Germanic)

10.3.4 Development of clusters *dental + t/s*

The traditional trajectory used to describe the development of IE clusters of *dental plosive + t* is that of affrication, used since Brugmann (first used 1880: 140–142 and continuously used since, but the idea was initially stated by Kräuter 1877: 88), assuming the affrication of the first plosive, later expanded on the right dental plosive, followed by a sibilantization of the whole cluster.

This model is used in all standard overviews (cf. Prokosch 1939: 85; Görtzen 1998: 441; Ringe 2006: 18, 87–88; Kroonen 2013: xxxiii; D. G. Miller 2019: 30) and it is, at least its older stage, a common Indo-European phenomenon, though the output *ss* is known only from Germanic, Italic and Celtic, forming either a dialectal continuum or parallel drifts (cf. Ringe 2006: 88). The development of the cluster of **Ts* is infrequently modelled, but we can assume a similar trajectory (inside the affricatization model) with affrication and later simplification:

Note: Miller (2019: 30) brings the analogy to the insertion of *s* (i.e. for the affrication of *Tt*) in the speech manner of Bernese Swiss German, when speaking High German.

T + **t** > t^{s}t > tsts > **ss** (Germanic)

T + **s** > t^{s}s > tss > **ss** (Germanic)

Note: Voyles (1992: 18) reconstructs: ***Tt*** > *t^{s}t* > *ts* > ***ss***, ***Ts*** > ***ss*** (accepted by Kümmel 2007: 391).

Our objections to this model are:

i. the too complex articulation of *tsts*;
ii. the unknown reason why *tss* should change to more complex articulation *tsts*, instead of using (the phonetically already present!) form *ts* (however, *tss* could be easily simplified as *ts*).

From parallel Continental Celtic we know many examples of *tau gallicum* (from IE **Tt*), alternating with *ss*,[226] of insecure phonetic value, definitely representing the older stage of the development, which in its essence had to be the same either in Celtic, Italic or Germanic.

[226] Cf. Gal. PN *Meliđđus, Meliđđius, Melissus* etc. (< **mélit-t-*; cf. G. μέλῐ, Goth. *miliþ*, W. *melys* 'soft'; cf. Pokorny IEW: 723–724; Evans 1967: 115, 293, 297; Delamarre 2003: 224; Matasović 2009: 263);

For this reason, we dare to propose the alternative model, first stated for the Italic development by de Saussure (1877), Cocchia (1883: 16–58) and Bartholomae (1887) (but cf. also Walde 1897: 498), who assumed that IE **Tt* > Italic **ϑϑ*. For explicit parallelism between Italic, Germanic and Celtic, we apply it to Germanic as well[227], assuming the spirantization of the left dental plosive and the later assimilation of the right plosive to it, both dental spirants being later sibilantized. Similarly, the IE cluster of **Ts* was spirantized first in its left dental plosive; later this secondary plosive was sibilantized:

T + **t** > ϑt > ϑϑ > **ss** (Germanic)

T + **s** > ϑs > **ss** (Germanic)

Note: The Germanic cluster of *ss* (of any origin) could be simplified as *0s* due to rhythmical rules (cf. Kroonen 2013: xxxiii).

Note: The different outcomes of IE **Tt* either as major *ss* or minor *st* were explained as a phonetic regular process by Kögel (1879), who relates the different outcomes to different accent positions in given words. This solution was accepted even by Brugmann (cf. Brugmann 1880–132–133 and later). However, Görtzen (1998: 146, 234–236) assumes that *st* was an older stage and its preserved examples are archaisms. In contrast, Bammesberger (1986: 96) argues that the only regular outcome is *ss*, and that *st* is a morphological restoration based on the analogy (on the detailed debate on this subject, cf. Hill 2003: 79–84).

10.3.5 Development of clusters *sibilant* + *t/s*

The IE cluster of **st* is fully preserved. The IE cluster of **ss* is securely attested only for 2nd sg. *√*es-si*, which had been already simplified to **esi* in Indo-European (OIA *asi*, Av. *ahi*, Gr. εἶ all prove that the input was -*s*-, not -*ss*-). We have to assume the very same situation for Germanic, otherwise we have not enough data to model any trajectory for IE **ss* cluster:

s + **t** > **st** (Germanic)

s + **s** > **ss** (?) (Germanic)

10.4 Conclusion and final remarks

The oldest development affected, as in other IE languages, is the dental series in both contexts. It could be summed under the term of the *fricativization* of the left dental, which followed either Kräuter/Brugmannian *affricativization* or de Saussure/Cocchia/Bartholomae's *spirantization* trajectory. Since the development of the **Ts* cluster is more probably via spirantization (the *t^ss* cluster is highly improbable to give an *ss*-output), we prefer the spirantization trajectory.

[227] Spirantization is assumed (after an affricatization) by Ringe (2006: 97) at least for original IE **tst/ts*: **Tt* > *t^st* > *ϑt* > *ss*, though he assumes the traditional affricate trajectory otherwise, cf. Ringe 2006: 88.

The spirantization later affected even the peripheral series; similar processes are known from Iranian, Celtic and other IE language branches.

A remarkable feature, probably related to the spirantization of plosives before a *t-* is that this *t* was not affected by Rask/Grimm's Law, as it was not original **st*-cluster. We can deduce that any *fricative* (either sibilant or a spirant) in a given cluster blocked the first leg of Rask/Grimm's Law (cf. Ringe 2006: 94). However, in a later development, the spirant segment was debuccalized (except for *ft* and *fs* clusters) and the resulting laryngeal approximant was later fully elided in later Germanic languages. Note that Ringe (2006: 97) noticed that if the affrication of the $t^s t$ cluster (from IE **Tt*) survived until the occurrence of Rask/Grimm's Law, the initial *t-* would be rightly expected to change into *ϑ-* (the *ϑϑ* cluster according to the spirantization trajectory is, due its nature, also immune to Rask/Grimm's Law). However, we dare to speculate this proves that the spirantization of the peripheral plosives also preceded Rask/Grimm's Law. Such a sequence of the developments could be logical: first, the voiceless plosives were spirantized in contexts of *t/s*; later, this spirantization dispersed to other positions since the position before *t/s* is a typical neutralization position in the best tradition of Trubetzkoy way (plosives are neutralized in their voice and aspiration). With the voiceless plosive, replaced in the neutralization position by a voiceless spirant, the spirant could be considered a new neutralized allophone and hence a neutral, unmarked form of the phoneme, which could cause the whole process of the first phase of the Germanic consonantal shift. The other phases are the consequences of this first phase: with originally voiceless plosives transformed into voiceless spirants, the original voiced plosives can lose their no longer necessary voicedness and become newly voiceless and similarly, original voiced aspirated plosives could be marked now only by the voicedness, aspiration being a redundant value.

We can model transformations of this kind as a sequence three of stages (T = any non-aspirated voiceless plosive; D = any voiced non-aspirated plosive; D^h = any aspirated voiced plosive; Θ = any voiceless spirant):

i. in the first stage (the input = Late Indo-European) the neutralization before **t/s-* is regularly realized; since this position is the neutralization, the original basic value is preserved in the non-alternating position (here the antevocalic position);
ii. after spirantization in the old neutralization position before **t/s-*, the old basic value is preserved in the antevocalic position;
iii. the spirant in the neutralization position is re-evaluated as an unmarked member, and spirantization is extended on the old voiceless non-aspirates through all positions. With the transition IE *T* > Germ. *Θ*, the old voiced non-aspirates do not have to be marked by the voicedness and are devoiced IE *D* > Germ. *T*; similarly old voiced non-aspirates could be revaluated as simple voiced plosives/spirants, IE D^h > Germ. *D/Đ* :

input			**spirantization**			**output/revaluation**	
antevocalic position	neutralization position		antevocalic position	neutralization position		antevocalic position	neutralization position
TV	Tt		TV	Θt		ΘV	Θt
	Ts			Θs			Θs
DV	TT	>	DV	ΘT	>	TV	ΘT
	Ts			Θs			Θs
D^hV	TT		D^hV	ΘT		DV	ΘT
	Ts			Θs			Θs

The development of the clusters of *sibilant* + *t/s* is conservative (sibilants block Rask/Grimms's Law on *t*-). We assume similar process for the IE cluster **ss*.

11 The development of the two-obstruent clusters from Indo-European into Anatolian

11.0 Anatolian languages

The Anatolian subgroup of Indo-European languages is attested from the middle of the second millennium BC to last centuries BC, with evidence of various quality and quantity, including either administrative archives and long texts of Hittite on the one hand and but few inscriptions for Pisidian and other later languages (cf. Melchert 2017: 171–172) on the other hand.

In the following lines, we will focus exclusively on Hittite data, representing the oldest and best-attested segment of Anatolian; other languages (very poorly attested, beside Luwian) are omitted. Hittite was preserved in the Assyrian cuneiform script, containing not only syllabograms *sensu stricto* but also Akkadograms or sumerograms (the reason why, for example, our knowledge of Hittite numerals is sketchy). A remarkable feature is that Hittite script does not use the Assyrian contrast of voiceless/voiced obstruents – such features of the script obscure our understanding of the Hittite data (for such reasons was Hittite long considered to do now have any modal opposition), which affects our understanding of the phonemic data more than anything else, as we will see below (cf. especially Hoffner/Melchert 2008: 9–24).

The particular problem is the writing of the consonantal clusters, since the cuneiform script has graphemes for *vowels*, *consonant* + *vowel*, *vowel* + *consonant* and *consonant* + *vowel* + *consonant* and the cluster had to be expressed by a combination only within of this limited set (cf. Friedrich 1974: 29; Hoffner/Melchert 2008: 11).

11.1 Anatolian and Indo-European

The typical features separating the Anatolian obstruent system from that of Indo-European are:

i. the merging of the reconstructed voiced non-aspirated and voiced aspirated plosives in a single modal series (the original voiceless non-aspirated plosives are preserved);
ii. the merging of the assumed palatovelars and plain velars in a single series: the often claimed preservation of palatovelars in Luwo-Lycian has to be abandoned (cf. Melchert 2012; Melchert 2017: 176);
iii. the preservation of the labiovelar series[228] (cf. Kronnasser 1956: 65–68; Lindemann 1965; Melchert 1994: 92, 120);

Note: The transliteration we will use is that of Friedrich 1990, including writing *z* to mark an affricate (*ts*). The precise phonetic value of a single Hittite sibilant is unknown and a matter of debate, but since it represents a single IE sibilant and stays a single Hittite sibilant, the phonemic status is the same, regardless of its phonetic value. Since for a graphic realization the ideogram used is that of Akkadian *š*-graphemes, we will use the *š* sign, according to the prevailing tradition, especially since Ugaritic writing of the name of Hittite king *Šuppiluliuma* is with *š*-, not with *s*-sign (Ugaritic has this option) (cf. Hoffner/Melchert 2008: 38). However, for its phonemic value will use *s*-signs when describing trajectories, i.e., the probable palatalization is entirely omitted.

11.2 Hittite clusters and their IE origins

The merging of the old voiced non-aspirates and the voiced aspirates is a common process in various Indo-European languages: similar processes are known from Iranian, Baltic, Slavic, Albanian, and Celtic languages. In some cases these could be related (in the Balto-Slavic), although they are often not (Celtic and other languages).

[228] Note that Sturtevant (1933:) and Sturtevant/Hahn (1951: 55) reject the phonemic status of labiovelars in Hittite.

In Anatolian two modal classes are distinguished; the phonetic value of this opposition is still a matter of debate. For simplicity, we will use symbols and terms for the *voiceless* and *voiced* modal classes (cf. Melchert 1994: 13–21; Hoffner/Melchert 2008: 25–26; Melchert 2017: 176–177), though we have to mention the different view of Kloekhorst, working with the opposition of *geminated* and *non-geminated* stops (Kloekhorst 2008: 21–25). The re-evaluation of the opposition in terms of *fortis/lenis* is another option (Melcher 1994: 18–20). However, we are focused on the position in neutralization contexts, not on the phonetic values in other contexts.

Note: However, voiceless stops often became voiced, either between unaccented vowels or after an accented long vowel or diphthong (Eichner 1973: 79–80, 100[86]; Eichner 1980: 146[69], Melchert 1994: 60–61)

The labiovelars are otherwise preserved in Mycenaean, Latin, the older phase of Goidelic Celtic, Tocharian and Germanic, and often delabialized in later stages of the development of the given branches.

11.2.1 The clusters *labial + t/s*

The Indo-European clusters of the labial plosive + *t/s* are fully preserved:

P + t = Hitt. pt/pt^s:[229]

Hitt. *šiptamiya*- ‘a liquid consisting of seven ingredients’; Luw. *sap*(*pa*)*tammimma/i*- ‘sevenfold’ (< PAnat. **šiptama*- ‘seven’ < IE **septmó*-; cf. OIA *saptá*-, L. *septem* ‘seven’; cf. Hrozný 1917: 96; Sturtevant 1933: 117; Sturtevant/Hahn 1951: 60; Kronasser 1956: 61; Pokorny IEW: 909; Eichner 1992: 84–85; Friedrich 1990: 194; Melchert 1994: 156; Blažek 1999: 247; Kloekhorst 2008: 775–756; CHD Š: 400);

Hitt. *epzi* ‘take grab, capture’ (< IE *√H_1*ep*-; cf. OIA *ī́psati* ‘reach’, OL. *apiō* ‘fasten’; cf. Pokorny IEW: 50–51; Friedrich 1974: 79; Friedrich 1990: 41–42; LIV^2: 237; HED 1–2: 273–282; Kloekhorst 2008: 242–243);

Hitt. pr. 3rd sg. *teripzi* ‘plough’ (< IE *√*trep*-; cf. Gr. τρέπω, L. *trepō* ‘turn’; cf. Pokorny IEW: 1094; Sturtevant 1933: 125; Sturtevant/Hahn 1951: 60; Friedrich 1990: 221; LIV^2: 650; Kloekhorst 2008: 871–872);

Hitt. 3rd sg. pret. *lapta* ‘glow’ (< IE *√*leH*$_2$*p*-; cf. Gr. λάμπω ‘give light, shine’, Lith. *lópė* ‘light’; cf. Kronasser 1956: 60; Pokorny IEW: 652–653; CHD L–N: 39–40; Friedrich 1990: 127; LIV^2: 402; Kloekhorst 2008: 519–520);

P + s = Hitt. ps:

Hitt. *tepšu*- ‘dry (?), reduced (?)’ (< IE *√*d^{h}eb^h*-; cf. OIA *ī́dabhnóti* ‘deceive’, Lith. *dóbiu* ‘invalidate’; cf. Pokorny IEW: 540; Friedrich 1990: 221; Melchert 1994: 156; LIV^2: 132–133; NIL ; HED 1–2: 273–282; Kloekhorst 2008: 866–868);

Hitt. *epši* ‘take grab, capture’ (< IE *√H_1*ep*-; cf. cf. OIA *ī́psati* ‘reach’, OL. *apiō* ‘fasten’; Pokorny IEW: 50–51; Friedrich 1974: 79; Friedrich 1990: 41–42; LIV^2: 237; NIL 85–86; HED 1–2: 273–282; Kloekhorst 2008: 242–243);

[229] The dental could be affricated due to the palatal context.

11.2.2 The clusters *plain velar + t/s*

The IE cluster **Kt* is preserved as such. There is no sure example for **Ks* (but since merging of IE clusters of **Ks* and **Ḱs*, we can be sure that the outcome was in Hittite also *ks*).

K + t = Hitt. kt/kt^s:[230]

Hitt. 3rd sg. pr. *lukzi*, 3rd sg. pret. *lukta* 'shine' (< IE *√*leu̯k*-; cf. Gr. λευκός 'light, bright, clear, white', L. *lūx* 'light', Lith. *laũkas* 'white-spotted'; cf. Sturtevant 1933: 116; Sturtevant/Hahn 1951: 57; Kronasser 1956: 64, 73; Pokorny IEW: 687–690; CHD L–N: 76; Friedrich 1990: 130; Melchert 1994: 156; HED 1–2: 103–108; LIV²: 418–419; Kloekhorst 2008: 530–531);

Hitt. pr. 3rd sg. *harakzi*, 2nd pl. pr. *ḫarakteni* 'perish' (< IE *√*H₃erg-ti*; cf. Arm. *harkanem* 'split, fell, smite'; cf. Sturtevant/Hahn 1951: 57; Kronasser 1956: 65, 166; Friedrich 1990: 57; HED 3: 135–137; LIV²: 301; Kloekhorst 2008: 304);

Hitt. *šaktā*(*i*) 'sick–maintain' (< IE *√*sok-to-i̯e*-; OIr *socht* 'stupor'; cf. Friedrich 1990: 177; Melchert 1994: 93, 156; HED 10: 47–48; Kloekhorst 2008: 701; CHD 10: 51–52)

Hitt. *ikt-/ekt-ikdu-/ekdu-* 'sole, a part of the foot (?)'/'hunting net (?)' (< IE *√*i̯ek-t*; cf. Friedrich 1990: 81; Melchert 1994: 156; HED 1–2: 259–260; Kloekhorst 2008: 235)

11.2.3 The clusters *palatovelar + t/s*

Since there is no distinction between the IE plain velars and the palatovelars, even outcomes of IE clusters of **Ḱt* are the same as **Kt*. The outcome of IE **Ḱs* is regularly *ks* in Hittite:

Ḱ + t = Hitt. kt/kt^s:[231]

Hitt. 3rd sg. pr. *u̯ekzi*, 3rd sg. pret. *u̯ekta* 'ask' (< IE *√*u̯eḱ*-; cf. OIA *vaṣṭi* 'wish', Gr. ἑκών 'willingly'; cf. Sturtevant 1933: 117; Sturtevant/Hahn 1951: 57; Pokorny IEW: 672; Friedrich 1974: 80; Friedrich 1990: 251; LIV²: 672–673; Kloekhorst 2008: 996–997);

Hitt. 3rd sg. pr. *šalikzi*, 3rd sg. pret. *šalikta* 'fall', 2nd pl. *šalikteni* 'prostrate' (< IE *√*slei̯ǵ^h-/leg^h-* (?); cf. Gr. λέχος 'bed', L. *lectus* 'bed', Goth. *ligan* 'lie'; cf. Sturtevant 1933: 117; Sturtevant/Hahn 1951: 57; Pokorny IEW: 658–659; Friedrich 1990: 179–180; LIV²: 398; CHD 10: 100–104; Kloekhorst 2008: 711);

Ḱ + s = Hitt. kš:

Hitt. nom. *takšan-* 'centre, joint, combination', adv. *takšan* 'together', nom. *takšeššar* 'combination', (verbal forms with an anaptyctic vowel: 3rd sg. pr. *takkešzi*, 2nd pl. pr. *takkešteni* 'put together, undertake') (< IE *√*tek-s*-; Gr. τέχνη 'skill', OHG *dehsala*- 'axe'; cf. Pokorny IEW: 1058; Melchert 1994: 156; Friedrich 1990: 204–205; LIV²: 619–620; Kloekhorst 2008: 813–814; CHD Š: 100–104);

11.2.3 The clusters *labiovelar + t/s*

[230] The dental could be affricated due to the palatal context.

[231] The dental could be affricated due to the palatal context.

The neutralization of the labial value of the IE labiovelar *$K^{u}t$ was originaly probably regular (as in Latin) but is often replaced by analogy. The cluster of *$K^{u}s$ is preserved only without neutralization:

K^{u} + t = Hitt. $k^{u}t$/$k^{u}t^{s}$:[232]

Hitt. 3rd sg. pret. *ekuta*, 3rd sg. pr. *ekuzi* (beside *e-uk-zi* with neutralization?) 'drink' (< IE *√H_1eg^{uh}-; cf. Toch. A *yok-* 'drink', L. *ēbrius* 'drunk'; cf. Pokorny IEW: 23; Friedrich 1990: 40; Melchert 1994: 92; LIV^2: 231; HED 1–2: 261–268; Kloekhorst 2008: 236–237);[233]

Hitt. *nekut-* 'twilight, evening' (< IE *√neg^{u}-; cf. Gr. νύξ, L. *nōx*, L. *naktìs*; cf. Pokorny IEW: 762–763; Puhvel 1972: 112; CHD L–N: 434–437; Friedrich 1990: 150; Melchert 1994: 61–62, 156; LIV^2: 449; NIL: 504–513; HED 7: 79–83; Kloekhorst 2008: 602);

Note: But note that there is an etymological cluster of *$K^{u}t$ > Hitt.: Hitt. 3rd sg. pr. *ḫuekzi*, 3rd sg. pret. *ḫuekta* 'conjure' (< IE *√$u̯ek^{u}$-; cf. OIA *vakti*, Gr. (ϝ)έπος, L. *vōx*; cf. Sturtevant 1933: 121; Kronasser 1956: 66; Pokorny IEW: 1135–1136; Friedrich 1990: 70; LIV^2: 673; Kloekhorst 2008: 347–348), similarly probably *e-uk-zi*, noted above as a variant of 3rd sg. pr. *ekuzi*.

K^{u} + s = Hitt. $k^{u}s$:

Hitt. *tekkuššāi-*, *tekkuššanu-* 'show' (< IE *√dek^{u}-*s*-; Av. *daxš-* 'to teach'; cf. Pokorny IEW: 189; Friedrich 1990: 220; Melchert 1994: 61–62, 113, 156; LIV^2: 112; Kloekhorst 2008: 865; Kimball 2017: 253);

Hitt. 2ndsg. pr. *ekušši* 'drink' (< IE *√H_1eg^{uh}-*s*-; cf. Toch. A *yok-* 'drink', L. *ēbrius* 'drunk'; cf. Pokorny IEW: 23; Friedrich 1990: 40; Melchert 1994: 92; LIV^2: 231; HED 1–2: 261–268; Kloekhorst 2008: 236–237);

Hitt. *nana*(*n*)*kušši(iye)* 'grow dark' (< PAnat. *no-nok^{u}-*s*- < IE *√ne-neg^{u}-*s*.; cf. Pokorny IEW: 762–763; CHD L–N: 394–395; Melchert 1994: 61–62; LIV^2: 449; NIL: 504–513; HED 7: 60–62, 79–83; Kloekhorst 2008: 595);

11.2.4 The clusters *dental + t/s s*

The first dental in the cluster of **Tt* is affricated; the cluster **Ts* is preserved:

T + t = Hitt. $t^{s}t$ (<zt>):

Hitt. 3rd sg. pret. *ezta*, 2nd pl. pr. *ezzteni* 'eat' (< IE *√H_1ed-; cf. OL. *est* 'he eats', Gr. Att. pr. ἐσθίω; cf. Hrozný 1917: 89; Sturtevant 1933: 127, 129; Sturtevant/Hahn 1951: 61, 63; Kronasser 1956: 61; Pokorny IEW: 287–289; Friedrich 1990: 44; Melchert 1994: 97, 109; Kimball 1999: 285–286; LIV^2: 230; NIL: 208–220; HED 1–2: 315–321; Kloekhorst 2008: 261–263);

Hitt. 3rd sg. pret. *ḫazta* 'dry up' (< IE *√H_2ed-; cf. Gr. pr. ἄζω; cf. Pokorny IEW: 68–69; Friedrich 1990: 64; Kimball 1999: 286; LIV^2: 255; HED 3: 247–248; Kloekhorst 2008: 328–329);

Hitt. 3rd sg. pr. *ḫuezta* 'pull' (< IE *√$H_2eu̯t$-(?); cf. Friedrich 1990: 72–74; Kimball 1999: 286; LIV^2: 294; HED 3: 343–352; Kloekhorst 2008: 349–351);[234]

Note: Some of the old *tt* geminates are preserved without any change: Hitt. *atta-* 'father' (cf. Friedrich 1990: 38; Melchert 1994: 150; Kloekhorst 2008: 225).

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[232] The dental could be affricated due to the palatal context.

[233] But note that *e-uk-zi* is delabialized, cf. Friedrich 1990: 40).

[234] Not attested outside Anatolian.

T + s = Hitt. t^s (<z>):

Hitt. 2nd sg. pr. *ezši* ‘eat’ (< IE *√*H_1*ed*-; cf. OL. *es* ‘he eats’, Gr. Att. pr. ἐσθίω; cf. Hrozný 1917: 89; Pokorny IEW: 287–289; Friedrich 1990: 44; Melchert 1994: 97, 109; LIV^2: 230; NIL: 208–220; HED 1–2: 315–321; Kloekhorst 2008: 26, 261–263);

Hitt. *ḫazziya*- ‘strike’ (< PAnat. *Hatsi̯e/o*- < IE *H_2*et*-?); cf. Friedrich 1990: 67; Melchert 1994: 96; LIV^2: 274; HED 3: 248–255; Kloekhorst 2008: 330–332);[235]

Hitt. loc. suffix -*zzi*(*ya*)- (< PAnat. -*tsi̯o*-; cf. Melchert 1994: 96);

Note: There are examples of the development of **Ts* > *šš*, attested only over the clitic boundary (cf. Hoffner/Melchert 2008: 41).

11.2.6 The clusters *sibilant + t/s*

The cluster of *sibilant* + *t* is fully preserved, as is the *ss* cluster, as far as we can depend on the scarce data:

S + t = Hitt. st/st^s:[236]

Hitt. *talukašti*, *dalugašti* ‘length’ (< IE *√*dolg*^{h}-; cf. OCS *dlъgostь*; cf. Hrozný 1917: 23; Kronasser 1956: 65; Pokorny IEW: 197; Friedrich 1990: 206; Kloekhorst 2008: 819–820);

Hitt. *kašt* ‘hunger’ (< IE *√*g*^{h}*os*-; cf. Toch. A *kaṣt*, Toch. B. *kest*, OIA *ghasati*, *kṣut* ‘hunger’; cf. Sturtevant 1933: 118; Sturtevant/Hahn 1951: 58; Kronasser 1956: 65; Pokorny IEW: 452; Friedrich 1990: 104; LIV^2: 198–199; HED 4: 121–123; Kloekhorst 2008: 461–463);

Hitt. 3rd sg. *ešzi*, 2nd pl. pret. *ešten* ‘be’ (< IE *√*H_1*es*-; cf. OIA *ásti*, Gr. ἐστί, L. *est*, OLith. *esti*; cf. Kronasser 1956: 169; Pokorny IEW: 340–342; Friedrich 1990: 42; LIV^2: 241–242; NIL 235–238; HED 1–2: 285–291; Kloekhorst 2008: 250–252);

Hitt. *ḫaštāi* ‘bone’ (< IE *√*H_3*est*^{h}-; cf. OIA *ásthi*, Gr. ὀστέον; cf. Sturtevant 1933: 124, 139; Sturtevant/Hahn 1951: 59, 65; Pokorny IEW: 783; Friedrich 1990: 63; HED 3: 233–237; Kloekhorst 2008: 325)

Hitt. *ḫašduir* ‘brushwood’ (< IE *√*H_2*st*H_1-*g*^{u}*er*-; cf. Gr. ὄζος, Aeol. ὕσδος ‘bough, branch, twig’; cf. Sturtevant 1933: 139; Sturtevant/Hahn 1951: 65; Kronasser 1956: 68; Pokorny IEW: 786; Friedrich 1990: 64; HED 3: 239–240; Kloekhorst 2008: 326)

Hitt. *ḫaštēr* ‘star’ (< IE *√*H_2*ster*-; cf. Gr. ἀστήρ, L. *stella*; cf. Sturtevant 1933: 77, 124; Kronasser 1956: 16, 204; Pokorny IEW: 1027–1028; NIL 348–354; HED 3: 238–239; Kloekhorst 2008: 326);

S + s = Hitt. ss:

Hitt. pr. 2nd sg. *ešši* ‘be’ (< IE *√*H_1*es*-; cf. OIA *ási*, L. *es*, OLith. *esi*; cf. Kronasser 1956: 169; Pokorny IEW: 340–342; Friedrich 1990: 42; LIV^2: 241–242; NIL 235–238; HED 1–2: 285–291; Kloekhorst 2008: 250–252, especially see the commentary here);

Note: Though examples of the development of the original IE **ss* clusters are scarce, Hittite sibilants were often geminated, cf. Melchert 1994: 120–123).

[235] Not attested outside Anatolian.

[236] The dental could be affricated due to the palatal context.

11.2.7 Overview of Hittite development

The Hittite development of our clusters is highly conservative, only IE **Tt* clusters are alternating (as in other IE languages). The assumed neutralization of the IE old labiovelars in the *t*- and *s*-contexts is usually replaced by analogous forms, the old neutralization preserved exceptionally:

IE	**Hittite**	t-	s-
-k$^{u̯}$/g$^{u̯}$/g$^{u̯h}$	-k$^{u̯}$/g$^{u̯}$	*k*$^{(u̯)}$*t*	*k*$^{u̯}$*s*
-k/g/g^{h}	-k/g	*kt*	*ks*
-ḱ/ǵ/ǵ^{h}	-k/g	*kt*	(*ks*)
-t/d/d^{h}	-t/d	*tst*	*ts*
-p/b/b^{h}	-p/b	*pt*	*ps*
-s	-s	*st*	*ss*

11.3 Trajectories of the Hittite development

Though some examples are scarce, we still can postulate that the development of clusters of *plosive/s* + *t/s* in Hittite is very conservative, as the single series affected by any changes is the dental one. We assume the devoicing before both *t/s* (cf. Kimball 1999: 300–301).

11.3.1 Development of clusters *labial* + *t/s*

Similarly to all peripheral series, labial clusters with *t/s* are fully preserved in Hittite:

P + **t** > **pt**

P + **s** > **ps**

11.3.2 Development of clusters *plain velar* and *palatovelar* + *t/s*

Since there is no distinction in Hittite between the Indo-European reconstructed plain velars and palatovelars, the trajectory is the same (cf. Kloekhorst 2008: 72); the velar plosives are fully preserved as such:

K + **t** > **kt**

K + **s** > **ks**

11.3.3 Development of clusters *labiovelar* + *t/s*

For the development of the cluster of *labiovelar* + *t*, we assume the original neutralization of the labial marker, attested otherwise fully in Latin and in diffused examples in other *centum*-languages. Later, this old neutralization is replaced by analogical clusters with reintroduced labiovelars. The very same process is attested even for clusters with *s* (cf. Melchert 1994: 61–62, 113; Kloekhorst 2008: 72):

K$^{u̯}$ + t > kt/→ k$^{u̯}$t

K$^{u̯}$ + s > (**ks** ?)/→ **k$^{u̯}$s**

11.3.4 Development of clusters *dental* + *t/s*

The IE cluster **Tt* developed in Hittite into a cluster of *t^{s}t* (cf. Melchert 1994: 22, 62, 97, 109, 117120; Hoffner/Melchert 2008: 37, 44). The first segment is a dental (voiceless) affricate, and the same affricate is a result of the development of the dental plosive before a palatal **i* (cf. Melchert 1994: 54, 116–117; Kümmel 2007: 350).

This development supports the traditional theory assuming that IE **Tt* regularly developed into **t^{s}t* (before a further development either in *st* or *ss*, according to the given branch of Indo-European languages). This model originates with Kräuter (1877: 88), but became a popular model due to Brugmann's influence (since Brugmann 1880: 140–142); Anatolian then would be a single IE branch preserving the older state, lost in other branches due to further development.

Note: Kloekhorst (2008: 26) assumes that the outcome of the affrication in *Tt* and *Ts* clusters is different from that of *Ti̯*, but this distinction is not fully phonetically explained (cf. *l.c.*). A simple solution could be that proposed by Hoffner/Melchert (2008: 37): one of the outcomes was palatalized, probably that originating from *Ti̯*. His statement that even the outcomes of clusters of *dental plosive* + *t/s* are different according to the original voice(less)ness of the input cluster remains more questionable, especially since there is no similar distinction from other clusters with plosives other that dental ones.

T + t > t^{s}t

Note: Görtzen (1998: 424) lists *išdu̯a-* 'announce' as an example of the Bartholomae's Law operatibility in Hittite but this seems hardly probably (cf. HED 1–2: 483–485; Kloekhorst 2008: 419–420 for other etymologies).

The Indo-European cluster **Ts* is either preserved as such (i.e., as a biphonematic sequence *ts*) or as an affricate (*t^{s}*) (cf. Melchert 1994: 96; Kloekhorst 2008: 72). Another possibility is that the plosive was subjected to affricatization, as in the case before *t* and this cluster was simplified as *ts*. We prefer this solution because of the analogy:

T + s > (t^{s}s >) **ts**

Note: Kloekhorst (2019) argues that *Ts* clusters are realized in Hittite regularly as a *ts* cluster, never as an affricate, at least in the antevocalic positon or before a diareme.

11.3.5 Development of clusters *sibilant* + *t/s*

The IE clusters of sibilant + *t/s* are fully preserved in Hittite (cf. Kloekhorst 2008: 70–71), though for the cluster **ss* we have a minimal set of examples:

s + t > st

s + s > ss

11.4 Conclusion and final remarks

The Hittite developments of the Indo-European clusters of our interest is an example of a very conservative development.

The dental series was subjected, as in all other IE languages, to the alternation of the left dental, which was affricated and preserved as such. A remarkable feature is that the IE **Ts* cluster is preserved as such (in other languages the cluster is realized often as a double or single sibilant – cf. the Iranian, Slavic, Baltic, Greek, Italic, Celtic and Germanic) – in this case either the left dental was not affected by any process, or the probable affricativization (parallel to that of the **Tt*-cluster) was later simplified/re-archaized.

The clusters of the peripheral series, on the contrary, are fully preserved in both contexts. The labiovelar series, originally with the neutralization of the labial value (as in Latin) is often restored in this feature due to analogy processes.

12 The development of the two-obstruent clusters from Indo-European into Tocharian

12.0 Tocharian languages

There are two Tocharian languages, termed Tocharian A and Tocharian B,[237] both derived from a single *centum*-language, attested from findings in the Tarim Basin.

Texts are written in the local version of the *brāhmī* script (a recent overview by Malzahn 2007b) and are either translations and adaptations of Indian Buddhist texts or non-literal texts from the Buddhist milieu usually written on paper, but also on wood and especially graffiti (Penney 2017; for an overview of manuscripts and their location, cf. especially Malzahn 2007a).[238]

Since the Tocharian B is better attested than Tocharian A, the following analysis will be based on this language. Tocharian A serves, if possible, as a complement (though listed, for alphabetic reasons, before B examples). However, both languages do not usually differ in outcomes of the analysed clusters, as we will see below.

12.1 Tocharian and Indo-European

Both Tocharian languages have been subjects of linguistic examination for just one century, and many details of their phonemic development are not fully understood yet.

The typical features separating Tocharian obstruent systems from that of Indo-European are:

i. the merging of the three modal classes, reconstructed for the Indo-European protolanguage;
ii. the preservation of old labiovelars (though in minimal scale due to later processes);
iii. the palatalization of plosives (*p* vs *ṕ*; *k* vs *ś*; *t* vs *c*; old labiovelars are palatalized in the same way as plain velars) and of *s* (as *ṣ*).

Note: Winter (1962b: 24–25) brings three examples of the alleged validity of Grassmann's Law in Tocharian, all of the deaspiration of the root-initial *d^h- (not any other voiced aspirate), cf. Ringe 1996: 47. However, Grassmann's Law is outside of the scope of our interest. Similarly, Winter (2011) tries to demonstrate that Proto-Tocharian had a similar lengthening of vowels before IE voiced non-aspirated plosives to that of Balto-Slavic (i.e., to Winter's Law in *sensu stricto* and to Lachmann's Law).

The first feature is unknown in any other IE language (though older opinions wrongly assumed the same development also for Hittite); the second feature is a parallel process common in all *centum*-languages; the third feature appears independently in various IE languages.

12.2 Tocharian clusters and their IE origins

Both Tocharian languages preserve old clusters with peripheral series. The dental series underwent a similar development as in all Indo-European languages, in this feature it does not differ from Hittite, Latin and Greek, which, as *centum*-languages, similarly keep the clusters of

[237] The name is a misnomer, resulting from a false connection between Bactrian Τόχαροι and the Tarim Basin inhabitants, but is preserved due to a long tradition.

[238] Though there are at least two known fragments written in the Manichean script, one a hymn to Mani and the other a hymn to Jesus.

peripheral series relatively intact (*satəm* Old Indo-Aryan or Lithuanian have similar development).

12.2.1 The clusters *labial + t/s*

As far as we can judge from the single attested data, the clusters of **Pt* are preserved as such, at least in Tocharian A. The **Ps* cluster is reduced to *0s* in the word-initial (but we have a single example only of such a development and it is doubtful), or often an epenthetic vowel splits the cluster:

P + t = Toch. pt/pt^{s}:

Toch. A num. pl. *ṣäptäntu*, *ṣäpta-* (in compounds),[239] Toch. B num. *suk, ṣukt* 'seven' (< Toch.**ṣäp(ä)t*, *ṣäktu* < IE **septm̥*;[240] cf. L. *septem*, OIA *saptá-*, Gr. ἑπτά; cf. Sieg/Siegling 1908: 927; Pokorny IEW: 909; Winter 1992b: 109, 137–138; Ringe 1996: 67; Blažek 1999: 250; Adams 2013: 720);

Toch. A pr. *kroptär*, inf. *kroptsi*, Toch. B pr. *krauptär* 'gather, assemble' (< Toch. *√*kreup-* < IE **kreu̯bʰ-*; cf. Gr. κρύπτω 'hide', without *p*-suffix cf. OCS *kryjǫ* 'cover'; cf. van Windekens 1976: 235; Carling 2009: 173–174; Malzahn 2010: 614–616; Adams 2013: 236–238);

Toch. B pr. *kleptär* 'touch, investigate' (< IE *√*klep-*; cf. LIV^{2}: 246; Malzahn 2010: 618–619; Adams 2013: 246);

Toch. B inf. *yaptsi* 'enter, set (sun)' (< Toch. *√*i̯äp-* < IE *√*i̯ebʰ-*; cf. OIA *yábhati*, OCS *jebǫ* 'fuck'; cf. Pokorny IEW: 298; van Windekens 1976: 605[241]; LIV^{2}: 309; Malzahn 2010: 796–798; Adams 2013: 537–538);

P + s = Toch. ps:

Toch. B pr. *lupṣtär*, grd. *lupṣalle* 'smear, rub' (< Toch.*√*läup-* < IE *√*sleu̯bʰ-*; cf. L. *lūbricus* 'slippery', Goth. *sliupan* 'slink, crawl'; cf. Pokorny IEW: 963–964; van Windekens 1976: 269; Malzahn 2010: 858–859; Adams 2013: 606);

Toch. B pt. *yopsa* 'enter, set (sun)' (< Toch. *√*i̯äp-* < IE *√*i̯ebʰ-*; cf. OIA *yábhati*, OCS *jebǫ* 'fuck'; cf. Pokorny IEW: 298; van Windekens 1976: 605; LIV^{2}: 309; Malzahn 2010: 796–798; Adams 2013: 537–538);

Note: P + s = Toch. pVs (with an epethetic vowel) is attested in Toch. A *päśśäṃ*, Toch. B *päścane* 'breast; [in plural] seat of wisdom' (< IE **pstḗm*; cf. Hitt. *istanza* 'soul', Av. *fštāna-*; cf. van Windekens 1976: 103; Ringe 1996: 71; Adams 2013: 386);
#Ps > Toch. #0s: Toch. A *sāt* 'hot', Toch. B *satāsk* 'exhale' (< IE **ps-ōd-*, derived from IE *√*bʰes-*; cf. OIA √*bhas-* 'breath'; cf. van Windekens 1976: 103, 419–420; Adams 2013: 736–737 doubt this etymology);

12.2.2 The clusters *velar + t/s*

[239] Tocharian A *ṣpät* "seven" is a result of a metathesis.

[240] The Tocharian B form is affected by the numeral eight. This particular trajectory was given by van Windekens (1976: 461) as: **septm̥* > **śäptäṃ* > *ṣäptu* → *ṣäktu* > **ṣukt*; in contrast, by Winter (1992b: 109) as: **ṣäwät* > **swät* > **ṣut* → *ṣukt*.

[241] Van Windekens gives a different etymology, *c. l.*!

Though secure examples of the development of IE *plain velars + t/s* are relatively scarce, we have to assume there the outcomes are not different from the outcomes of IE *palatovelars + t/s* (cf. below), since Tocharian is a *centum*-language:

K + t = Toch. kt/kt^{s}:

- Toch.B pr. *klyeñktär*, inf, *kläṅktsi* 'doubt' (Toch. *√*kläṅk*- < IE *√*kleng*-; cf. L. *clingō,* OE *hlinc* 'ringe'; Pokorny IEW: 603; Carling 2009: 177; Malzahn 2010: 623–624; Adams 2013: 240);
- Toch. B prtcl. *täṇktsi* 'up to, until; including, even' (historical infinitive of Tocharian *√*täṅk*- < IE *√*teng^{h}*-; cf. OIA *tęgnǫti* 'pull', ON *Þungr* 'heavy'; Pokorny IEW: 1167; van Windekens 1976: 502; LIV^{2}: 567; Malzahn 2010: 648; Adams 2013: 307);
- Toch. B pr. *wākṣtär-ś* 'split apart' (< Toch. *√*u̯āk*- < IE *√*u̯ag*-; cf. Gr. ἄγνῡμι 'break apart', L. *uāgīna* 'sheath' (?); cf. Pokorny IEW: 1110; van Windekens 1976: 550–551; LIV^{2}: 664–665; Malzahn 2010: 862–863; Adams 2013: 635–636);

K + s = Toch. ks/kṣ:

- Toch. A grd. *taṅkṣäl,* Toch. B pr. *taṇksäṁ* 'check, stop, hinder' (Toch. *√*täṅk*- < IE *√*teng^{h}*-; cf. OIA *tęgnǫti* 'pull', ON *Þungr* 'heavy'; Pokorny IEW: 1167; van Windekens 1976: 502; LIV^{2}: 567; Malzahn 2010: 648; Adams 2013: 306);
- Toch. B pr. *trikṣäṃ* 'go astray, be confused', nom. *trikṣo*-'error, mistake' (Toch. *√*trik*- < IE *√*trei̯k*- (?); cf. L. *trīcae* 'trifles, nonsense; vexations, troubles', *trīcārī* 'make difficulties; shuffle; trifle'; Pokorny IEW: 1167; van Windekens 1976: 514–515; LIV^{2}: 514–515; Malzahn 2010: 668–670; Adams 2013: 334–335);
- Toch. A pr. *okṣoññäṃ*, Toch. B pr. *auksäṣṣäṁ* 'grow, increase' (< Toch. *√*ṣäk(ä)s*- < IE *√*H₂eu̯ks*; cf. OIA *vakṣáyati* 'grow', Gr. ἀέξω 'increase, foster', Goth. *wahsjan* 'grow'; cf. Pokorny IEW: 85; van Windekens 1976: 329; LIV^{2}: 288–289; NIL: 368–370; Malzahn 2010: 549–550; Adams 2013: 1387);
- Toch. A *nt*-part. *wākṣantāṃ* 'split apart' (< Toch. *√*u̯āk*- < IE *√*wag*-; cf. Gr. ἄγνῡμι 'break apart', L. *uāgīna* 'sheath' (?); cf. Pokorny IEW: 1110; van Windekens 1976: 550–551; LIV^{2}: 664–665; Malzahn 2010: 862–863; Adams 2013: 635–636);

12.2.3 The clusters *palatovelar + t/s*

The clusters of IE *palatovelar + t/s* are preserved as *kt/ks*:

Ḱ + t = Toch. kt/kt^{s}:

- Toch. A *okät,*[242] B *ok*(*t*) 'eight', Toch. A *oktuk* 'eighty', Toch. A *oktänt*, Toch. B *oktante, oktunte* 'eighth' (Toch. **oktu* < IE **oḱtō;* cf. L. *octō,* Goth. *ahtau,* Gr. ὀκτώ; cf. Pokorny IEW: 775; van Windekens 1976: 330–332; Winter 1992b: 110–112; Blažek 1999: 268; Carling 2009: 83; Adams 2013: 115);
- Adams (2013: 202–203) relates Toch. B *ketseñe* 'body' to a verbal abstract **kᵘoḱ-ti*- (< IE *√*kᵘeḱ*- 'see, appear'; cf. Pokorny IEW: 638–639; LIV^{2}: 664–665; van Windekens (1976:103, 187–188) relates it to OIA *cakṣus*- 'aspect, form' (< IE √*kᵘoḱ-s*-, i.e., to the same root but with a different suffix, Adams considers this form irregular), Pinault 1999 derives from a collective **koḱse-den*-);
- Toch.B inf. *praktsi* 'ask' (< Toch. **pärk-sa*- < IE *√*preḱ*-; cf. OIA *pṛcchati* 'ask', *praśná*- 'question', cf. Pokorny IEW: 821–822; van Windekens 1976: 386; Ringe 1996: 68; LIV^{2}: 490–491; Malzahn 2010: 707–708; Adams 2013: 398)

[242] The cluster is split here, but cf. the form of the ordinal numeral further with the cluster preserved.

Ḱ + s = Toch. ks/kṣ:

Toch. B *laks* 'fish' (< IE **loḱsi*; cf. OHG *lahs*, Lith. *lãšiš* 'salmon'; cf. Pokorny IEW: 653; van Windekens 1976: 254–255; Adams 2013: 590);

Toch. B *kakse* '[a body part?]' (probably < IE **kuḱsi* or IE **koḱso*; could be related to OIA *kukṣí-* 'belly', *kákṣa-* 'armpit', L. *coxa* 'hip', OHG *hahsa* 'back of knee'; cf. Pokorny IEW: 611; cf. especially Adams 2013: 143–144 for the detailed analysis);

Toch. A pr. *praksam*, grdv. *prakṣäl*, Toch. B pr. *preksau*, pr. part. *preksemane*, imp. *parksat* 'ask' (< Toch. **pärk-sa-* < IE *√*preḱ-*; cf. OIA *pṛcchati* 'ask', *praśná-* 'question', cf. Pokorny IEW: 821–822; van Windekens 1976: 386; Ringe 1996: 68; LIV^2: 490–491; Malzahn 2010: 707–708; Adams 2013: 398);

12.2.4 The clusters *labiovelar + t/s*

The phonemic status of labiovelars in Tocharian languages is a matter of debate (cf. especially Hilmarsson 1993a; Kim 1999 and Fellner 2006). The author of the present article presumes that there was a synchronic phoneme *kᵘ̯* in both Tocharian languages (as does Kim explicitly 1999: 177). However, the old IE labiovelars were later subjected to delabialization in numerous other contexts (as they were in Romance vs Latin or later Germanic languages vs their older stages).

The clusters of IE *labiovelar* + *t/s* are preserved as *kt/kts* (i.e. the same as the palatovelars in the same context), with a loss of the labialization:

Kᵘ̯ + t = Toch. kt/kt^s:

Toch. A *pänt*, Toch. B *piṅkte* 'fifth' (< Toch. **pi̯änkte* < IE **penkᵘ̯-to-*; cf. L. *quīnctus*, *quīntus* 'fifth'; OIA *pakthá-*, Gr. πέμπτος; cf. Pokorny IEW: 808; van Windekens 1976: 360–361; Winter 1992b: 107–108, 119–120, 136–137; Blažek 1999: 224; Adams 2013: 411, 415–416).

Toch. A *naktsu*, Toch. B *nektsīye* adv. 'last night, at night', Toch. A *nokte* 'at night', *noktiṃ* 'last night' (< Toch. **nekᵘ̯t-* < IE **nekᵘ̯t-*; cf. L. Gr. νύξ, νυκτός, L. *nox*, *noctis*, Goth. *nahts*; Pokorny IEW: 762–763; van Windekens 1976: 319–320; Pinault 1990: 181–190; LIV^2: 449; NIL: 504–513; Adams 2013: 363);

Toch. B *laṅktse* 'easy, light' (< IE **H_1l̥ngᵘ̯ʰ-ti̯o-*; cf. Gr ἐλαφρός 'light in weight', Goth. *leihts*, Lith. *leñgvas* 'light'; cf. Pokorny IEW: 660–661; van Windekens 1976: 255–256; Adams 1988: 37; NIL: 243–245; Adams 2013: 590–591).

Toch. B *mäkte* 'as' (< IE **mén-kᵘ̯-tō-*; van Windekens 1976: 286; Adams 2013: 484–485).

Toch. A pt. *pakt-äṁ* (< Toch. *√*päkᵘ̯-s-* < IE *√*pekᵘ̯-s-*; cf. non-extended and *s*-extended forms: OIA pr. *pácati*, ao. *pákṣat*, L. pr. *coquō*, pf. *cōxī* 'cook'; cf. Pokorny IEW: 798; van Windekens 1976: 355; LIV^2: 468; NIL: 548–552; Malzahn 2010: 700–701; Adams 2013: 393–394);

Kᵘ̯ + s = Toch. ks:

Toch. [A *ops*,] Toch. B *okso* 'ox, cow' (< Toch. **okᵘ̯so-* < IE * *H_2ukᵘ̯son-*; cf. OIA *ukṣan-*, Av. *uxšan-* 'bull, ox', W. *ych*, OHG *ohso* 'ox'; cf. Sieg/Siegling 1908: 927; van Windekens 1976: 333; NIL: 368–370; Adams 2013: 117);

Toch. A pr. imp. *pakṣānt*, Toch. B pr. *päksäṁ*, part. pr. *päksemane* 'become ready for eating, cook, ripen' (< Toch. *√*päkᵘ̯-s-* < IE *√*pekᵘ̯-s-*; cf. unextended and *s*-extended forms: OIA pr. *pácati*, ao. *pákṣat*, L. pr. *coquō*, pf. *cōxī* 'cook'; cf. Pokorny IEW: 798; van Windekens 1976: 355; LIV^2: 468; NIL: 548–552; Malzahn 2010: 700–701; Adams 2013: 393–394);

Toch. B *mäksu* 'which, who, what' (< IE **mén-k*$^{u̯}$*-sō-*; van Windekens 1976: 285; Adams 2013: 485).

12.2.5 The clusters *dental + t/s*

The attested outcomes of the IE cluster **Tt* are usually *ts* or $t^s t^s$, often attested from the same root (van Windekens 1976: 105).

Note: The outcome *tts*, reconstructed in the example of TB *wrattsai* could be a reading mistake, according to Adams 2018: 670, who reconstructs *wrantsai*, and gives a different etymology (cf. *l.c.*).

T + t = Toch. t^st/t^st^s:

Toch. A *wärts*, Toch. B *aurtse, wartstse* 'broad, wide' (< Toch. **wärtse* < IE **u̯r̥d*^{h}*-to-*; cf. OIA *vr̥ddhá-* 'enlarged, big'; cf. Pokorny IEW: 1167; van Windekens 1976: 105, 562–563; Adams 1988: 39; Görtzen 1998: 412; Adams 2018: 139–140);

Toch. B *orotstse, wrotstse* 'great, big, large; adult' (< Toch. **nätsw* < IE **ā-√u̯ r̥H*$_2$*d*^{h}*-to-*; cf. OIA *vrādhant-* 'being big'; cf. Pokorny IEW: 1167; van Windekens 1976: 105, 341; Görtzen 1998: 412; Adams 2018: 127–128, note here on detailed discussion);

Toch. A *nätsw-*, Toch. B *mätsts-*[243] 'starve' (< Toch. **nätsw* < IE **n-H*$_1$*d-tu̯-i̯e/o-*; cf. Gr. νηστεύω 'fast', νῆστις 'fasting'; cf. Pokorny IEW: 287–288; van Windekens 1976: 105, 316–317; Adams 2018: 139–140);

Toch. B *wrattsai*[244] 'against' (< IE **u̯r̥t-to-*; cf. L. *versus*; cf. Pokorny IEW: 1156–1157; van Windekens 1976: 105, 583; Adams 1988: 39);

Toch. B inf. *lyutsi* 'cross, go out, leave' (< Toch. **√läut-* < IE **√H*$_1$*leu̯d*^{h}*-*; cf. Gr. ἐλεύσεται 'go', OIr *luid* 'went'; cf. Pokorny IEW: 306–307; van Windekens 1976: 269–270; LIV^2: 248–249; Malzahn 2010: 856–858; Adams 2013: 605–606);

Toch. B *wästarye* 'liver' (< Toch. **wästäri̯ä-* < IE **ud-tr̥i̯o -*; cf. OIA *udára-* 'belly', Gr. ὑστέρα, L. *uterus* 'womb'; cf. Pokorny IEW: 1104; van Windekens 1976: 565; Adams 1988: 39; Hilmarsson 1993b: 216–217; Ringe 1996: 71; Adams 2018: 651);

T + s = Toch. ts:

Toch. A pr. *lutseñc*, grd. *lutṣäl*, Toch. B pt. *lyutsāmai* 'cross, go out, leave' (< Toch. **√läut-* < IE **√H*$_1$*leu̯d*^{h}*-*; cf. Gr. ἐλεύσεται 'go', OIr *luid* 'went'; cf. Pokorny IEW: 306–307; van Windekens 1976: 269–270; LIV^2: 248–249; Malzahn 2010: 856–858; Adams 2013: 605–606);

Toch. A pr. *yātṣānt*, Toch. B pr. *yātṣäṃ*'be capable of; succeed; tame' (< Toch. **√yēt-* < IE **√yet-*; cf. Av. *yateiti* 'place in order, strive after'; cf. Pokorny IEW: 506–507; LIV^2: 313–314; Malzahn 2010: 785–787; Adams 2013: 527–528, but van Windekens 1976: 645 assume a borrowing!);

secondary: Toch. A, *tsepant* 'danceur', B verb. *tsip-* nom. *tsaipe* 'dance' (cf. OIA *túṣyati* 'be satisfied'; cf. van Windekens 1976: 110; but sceptical Adams 2018: 808, 812);

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[243] The Tocharian B form is with a distant assimilation on following **u̯*, cf. Adams 2013: 493.

[244] But Adams 2003: 670 reconstructs *wrantsai*, based on the graphical evidence, this form absolutely excludes the etymology given in the entry above (cf. *l.c.*).

12.2.6 The clusters *sibilant + t/s*

The IE cluster **st* is preserved (often cerebralized, at least in writing); there are no examples for the development of the IE cluster **ss*:

S + t = Toch. st:

Toch. A, *kaṣt*, Toch. B *kest* 'hunger' (< Toch. **kestā* < IE *√*kost*-; cf. Hitt. *kašt*, OIA *ghasati*, *kṣut* 'hunger' ; cf. Pokorny IEW: 841–842; van Windekens 1976: 189; LIV^2: 198–199; Carling 2009: 107; Adams 2013: 213);

Toch. B *pest*, *päst* '[some particle]', *postäṃ* 'later, afterwards' (< Toch. **scar-ii̯ē* < IE **post*; cf. L. *post*, Gr. ἀστήρ; cf. Pokorny IEW: 841–842; van Windekens 1976: 367, 383–384; Adams 2013: 408–409, 430–431, 436–437);

Toch. A *ṣtare* 'effort', Toch. B *ścīre* 'hard, harsh, rough, crude' (< Toch. **scärēn* < IE **sterH₁-eH₁-en*; cf. Gr. στερεός, στερρός 'firm, solid', OHG *starēn* 'stare at'; cf. Pokorny IEW: 1022, 1029–1030; van Windekens 1976: 482; LIV: 597–598[245]; Adams 2013: 700–701);

Toch. [A *śreñ*],[246] Toch. B n. [f. pl.] *ścirye* 'star' (< Toch. **scar-ii̯ē* < IE **H₂stēr*; cf. L. *stella*, Gr. ἀστήρ; cf. Pokorny IEW: 1027–1028; van Windekens 1976: 486; NIL: 348–354; Adams 2013: 701);

Toch. B pr. *yaṣtär* 'excite, touch' (< Toch. *√*i̯as*- < IE *√*i̯es*-; cf. OIA *yásati* 'froths up; strives after', Gr. ζέω 'boil, seethe'; cf. Pokorny IEW: 506; van Windekens 1976: 595; LIV^2: 312–313; Malzahn 2010: 533; Adams 2013: 802–803);

Toch. A inf. *wassi* (!), B inf. *wastsi/wassi* (!) 'dress, wear clothes', nom. *wastsi* 'clothing' (< Toch. **u̯äs-t/d^h*- < IE *√*u̯es*-; cf. OIA *váste* 'be dressed', Alb. *vesh* 'wear', Goth. *wasjan* 'wear'; cf. Pokorny IEW: 1172–1173; van Windekens 1976: 564; LIV: 692–693; Malzahn 2010: 896; Adams 2013: 635, 649);

S + s = Toch. ss:

Toch. B pr. *āṣṣäṁ* 'bring, fetch' (< Toch. **ās-sk*-; etymology unclear, could be a borrowing; cf. van Windekens 1976: 624; Malzahn 2010: 533; Adams 2013: 63);

Toch. B pr. *keṣäṁ* 'quench, extinguish' (< Toch. **käs-s*- < IE *√*g^{u}es-;* cf. OIA *jásate* 'be exhausted', OCS *-gasiti* 'extinguish'; cf. Pokorny IEW: 479–480; van Windekens 1976: 210; LIV: 541–542; Carling 2009: 160; Malzahn 2010: 594; Adams 2013: 188);

12.2.7 The overview of the Tocharian development

In the following table, the palatalized outcomes are omitted, since specifically Tocharian and their outcomes could be easily deduced from the non-palatalized outcomes.

IE	Tocharian	t-	s-
-k^u/g^u/g^{uh}	k^u	*kt*	*ks*
-k/g/g^h	k	*kt*	*ks*
-ḱ/ǵ/ǵ^h	k	*kt*	*ks*
-t/d/d^h	t	*t^{s}t^s* (?)	*ts*
-p/b/b^h	p	*pt*	*ps*
-s	s	*st*	*ss*

[245] LIV does not list Tocharian with the root!
[246] The Tocharian A form is from the syncopated form, with *t/c* lost in a newly created cluster.

12.3 Trajectories of the development

The development of IE clusters in Tocharian is, besides the dental series, very conservative. The labiovelars are neutralized on plain velars (as they are in Latin, for comparison). Surprisingly the clusters *ss* are fully preserved (or restored). The clusters of *dental plosive + t* are usually realized either as simple affricates or as clusters of two affricates.

12.3.1 Development of clusters *labial* + *t/s*

Labials, like all other peripheral series in Tocharian, did not undergo any particular development in clusters formed by *t/s*: the plosives are fully preserved (at least in the internal clusters):

P + **t** > **pt**

P + **s** > **ps**

Note: The attested development of the IE *#Ps > Toch. *#0s: Toch. A *sāt* 'hot', B *satāsk* 'exhale' (< IE **ps-ōd-*, derived from IE *√b^h*es-*; van Windekens 1976: 103, 419–420; doubted as genuine by Adams 2013: 736–737) is a regular process not a chance one, especially since Peyrot (2008: 72) lists many examples of variation of the Tocharian B clusters #*PC-* (where *C* is any obstruent).
We meet another example in IE *Ps > Toch. *#pVs attested in Toch. A *päśśäṃ*, B *päścane* 'breast; [in plural] seat of wisdom' (< IE **pstḗm*; cf. Hitt. *istanza* 'soul'-; cf. van Windekens 1976: 103; Ringe 1996: 71; Adams 2013: 386) is simply a case of an anaptyctic vowel. To judge if this process of anaptyxis is regular for word-initials is also hard due to lack of other examples.

12.3.2 Development of clusters *plain velar* and *palatovelar* + *t/s*

The plain velar and palatovelar plosives are preserved as plain velar plosives before *t-* and *s-*, since, as Tocharian languages are both *centum*-languages, there is no trace of any phonemic distinction preserved:

K/Ḱ + **t** > **kt**

K/Ḱ + **s** > **ks**

Note: Tocharian A alternation between *tā* '(vers) où' vs Toch. A *te* '(L.) -ne' (both from *k^{u}*u-* + **to-*, van Windekens 1976: 105) could be a sign of an alternation #*Kt* ~ #*0t-*, as it is with Toch. B k_u*se*, k_u*ce* vs *se*, *ce* of the same compound pronoun (Peyrot 2008: 71–72).
Peyrot (2008: 72) lists examples of a variation of Toch. B *kṣ* ~ *k* in borrowings from Sanskrit, but not in autochthonous words; Peyrot connects it to a received pronunciation of this cluster in Middle Indo-Aryan and a stylistic marker sui generis.

12.3.3 Development of *clusters* labiovelar + *t/s*

For the development of IE labiovelars in clusters with *t/s* we assume the neutralization of the labial marker before any obstruent, similarly as attested fully in Latin, partially in other languages. This neutralization of labiality was later extended to other contexts (cf. Adams 1988:37; Kim 1999, especially pp. 177–182):

K$^{\text{u̯}}$ + t > kt

K$^{\text{u̯}}$ + s > ks

12.3.4 Development of clusters *dental* + *t/s*

The traditional trajectory for IE clusters of **Tt* is assumed as that for affrication, either of the first member or both dental plosives, cf. Krause (1952: 18) or van Windekens (1976: 105). Adams (1988: 39–40) assumes that IE **Tt* > *st*, **Ti̯* > *tsts*, i.e. that the outcomes differentiate due to the palatal context; Ringe (1996: 71) doubts the fact that there is a secure example of the development of IE **Tt* at all (otherwise he states **Tt* > *st*, based on the singular example of Toch. B *wästarye* 'liver'), and Kümmel (2007: 352) lists the same outcome. However, the above-noted examples are of the wide range: *tsts*, *tst*, *ts*, even *st*. It would be easiest to assume affrication since the early phase, often doubled (either as progressive assimilation or due to a secondary palatalization), partially simplified as *tts*.

Note: The single example of *st* of Toch. B *wästarye* 'liver'; cf. van Windekens 1976: 565; Adams 1988: 39; Hilmarsson 1993b: 216–217; Ringe 1996: 71; Adams 2018: 651, though etymologically entirely acceptable as reflecting the same formation as OIA *udára-*, remains a mystery, could be a result of a unique process, or of an unknown context feature.

The development of IE cluster **Ts* could be modelled either as a preservation of the old cluster (but note that other IE languages often have a specific simplification as **0s*) or as restoration, the process we prefer (cf. Görtzen 1998: 415):

T + t > t^{s}t > **t^{s}t^{s}/t^{s}t**

T + s > t^{s}s > **ts**

Note: We have to reject that there is a Bartholomae-like distinction in Pre-Tocharian, as Görtzen (1998: 415), who models **Tt* > *t^{s}t/t^{s}t^{s}/ts* and **d^{h}t* > *d^{z}d^{h}* > *zd^{h}* > *st*, proposes.

12.3.5 Development of the clusters *sibilant* + *t/s*

The IE clusters of a sibilant + *t/s* are preserved as such, surprisingly in the case of *ss* clusters, since we have reasons to assume that such clusters were often simplified as *0s* in other IE languages, probably even in the proto-language itself, which is usually typical and well-attested for clusters with the IE root **H₁es-*, cf. OIA *ási*, Gr. εἶ, Lith. *esì*, OCS *jesi*. For Tocharian, we can assume either preservation, or restitution (cf. Gr. Aeol. ἔσσι, Ep. and Dor. ἐσσί, OL. *essis*, *ēs* vs L. *es*):

s + t > st

s + s > ss

12.4 Conclusion and final remarks

The development of the IE obstruent clusters in Tocharian is very conservative. The single progressive feature is the fricativization of the IE cluster **Tt*, shared with other IE languages. In Tocharian this process is affricativization, attested otherwise only in Hittite, though usually generalized for the development of all IE languages as a first stage of a more complex development, usually ending in sibilant outputs. The cluster **Ts* has a natural affricate outcome either due to the preservation of the original state or through the re-archaization of the intermediate **t*^{s}*s*.

The peripheral series fully preserves the original plosives in all clusters, as do clusters with the sibilant. What is remarkable is the development of labiovelars, for which we assume the neutralization of a labial marker in the contexts of *t/s*, the same is known either fully preserved (Latin) or at least partially (especially Germanic languages), but we have to keep in mind that delabialization of labiovelars is often present in other contexts in Tocharian, being almost universal.

Note: Beyond the scope of this work, there are interesting developments of three-obstruent clusters, which could be worthy of a reader´s interest: Adams (1988: 38–39) notes that IE clusters of **Ksḱ*, **Tsḱ* (*sḱ* is here a part of an iterative/intensive suffix) are realized as Tocharian *sk* and *tk* respectively. He assumes that **Psḱ* would realize as *sk*, if we accept the analogical process with all peripheral series, but knows no examples. The example for **Ksḱ* > *sk* is: IE **u̯ok*^{u}*-sḱe/o-* > Toch. AB *wesk* 'speak' (cf. Pokorny IEW: 1135–1136; Adams 2013: 658–660), for **Tsḱ* > *tk* then: IE **snud-sḱe/o-* > Toch. B *snätk-* 'permeate' (cf. Pokorny IEW: 972; Adams 2013: 779). A remarkable feature of the development is different outcomes: in the case of **Ksḱ* > Toch. *sk* the left velar is lost and a sibilant preserved, in the case of **Tsḱ* > *tk* the sibilant is lost. Neither development mirrors the other.

13 The development of the two-obstruent clusters in the Indo-European languages: the summary and conclusions

The processes affecting the development of clusters of *obstruent* + *t/d^h/s* in various Indo-European sub-branches could be classified as:

i. the *shared*-processes, i.e. the processes in similar contexts, of the same origin (e.g., the Common Indo-European first phase of the development of the *dental* + *t/d^h/s* clusters; another example is the earliest phase of the development of the *palatovelar* + *t/d^h/s* clusters in the *satəm*-languages; the third example is the old neutralization of labiovelars in the context of + *t/d^h/s*, securely attested at least in some of the *centum*-languages);
ii. the *drift*-processes, i.e. parallel processes in similar contexts, independently caused (e.g., the spirantization of the peripheral series in Iranian, Celtic, Sabellian, Slavic);
iii. the *zero*-processes; i.e. the retention of the original state (e.g., the preservation of the peripheral series in Latin, Greek, Vedic, Baltic). Zero-processe seems to be trivial, but we have to remember that the preservation of a state is as important as a change of it, especially in comparison. The *zero*-processes has to be distinguished from *re-archaization* processes (as is the restitution of a plosive in clusters of *dental* + *t/s/d^h*- in Indic).

In the following lines, we will list the known outcomes of the IE clusters in given daughter languages and branches and then sketch up possible trajectories. The boldly marked outcomes are attested; the lightly marked outcomes are constructs. Analogous forms are listed, but not included in the trajectories graphs.

13.1 The development of the central series

There are two developments of the central series: the shared development of the dental series, present in some form in all Indo-European languages, with the seemingly (and false) exception of Indo-Aryan; and the shared development, limited to the *satəm*-languages, of the palatovelar series.

A similarity in the development of both series is striking since both series, however, with original plosive inputs, usually have sibilant outcomes (Hittite and Tocharian being remarkable exceptions with affricate outcomes of the IE cluster **Tt*, Nūristānī and Armenian with a zero outcome for the same cluster, Albanian with a zero outcome both for the IE **Tt*, but also for IE **Ḱt*).

For the development of both central series we can draw two possible trajectories through the ‘black box’, which could be summed under terms of the *affricativization* trajectory and the *spirantization trajectory*.

13.1.1 The development of central series I: the dental series

The singular development of the IE cluster **Tt*, common to all sub-branches of Indo-European languages, is the development of the dental series.

Note: Surprisingly, Kümmel (2007: 349–350) gives a shortlist of shared IE consonantal developments without at least the first phase of the development of the dental series, but deals with the whole process with as a series of later developments in each of the IE sub-branches (Kümmel 2007: 350–411).

This development has the following outcomes:

i. IE *Tt** > $t^s t^{(s)}$, attested in Anatolian and Tocharian;
ii. IE *Tt** > *tt*, attested in Old Indo-Aryan (and probably attested in Nūristānī);
iii. IE *Tt** > *st*, attested in Iranian, Greek, Balto-Slavic;
iv. IE *Tt** > *ss*, attested in Italic, Celtic[247] and Germanic;
v. IE *Tt** > *u̯t*, attested in Armenian;
vi. IE *Tt** > *c*, attested Albanian;

The Albanian outcome could not be the result either of an older *st*-outcome (Balto-Slavic/Iranian/Greek style) since IE **st* is realized as Albanian *št* nor could it be a result of the Italic/Celtic/Germanic **ss*-outcome, since the outcome of the IE **ss* in Albanian is *0š* (as it is of the IE **Ts*). The most probable predecessor of IE **Tt* in the earlier stages of the Albanian development was probably an affricate (Anatolian/Tocharian style) or a fricative (assumed as on older stage for all developments outside the Anatolian/Tocharian model).

The Armenian outcome could not be attributed directly to one of the four types mentioned above either, since the stage **st* is impossible, since the IE **st* cluster is fully preserved and if this cluster merged with that of IE **Tt*, the outcome would be the very same. Moreover, the **ss* outcome for **Tt* is also impossible since IE **ss* is realized as Arm. *0s*.

The development of the cluster of dental plosive + *s* in various IE branches can be listed as:

i. IE **Ts* > *ts*, attested Old Indo-Iranian, Hittite and Tocharian;
ii. IE **Ts* > *0s*, attested in Avestan, Baltic, Slavic, Greek and Albanian;[248]
iii. IE **Ts* > *ss*, attested in Italic, Celtic (the Gaulish *ðð* being its variant) and Germanic;
iv. IE **Ts* > $t^{š}$, attested in Nūristānī;
v. IE **Ts* > *c*ʿ, attested in Armenian;

The Hittite and Tocharian developments are securely archaic, preserving the older state. The Indo-Aryan development can not be detached from the Iranian – we have all the reasons to assume that both branches had a shared development, from which we have to model both

[247] The Gallic outcome *đđ* (of the insecure phonetic value) alternates with *ss* and is considered both a variant and a predecessor of the *ss* outcome.
[248] In Albanian, the outcome is *0š*, due to later palatalization of the sibilant.

trajectories; therefore the preservation of the older state (as in Hittite and Tocharian) is then impossible for Indo-Aryan. We assume the spirantization of *T* before *s* not only for Indo-Iranian but for all IE languages (outside Hittite and Tocharian); the Indic outcome is the later re-archaization, while the Iranian state is a progressive outcome, resulting from the merging of the dental spirant with a sibilant. All other languages with *0s* outcomes followed the same trajectory.

The development of the clusters of *dental plosive* + d^h can be securely reconstructed in a few languages, and we have to highlight that the outcome is **always** given by the voicedness of these right contexts, even in Greek, where the IE *d^h was devoiced, and subsequently, the clusters were analogically remodelled. The outcomes in Indo-Iranian, Greek and Baltic are:

i. IE *Td^h > dd^h, attested in Old Indo-Aryan as the *major* outcome;
ii. IE *Td^h > *zd*, attested in Iranian and Baltic as a regular outcome, in OIA in the form of $0d^h$ as the *minor* outcome;
iii. IE *Td^h > st^h, attested in Greek;

The traditional **affricativization trajectory**, first formulated by Kräuter (1977: 88)[249], evaluated by Verner (1878: 341–342) and popularized by Brugmann (1880 and passim) is usually assumed for the whole development, which can be modelled for first four outcomes as follows: with a sibilantization of the left plosive (= the loss of the plosive segment of the affricate), with a loss of the sibilant segment (= re-archaization) or with a further affrication of the whole cluster and its simplification of sibilants:

Tt > tt > **t^{s}t** > **st**
> **tt**
> t^{s}t^s > **ss**

Note: Both the Armenian and Albanian outcomes could hardly be put within the affricativization trajectory, hence we do not dare to propose any trajectories of their developments.

The great advantage of the affricativization trajectory is the attested preservation of affricates in Hittite and Tocharian (exceptions in Tocharian could be explained as a further development along the very same trajectory). What is problematic is application for the development of Armenian, which could not be attached to the affricate stage, to a sibilant or to the double sibilant stage. Similarly we might be tempted to attach the Albanian outcome to the double-sibilant outcome, but the Albanian outcome of *Tt* is different from that of *Ts* and *ss,* hence impossible. That the Indo-Aryan outcome is re-archaized is supported by the fact that the IE cluster **ss* is realized in OIA usually as *ts*, which demonstrated that outcomes of IE **Tt* and **ss*

[249] Also Verner (1878: 341–342).

were merged in some point of development. Italo-Celtic-Germanic development is the result of a similar trajectory.

Note: A specific development of the final -d^h, affected by Bartholomae's Law, is known from Indo-Iranian. The trajectory would be modelled, according to the affricativization strategy, as:

$d^h t > d^z d^h >$ $\mathbf{dd^h}$
$> \mathbf{zd^{(h)}}$

The affricativization trajectory for the development of IE clusters of **Ts* was reconstructed fully only by Lipp (Lipp 2009a: 169) for the Indo-Iranian languages. It is remarkable that both languages with affricate outcomes of the **Tt* cluster (Hittite and Tocharian) do not show any trace of the more complex developments attested in languages **without** the attested affricativization of **Tt* clusters. The Hittite/Tocharian development could be either an archaic feature or a simplification of the affricate back to *ts* by the loss of one of the sibilants. We can also consider Indic, Nūristānī and Armenian outcomes as archaic (or re-archaized) (here with later aspiration).

Ts > **ts**
> $t^s s$ > **ss** > 0**s**
> **ts** (?)

The affricativization trajectory assumes affricativization, followed in OIA by re-plosivation, and by a sibilantization in other languages (and the same process is the minor process in OIA, the loss of a voiced sibilant allophone is known from proper sibilants in the same context, cf. below). The Greek trajectory is affected by analogy remodelling, hence omitted:

$Td^h > d^z d^h >$ $\mathbf{dd^h}$
$> zd^{(h)} > 0\mathbf{d^h}$

The **spirantization trajectory** was independently brought forward for Italic by de Saussure (1877), independently by Cocchia (1883: 16–58)[250] and Bartholomae (1887: 83; Bartholomae 1895: 16), followed by Leumann (1942: 13) and Morgenstierne (1942: 80; for Iranian only). Applying this trajectory to the development of the IE cluster of *plosive* + *t*, the trajectories for the *st*-group (Iranian, Greek, Balto-Slavic), Indic and the *ss*-group (Celto-Italic-Germanic) could be modelled as:

[250] And we have to remark that his idea was dismissed by Brugmann (1885: 183).

Tt > tt > ϑt > **st**
> **tt**
> ϑϑ > **ss**

That the Indo-Aryan outcome is re-archaized is supported by the fact that the IE cluster **ss* is usually realized in OIA as *ts*, which demonstrated that outcomes of IE **Tt* and **ss* were merged in some point of development. Italo-Celtic-Germanic development is the result of a similar trajectory: IE **Tt* was spirantized as *ϑt*, assimilated first to *ϑϑ* and later to *ss*, merging both with the original IE **Tt* and **st* clusters.

Albanian development, according to the spirantization trajectory is a series of spirantization and later affricativization and sibilantization: *Tt > ϑt > ϑϑ >* t^s (= *c*) > *0s*.

Armenian development has (after spirantization) the later debuccalization of the fricative: *Tt > ϑt > ht > u̯t.*

Note: A specific development of -d^h, affected by Bartholomae's Law, is known from Indo-Iranian. For the trajectory of Bartholomae's Law, we assume spirantization for all series , followed by a re-plosivation in OIA:

d^ht > ðð > **dd**$^{\mathbf{h}}$
> **zd**$^{\mathbf{(h)}}$

The development of the cluster of *dental plosive + s* according to the spirantization trajectory is similar to that of **Tt*: the spirant was often sibilantized (and the geminate simplified). In Indic the spirant was fortified as a plosive, and a similar process, followed by affricativization and later aspiration, is attested in Armenian and probably in Nūristānī (here the re-plosivation is probably related to that of OIA). The Gallic state shows the free variantion of the dental spirants with dental sibilants.

Ts > ϑs > **ss** > 0**s**
> **ts** > **c**ʻ

Note: Bartholomae's Law applies even on clusters of d^hs in Indo-Iranian, but Indic outcomes are levelled:

d^hs > ðz > zz > **0z**

The proposed trajectory of the development of the Td^h-clusters within the spirantization/lenition trajectory assumes first spirantization, followed in OIA by re-buccalization as a plosive, or by a sibilantization in other languages (and the same process is the minor process in OIA, as the loss of a voiced sibilant allophone is known from proper sibilants in the same context, cf. below). The Greek trajectory is affected by analogy remodelling, hence omitted:

$Td^h > ðd^h >$ **dd^h**
$> zd^{(h)} > 0$**d^h**

Note: Principally the same development is valid for the development of IE clusters of $*d^hd^h$ into Indo-Iranian.

To sum up: there are two languages with affricate outcomes both for the **Tt* and **Ts* clusters, namely Hittite and Tocharian, both being peripheral languages, and there is no other possible trajectory for both languages than the affricativization trajectory. On the other hand, for all other languages the spirantization trajectory is more probable, since especially the development of the **Ts* > (*s*)*s* excludes the possibility of affricativization (the intermediate $*t^ss$ could be easily simplified on t^s but we have full sibilant outcomes). Affricativization development is wholly impossible for Indic: if we accepted affricativization development both for the dental and the palatovelar series, it would be impossible for the assumed (**Tt* >) t^st (> Indic *tt*) to lose the plosive segment and the parallel and contemporary (since both processes are operating after the split of the Indo-Iranian languages) (**Ḱt* >) $t^{\check{s}}t$ (> Indic *ṣṭ*) would lose the fricative segment of the affricate – this paradox is not present within the spirantization trajectory.

The spirantization trajectory also makes it easier to explain Italic-Celtic-Germanic *ss*-outcome; the merging of the IE **Ts* and **ss* in a single *ϑs* output also explains why the Indic outcome of the **ss* is surprisingly *ts* (and of **šs* is *kṣ*), which is otherwise a solitary and isolated process.

However, the distinction between the affricativization and the spirantization trajectory is not as wide as it could see: both fell within the same frame of fricativization, and while the affricativization presumes the insertion of the fricative segment into a given cluster, the spirantization presumes the fricativization of the already existing segment. Both peripheral languages (Tocharian and Hittite) used the affricativization variant of the fricativization trajectory, but all other languages used the spirantization variant of the same trajectory.

13.1.2 The development of the central series II: the palatovelar series

The development of the IE clusters of **Ḱt* into given *satəm*-languages usually has an outcome in the form of a sibilant (either palatal or non-palatal) + *t*. The single exception is Albanian, where the outcome is *0t*:

i. IE *Ḱt** > *št*, attested in Iranian, Lithuanian;
ii. IE *Ḱt** > *ṣṭ*, attested in Indo-Aryan and Nūristānī; the geographical variant of the preceding development;
iii. IE *Ḱt** > *st*, attested in Slavic and Armenian;
iv. IE *Ḱt** > *0t*, attested in Albanian;
(v. IE *Ḱt** > *kt*, attested in the *centum*-languages).

The development of the cluster of *palatovelar + s* in various IE branches can be listed as:

i. IE **Ḱs* > *kṣ*, attested Old Indo-Iranian;
ii. IE **Ḱs* > *0š*, attested in Avestan, Lithuanian and Albanian;[251]
iii. IE **Ḱs* > *0s*, attested in Slavic;
iv. IE **Ḱs* > *t*^{s}, attested in Nūristānī; the outcome *c*^{ʿ}, attested in Armenian, is a variant;
(v. IE **Ks* > *0š*, attested in the *centum*-languages)

The **affricativization strategy** assumes the affricativization of the original palatovelar in the *satəm*-languages, and its later sibilantization (in Indo-Iranian, Armenian and Balto-Slavic).[252]

Ḱt > t^{š}t > **št** > **st**
> **ṣṭ**

Note: Bartholomae's cluster of **ǵ*^{h}*t*, according to the affricativization trajectory, can be modelled as follows both for Indic (i̯ḍ^{h}) and Iranian (*žd*):

ǵ^{h}t > ȷd^{h} > žd^{h} > ẓḍ^{h} > **i̯ḍ^{h}**
> **žd**

The development for the cluster of **Ḱs* in the *satəm*-languages within the affricativization trajectory can be modelled as follows (with affricativization, sibilantization, simplification for Iranian, Lithuanian and Albanian with depalatalization for Slavic; with de-affricativization and location shift for Indic; with the later aspiration of the affricate in Armenian; a simplified affricate is attested in Nūristānī):

Ḱs > t^{š}s > šš > **0š > 0s**
> ṭṣ > **kš**
> **ts** > **c**$^{(ʿ)}$

Note: Bartholomae's cluster of **ǵ*^{h}*s*, the affricate model is (the Indic outcome is due to the analogy):

ǵ^{h}s > ȷž^{h} > dž^{h} > ḍẓ (→ **kṣ**)
> žž^{h} > žž > **0ž**

Within the **spirantization strategy**, we assume that the clusters were spirantized, either as a palatal spirant or as a velar one (either directly from the 'neutralization' form *kt* or due to the depalatalization of **çt*). The palatal spirant was later sibilantized (eventually depalatalized later), the velar spirant was debuccalized as simple *ht* or even fully elided (we model this development for Albanian, since in Albanian even IE **Kt* realizes as *0t*).

[251] The Albanian outcome should be listed with Slavic, since old sibilants merged into *š* in Albanian.
[252] The Albanian development (based on Schumacher 2013: 243) assumes deaffricativization (technically gemination) and simplification of the cluster (*Ḱt* > *t*^{š}*t* > *tt* > *0t*).This development definitely must have been later than the development of the IE cluster **Tt*, since it had not merged with it.

Ḱt > çt   > **št** > **st**
(> kt) > xt > ht > **0t**

Note: As with all series, there is a specific development of -*ǵ^h+t* in Indo-Iranian, affected by Bartholomae's Law. We model the following spirantization trajectory, assuming the spirantization of the palatovelar:

ǵ^{h}t > ǰð > žð > ẓḍ^h > **0ḍ^h**
> **žd**

Within the **spirantization** strategy, for the development of the cluster of a palatovelar plosive + *s*-, we assume first the neutralization of a palatalization (and palatalization of a sibilant due to the *ruki*-rule), followed in many languages by spirantization, sibilantization and simplification:

Ḱs > kš > **kṣ**
> çš > šš > **0š**
> ϑš > **ts** > **0s**

Note: We can model the 'Bartholomaen' development of the cluster of **ǵ^{h}s* according to the spirantization trajectory as (valid for Iranian; Indic development was replaced by the analogy):

ǵ^{h}s > ǰz > ǰž > žž > **0ž**

The development of the clusters of *palatovelar plosive + d^h* can be securely reconstructed in a few *satəm*-languages (technically: Indo-Iranian and Baltic), and the outcomes are always voiced. The outcomes in Indo-Iranian and Baltic are:

i. IE **Ḱd^h > ḍḍ^h*, attested in Old Indo-Aryan;
ii. IE **Ḱd^h > žd*, attested in Iranian and Baltic;

The proposed trajectory assumes the spirantization of the palatovelar and later sibilantization of the spirant, this sibilant is lost in Indic:

Ḱd^h > ǰd^h > žḍ^h > **ḍd^h**
> žd^h > **žd**[253]

Note: Essentially the same development is valid for the development of IE clusters of **ǵ^{h}d^h* into Indo-Iranian, since they share the same outcome.

13.2 The development of the peripheral series

The set of the input peripheral series differ according to the *centum/satəm* languages dichotomy, the first having labiovelars preserved (at least on a re-constructible level) beside plain velars

[253] The outcome is *zd* after depalatalization in Prussian and Latvian.

and labials, the second having the old IE labiovelars merged fully with the plain velars (however, such merging is known from the *centum*-languages as well).

Note: The logical consequence of this feature is clear: the positive marker we can use to distinguish the *centum/satəm* languages is not the presence of the labiovelars series, but the presence of the palatovelar series. In other words: the *centum*-languages are all languages without the presence of the original palatovelar series, so the *centum*-languages are hence ‘negatively’ defined and the *satəm*-languages are defined ‘positively’.

Regarding the data of the attested Indo-European languages, we can state that there are two strategies in general: the **conservative strategy** (with the ‘zero’ trajectory) and the **progressive strategy** (with the spirantization/lenition trajectory). We can express the distribution of both strategies in the following table:

CONSERVATIVE STRATEGY	PROGRESSIVE STRATEGY
Old Indo-Aryan	Old Iranian
Baltic	Slavic
	Armenian
	Albanian
Greek	(Middle Greek)
Latin	Sabellian
	Celtic
	Germanic
Hittite	
Tocharian	

A remarkable feature is that the split between both strategies could run through a given sub-branch, as we can see in the examples of the Indo-Iranian, Balto-Slavic or Italic language families.

Note: As we can see in the example of Middle Greek, spirantization could affect archaic clusters later. Similarly process we can see in the development of French from (Vulgar) Latin.
Note: Beside spirantization, there is another progressive strategy, far less attested: gemination. The process of gemination of the consonantal clusters is known from Middle Indo-Aryan and Italian. It is also usually attributed to the Pre-Slavic development.

13.2.1 The development of the peripheral series I: the plain velar series

A development of the plain velar series can be listed as:

i. IE **Kt* > *kt*, attested in Old Indo-Aryan, Baltic, Greek, Latin, Hittite and Tocharian;
ii. IE **Kt* > *xṭ*, attested in Iranian, Gallic, Irish;
iii. IE **Kt* > *ht*, attested in Sabellic and Gothic;
iv. IE **Kt* > *i̯t*, attested in Brythonic;
v. IE **Kt* > *0t*, attested Nūristānī, Armenian, Albanian and as a minor outcome in Slavic;
vi. IE **Kt* > *št*, attested in OCS as the major outcome.

The first group is within the *zero*-process, the old plain velars are preserved as plain velar stops.

The outcomes from ii. to v. are products of various lenitions, which we can order according to decreasing consonantal strength, *i̯* being the palatal counterpart of *h*:

Kt > **kt** > **xt** > **ht** > **0t**
> **i̯t**

The *št*- outcome of OCS (*c/ć*-outcome in other Slavic languages) is an original prepalatal variant, extended, due to analogy, to all productive clusters.

Note: The Armenian outcome displays aspiration of the *t*-context, known from the development of the all peripheral series (but not the central series!) in Armenian, cf. the development of labials in Armenian below. The older form was highly probably a spirant: the trajectory is: ***Kt*** >*xt* > *xϑ* >*hϑ* > **0t**ʿ.
Note: We model the 'Bartholomaen' development of the cluster of -*g*^{h}+*s* as:

g^{h}t > γð > gd$^{(h)}$[254]

The development of the cluster of *plain velar + s* in various IE branches can be listed as:

i. IE **Ks*> *ks*, attested in Hittite, Tocharian, Greek, Latin and in Baltic[255];
ii. IE **Ks*> *kṣ*, attested Old Indo-Aryan;
iii. IE **Ks* > *xš*, attested in Avestan;
iv. IE **Ks* > *xs*, attested in Gaulish;
v. IE **Ks* > *hs*, attested in Gothic;
vi. IE **Ks* > *0x*, attested in Brythonic and Slavic (beside its palatalized variant *0š*);
vii. IE **Ks* > *0š*, attested in Armenian, Albanian and Slavic (beside its non-palatalized variant *0x*);
viii. IE **Ks* > *ss*, attested in Goidelic, with *0s* attested in Sabellian;

The *ks*-outcome is the conservative one, with OIA *kṣ* as its *ruki*-variant attested in OIA. The progressive outcomes follow the spirantization/lenition trajectory:

Ks > **ks** > **xs** > **hs**
> xx > **0x**
> **ss** > **0s**
> **kš**[256] > **xš** > šš > **0š**

Note: Similarly, we model the 'Bartholomaen' development of the cluster of -*g*^{h}+*s* as follows (the outcome is attested in Iranian, Indic has the analogous levelling again):

g^{h}s > γz > gž[257]

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[254] This reconstruction is also valid for the development of **K*^{u}*t* clusters, since there is no distinction between plain velars and labiovelars in Indo-Iranian.
[255] The Baltic outcome is surprising, since it is the position where the *ruki*-rule is supposed to be operating.
[256] Also represents OIA *kṣ* here.
[257] Similarly to the development of the cluster of **K*^{u}*t*, this reconstruction is also valid for the development of **K*^{u}*s* clusters, since there is no distinction between plain velars and labiovelars in Indo-Iranian.

The development of the *plain velar plosive* + d^h clusters can be reconstructed securely in Indo-Iranian, Baltic and Greek, and the outcomes are always voiced. The outcomes in Indo-Iranian, Greek and Baltic are:

i. IE *Kd^h > $gḍ^h$, attested in Old Indo-Aryan;
ii. IE *Kd^h > *gd*, attested in Iranian and Baltic;
iii. IE *Kd^h > k^ht^h, attested in Greek;

The trajectory is simple for OIA and Baltic, but in Iranian we meet a typical spirantization and Greek has an analogy-based outcome, omitted below:

Kd^h > **gd^h** > γḍ^h > **γð/gd**

Note: The clusters of *g^hd^h are similarly developed.

13.2.2 The development of the peripheral series II: the labiovelar series

The development of the cluster of *labiovelar* + *t* in various IE branches can be listed as:

i. IE *K^ut > k^ut, attested in Hittite and Mycenaean;
ii. IE *K^ut > *kṭ*, attested in Latin, Tocharian, partially in Greek;
iii. IE *K^ut > *pt*, attested in partially in Greek;
iv. IE *K^ut > *xt*, attested in Goidelic (and probably in Gaulish);
v. IE *K^ut > *ht*, attested in Sabellic and Gothic;
vi. IE *K^ut > *i̯t*, attested in Brythonic;

The first group could be suspected to represent the *zero*-process, but it is more probable that this development is the result of a secondary analogous levelling, the older state being preserved in the second outcome, with the neutralization of the related series on the plain velars.

Note: The outcome in the conservative *satəm*-languages (OIA, Baltic) is also *kt*, the outcomes in the progressive *satəm*-languages follows the development of the *kt*-clusters (see above). We dare to propose that it is was the neutralization of labiality in the *t/s/*d^h-contexts (and in some other context too, especially before labial vowels, the process well known from Italic) which caused the final loss of labiality of the old labiovelars in later *satəm*-languages (the process with its parallel in Tocharian).

The third version of the development is limited to Greek and it is a secondary outcome of the development of labiovelars in Greek; here a labial is a direct heir of Mycenaean k^u.

The last three outcomes are all results of the spirantization (attested directly in Goidelic) or of a further lenition (attested in Sabellic, Gothic and Brythonic), all within the progressive strategy, following the development of plain velars, as described above[258]:

K^{u}t > **kt** > **xt** > **ht**
> **i̯t**

[258] A remarkable difference is the non-existence of the elided form *0t*, since it is attested for velars only in the *satəm*-languages.

The development of the cluster labiovelar + *s* in various IE branches could be listed as:

i. IE *$K^{u̯}s$> $k^{u̯}s$, attested in Hittite and Mycenaean;
ii. IE *$K^{u̯}s$> *ks*, attested in Latin, Tocharian, partially in Greek;
iii. IE *$K^{u̯}s$ > *ps*, attested in partially in Greek;
iv. IE *$K^{u̯}s$ > *hs*, attested in Gothic;
v. IE *$K^{u̯}s$ > *ss*, attested in Goidelic and *0s* attested in Sabellic;
vi. IE *$K^{u̯}s$ > *0x*, attested in Brythonic;

The $k^{u̯}s$-outcome is in our opinion a result of analogical levelling (as $k^{u̯}t$ is), while the *ps*-outcome is a result of the specific Greek development of the levelled clusters of $k^{u̯}s$, hence the conservative outcome follows the spirantization/lenition trajectory:

$K^{u̯}$s > **ks** > xs > **hs**
> xx > **0x**
> **ss** > **0s**

Note: The *satəm*-languages follow the same trajectory as the *Ks* clusters (see above), with the exception of Baltic languages.

Note: Since there are no wide and secure examples of the development of the IE clusters of *$K^{u̯}$ + d^h in the *centum*-languages (Greek clearly restoring both the labialization of the labiovelar and remodelling the cluster due to the loss of voicedness of the d^h), we willingly omit to reconstruct the trajectory.

Note: The development of the clusters of *$K^{u̯}d^h$ and *$g^{uh}d^h$ is essentially the same as the developments of the clusters of *Kd^h and *g^hd^h, respectively (cf. above).

13.2.3 The development of the peripheral series III: the labial series

The development of the cluster of *labial + t* can be summed up as:

i. IE **Pt* > *pt*, attested in Old Indo-Aryan, Avestan, Baltic, Greek, Latin, Hittite and Tocharian;
ii. IE **Pt* > *ft̯*, attested in Oscan, Gothic, reconstructed for Old Persian;
iii. IE **Pt* > *i̯t̯*, attested in Brythonic;
iv. IE **Pt* > *0t*, attested in Nūristānī, Slavic (as a major outcome), Armenian, Albanian;
v. IE **Pt* > *st*, attested as a minor outcome in Slavic;

The first outcome is a conservative one, other clusters falling within the spirantization/lenition trajectory, the oldest stage of which is roughly represented in the second outcome (for the first stage **φt* seems to be a more probable variant). Brythonic attests the further weakened approximant, the outcome *0t* the final, elided form. The minor outcome *st* known from Slavic is a result of a parallel process: sibilantization instead of lenition.

Pt > **pt** > φt > **ft**
> ht > **0t**
> **i̯t**
> st

Note: The Armenian outcome displays the aspiration of the *t*-context, known from the development of all the peripheral series (but not the central series!) in Armenian. The older form was highly probably a spirant; the trajectory is: ***Pt*** *>φt > φϑ >hϑ >* ***0t*‘**.

Note: We model the 'Bartholomaen' development of the cluster of -b^h+*t* again with a spirantization in the first phase:

b^hs > βð > **$bd^{(h)}$**

The development of the cluster of *labial plosive + s* in various IE branches can be listed as:

i. IE **Ps*> *ps*, attested in OIA, Lithuanian, Greek, Latin, Hittite and Tocharian;
ii. IE **Ps*> *fs*, attested in Avestan (beside *fš*)[259] and Gothic;
iii. IE **Ps > 0s*, attested in Slavic, Armenian, Albanian[260] and Sabellic;
iv. IE **Ps > xs*, attested in Gaulish;
v. IE **Ps > ss*, attested in Goidelic;
vi. IE **Ps > 0x*, attested in Brythonic;

Ps > **ps** > φs > **fs** > **0s**
> xs > **0x**
> **ss** > **0s**

Note: Similarly, we can model the 'Bartholomaen' development of the cluster of -b^h+*s* with an early spirantization as follows (again, Indic development is based on the analogy):

b^hs > βz > **bz**

The development of the clusters of *labial plosive +* d^h can be reconstructed again securely in Indo-Iranian, Baltic and Greek, and the outcomes are always voiced. The outcomes in Indo-Iranian, Greek and Baltic are:

i. IE *Pd^h > $bḍ^h$, attested in Old Indo-Aryan;
ii. IE *Pd^h > *bd*, attested in Iranian (the two-spirant cluster βð being its variant) and Baltic;
iii. IE *Pd^h > p^ht^h, attested in Greek;

The trajectory is simple for OIA and Baltic; in Iranian we meet a typical spirantization; Greek has an analogy-based outcome, omitted below:

Pd^h > **bd^h** > β$ḍ^h$ > **bd**

Note: Clusters of *b^hd^h are similarly developed.

[259] This outcome is an extension of the *ruki*-rule in Iranian (actually attested in Avestan only, not in Old Persian).

[260] The variant Albanian outcome *f* is a result of a metathesis of IE **ps* on **sp*. The trajectory is: *ps > sp > hf > 0f*, see above. The Albanian outcome of a cluster without this metathesis is *0š*, i.e., with a typical Albanian palatalization of a sibilant.

13.3 The development of the sibilant clusters

The set of phonemes of the reconstructed IE obstruent system has a single sibilant phoneme **s* (with a positional allophone *z before voiced plosives). The *satəm*-languages had another phoneme **š*, resulting from the split of the old single sibilant due to Pedersen's law (the *ruki*-rule), securely attested for four of the six *satəm*-branches, but insecure for Albanian and Armenian.

The development of the sibilant clusters are remarkably stable, the Celtic development being an exception.

The developments of the IE cluster of **st* could be summed as:

i. IE **st* > *st*, attested in all branches except Celtic and Albanian;
ii. IE **st* > *šṭ*, attested in Albanian;
iii. IE **st* > *ss*, attested in Celtic languages (in Gaulish beside the variant *ðð* of the insecure phonemic value);

The conservative *st*-outcome is a regular one, the Albanian *št*-outcome is a later result of the independent Albanian development.

The Celtic development, tied with the development of the IE clusters **Tt*, **Ts* (see above), can be explained only within this wider frame. If the Gaulish *ðð* had a value of an affricate, the trajectory would be, if we accept the proposal of Lewis/Pedersen (1937: 20): *st* > *ts* > *ss*, or, as we dare to propose: *st* > st^s > t^st^s > *ss*.

st > **st** > sϑ > **ϑϑ** > **ss**

The developments of the *satəm*-cluster of **št* can be summed up as:

i. IE **št* > *št*, attested in Iranian and Lithuanian;[261]
ii. IE **st* > *ṣṭ*, attested in OIA and Nūristānī;

Note: The OIA–Nūristānī outcome is just an area variation of the preceding regular outcome, as it is in the case of IE clusters of **Ḱt* > OIA *ṣṭ*.

The development of the clusters of *sibilant* + *s* usually leads towards the degeminated form of a single sibilant or to the preservation of the geminate. The bisibilant cluster could be considered not as a preserved one, but as an analogical restoration, since we have all the reason to consider the simplification **ss* > *0s* as already being Indo-European at least in the 2nd sg. pr. of the root *√H_1*es*- 'be' (cf. OIA *asi*, L. *es*, OCS *jesi*, Lith *esi*). A remarkable development is attested in OIA, where the verbal forms have the outcome *ts*. This form can be traced back to the older

[261] The Albanian outcome can not be distinguished from the outcome of the IE cluster **st*, since the old IE sibilant was regularly palatalized in Albanian.

spirant stage, resulting from the levelling of this cluster with a cluster of *ϑs*, which we reconstruct as a stage of the development of the IE cluster *Tt*, later re-buccalized in OIA.

ss > **ss** > **0s**
> ϑs > **ts**

The development of the clusters formed by a *ruki-sibilant* + *s* in the *satəm*-languages[262] usually also leads towards the degeminated form of a single sibilant or to the preservation of the geminate. Again, OIA is an exception, where the right sibilant is replaced by a plosive, this time velar (and the sibilant is cerebral). Even in this case we assume the shift of the original sibilant towards a spirant and later re-buccalization of the spirant (and an area cerebralization of a right sibilant):

šs > **šš** > **0š**
> xš > **kṣ**

The development of the clusters of *sibilant* + d^h is simple outside Indic (where any voiced sibilant of any origin is regularly lost), with the voicing of a sibilant. The Greek development is remodelled due to devoicing of the original IE context *d^h. For the IE **s* the development can be modelled as:

i. IE *sd^h > $0d^h$, attested in Old Indo-Aryan;
ii. IE *sd^h > *zd*, attested in Iranian and Baltic;
iii. IE *sd^h > st^h, attested in Greek;

And similarly, for the *ruki*-sibilant **ž* the outcomes are in the *satəm*-languages, with a loss of a sibilant in OIA, preserved as voiced in Iranian and Baltic:

i. IE *šd^h > $0ḍ^h$, attested in Old Indo-Aryan;
ii. IE *šd^h > *žd*, attested in Iranian and Baltic;

The trajectories for both sibilants we can model as:

sd^h > $\mathbf{zd^{(h)}}$ > zð > ðð > $\mathbf{0d^h}$
šd^h > **ž**$\mathbf{d^{(h)}}$ > žð > ð̣ð̣ > $\mathbf{0ḍ^h}$

262 Again, the Albanian and Armenian data do not distinguish this outcome from that of **ss*, since the validity of Pedersen's Law in these languages is questionable.

Appendix I: The comparative table of IE clusters *plosive* + t/*s*- in the given Indo-European languages[263]

i. the clusters *dental plosive + t/s-*:

IE	OIA	Av.	N.	Lith.	OCS	Arm.	Alb.	Gr.	L.	Os.	Gal.	Ir.	W.	Goth.	Hitt.	TB
Tt	tt	st	0t	st	st	u̯t	0s	st	ss	ss	ðð ss	ss	ss	ss	$t^{s}t$	$t^{s}t^{s}$
Ts	ts	0s	ć	0s	0s	cʿ	0š	0s	ss	ss	ðð ss	ss	ss	ss	ts	ts
tV	tV	tV	tV	tV	tV	tʿV	tV	tV	tV	tV	tV	tV	tV	þV	tV	tV

ii. the clusters *palatovelar plosive + t/s-*:

IE	OIA	Av.	N.	Lith.	OCS	Arm.	Alb.	Gr.	L.	Os.	Gal.	Ir.	W.	Goth.	Hitt.	TB
Ḱt	ṣṭ	št	ṣṭ	št	st	st	0t	kt	kt	ht	xt	xt	i̯t	ht	kt	kt
Ḱs	kṣ	0š	c	0š	0s	cʿ	0š	ks	ks	0s	xs	ss	0x	hs	ks	ks
ḱV	śV	šV	cV	šV	sV	sV	ϑV	kV	kV	kV	kV	kV	kV	hV	kV	kV

iii. the clusters *velar plosive + t/s-*:

IE	OIA	Av.	N.	Lith.	OCS	Arm.	Alb.	Gr.	L.	Os.	Gal.	Ir.	W.	Goth.	Hitt.	TB
Kt	kt	xt	0t	kt	št 0t	0tʿ	0t	kt	kt	ht	xt	xt	i̯t	ht	kt	kt
Ks	kṣ	xš	?	ks	0x 0š	0š	0š	ks	ks	0s	xs	ss	0x	hs	ks	ks
kV	kV cV	kV cV	kV cV	kV cV	kV čV	kʿV	kV	kV	kV	kV	kV	kV	kV	hV	kV	kV

iv. the clusters *labiovelar plosive + t/s-*:

IE	OIA	Av.	N.	Lith.	OCS	Arm.	Alb.	Gr.	L.	Os.	Gal.	Ir.	W.	Goth.	Hitt.	TB
$K^{u̯}t$	kt	xt	kt	kt	št	0tʿ	0t	pt[264]	kt	ht	(xt)	xt	i̯t	ht	$k^{u̯}t$	kt

[263] The examples are limited on the non-Bartholomaean clusters. The d^{h}-clusters are fully omitted since not securely attested in many daughter languages. The cluster *obstruent* + *vowel* is added to demonstrate the unmarked form of the given obstruent (secondarily palatalized velars from Indo-Iranian and Slavic are omitted, as similar secondary forms).

[264] $k^{u̯}t$, $k^{u̯}s$ in Mycenaean.

K$^{u̯}$s	kṣ	xš	?	ks	0t 0x 0š	0š	0š	kt ps ks	ks	0s	(xs)	ss	0x	hs	k$^{u̯}$s	ks
k$^{u̯}$V	kV cV	kV cV	kV cV	kV	kV čV	kʿV	kV	pV	k$^{u̯}$V	pV	pV	kV	pV	h$^{u̯}$V	k$^{u̯}$V	kV

v. the clusters *labial plosive* + *t/s*-:

IE	OIA	Av.	N.	Lith.	OCS	Arm.	Alb.	Gr.	L.	Os.	Gal.	Ir.	W.	Goth.	Hitt.	TB
Pt	pt	pt	0t	pt	0t st	0tʿ	0t	pt	pt	ft[265]	xt	xt	i̯t	ft	pt	pt
Ps	ps	fs fš		ps	0s	0s	0š (0f)[266]	ps	ps	0s	xs	ss	0x	fs	ps	ps
pV	pV	pV	pV	pV	pV	hV	pV	pV	pV	pV	0V	0V	0V	fV	pV	pV

vi. the clusters *sibilant* + *t/s*-:

IE	OIA	Av.	N.	Lith.	OCS	Arm.	Alb.	Gr.	L.	Os.	Gal.	Ir.	W.	Goth.	Hitt.	TB
st	st	st	st	st	st	st	št	st	st	st	ðð ss	ss	ss	st	st	st
ss	ts	0s		0s	0s	0s	0š	0s	0s	0s	0s	0s	0s	(ss)	ss	ss
sV	sV	hV	sV	sV	sV	hV	gjV šV	hV	0s	0s	0s	0s	0s	sV	sV	sV
(št)	ṣṭ	št	ṣṭ	št	st	st	št	st	st	st	ðð ss	ss	ss	st	st	st
(šs)	kṣ	0š		0š	0š	0s	0š	0s	0s	0s	0s	0s	0s	(ss)	ss	st
(šV)	ṣV	šV	ṣV	šV	šV	hV	šV	hV	sV	sV	sV	sV	sV	sV	sV	sV

[265] Umbr. *ht*

[266] Due to metathesis of **ps* on **sp*, later fricativized, debuccalized and elided.

Appendix II: The pan-chronic overviews of the given developments

i. The pan-chronic overview of the Indic development:

Kt > **kt**				
Ḱt > çt > št> **ṣṭ**	(SPT)	vel	**Ḱt** > t^{š}t > št > **ṣṭ**	(AFT)
Tt > ϑt > **tt**	(SPT)	vel	**Tt** > t^{s}t > **tt**	(AFT)
Pt > **pt**				

g^{h}t > γδ > **gd^{h}**				
ǵ^{h}t > ɟδ > žδ > ẓḍ^{h} > **i̯ḍ^{h}**	(SPT)	vel	**ǵ^{h}t** > d^{ž}d^{h} > žd^{h} > ẓḍ^{h} > **i̯ḍ^{h}**	(AFT)
d^{h}t > δδ > **dd^{h}**	(SPT)	vel	**d^{h}t** > d^{z}d^{h} > **dd^{h}**	(AFT)
b^{h}t > βδ > **bd^{h}**				

st > **st**				
št > št > **ṣṭ**				

Kd^{h} > γδ > **gd^{h}**				
Ḱd^{h} > ɟδ > ɟɟ > **ḍḍ^{h}**	(SPT)	vel	**Ḱd^{h}** > d^{ž}d^{h} > žd^{h} > **ḍḍ^{h}**	(AFT)
Td^{h} > δδ > **dd^{h}/0d^{h}**	(SPT)	vel	**Td^{h}** > d^{z}d$^{(h)}$ > **dd^{h}/0d^{h}**	(AFT)
Pd^{h} > βδ > **bd^{h}** (?)				

g^{h}d^{h} > γδ > **gd^{h}** (?)				
ǵ^{h}d^{h} > ɟδ > žḍ^{h} **> i̯d^{h} > 0ḍ^{h}**	(SPT)	vel	**ǵ^{h}d^{h}** > d^{ž}d^{h} > žd^{h} > i̯d^{h} > **0ḍ^{h}**	(AFT)
d^{h}d^{h} > δδ > **i̯d^{h}**	(SPT)	vel	**d^{h}d^{h}** > d^{z}d^{h} > **i̯d^{h}**	(AFT)
b^{h}d^{h} > βδ > **bd^{h}** (?)				

sd^{h} > zδ > hδ > **i̯d^{h}**				
šd^{h} > žδ > ɟδ > **ḍḍ^{h}**				

Ks > kš > **kṣ**				
Ḱs > çš > xš/ϑš > **kṣ**	(SPT)	vel	**Ḱs** > t^{š}š > kš/ṭṣ > **kṣ**	(AFT)
Ts > ϑs > **ts**	(SPT)	vel	**Ts** > t^{s}s > **ts**	(AFT)
Ps > **ps**				

g^{h}s > γž → kš > **kṣ**				
ǵ^{h}s > jž → kš > **kṣ**	(SPT)	vel	**ǵ^{h}s** > d^{ž}ž → kš > **kṣ**	(AFT)
d^{h}s > δz → **ts**	(SPT)	vel	**d^{h}s** > d^{z}z → **ts**	(AFT)
b^{h}s > βz → **ps**				

ss > ϑs > **ts**				
šs > çš > **kṣ**				

ii. Pan-chronic overview of the Iranian[267] development:

Kt > kt > **xt**				
Ḱt > çt > št	(SPT)	vel	**Ḱt** > t^{š}t > **št**	(AFT)
Tt > ϑt > st	(SPT)	vel	**Tt** > t^{s}t > **st**	(AFT)
Pt > pt > φt ⇒ **pt/*ft** (?)				

[267] There is no difference in the general features of the development between Avestan and Old Persian.

g^h**t** > γδ > **gd**				
ǵ^h**t** > ɟδ > **žd**	(SpT)	vel	**ǵ**^{h}**t** > d$^{\check{z}}$d$^{(h)}$ > **žd**	(AfT)
d^h**t** > δδ > **zd**	(SpT)	vel	**d**^{h}**t** > d^{z}d$^{(h)}$ > **zd**	(AfT)
b^h**t** > βδ > **bd**				
st > **st**				
št > **št**				
Kd^h > γδ > **gd**				
Ḱd^h > ɟδ > **žd**	(SpT)	vel	**Ḱd**^{h} > d$^{\check{z}}$d$^{(h)}$ > **žd**	(AfT)
Td^h > δδ > **zd**	(SpT)	vel	**Td**^{h} > d^{z}d$^{(h)}$ > **zd**	(AfT)
Pd^h > βδ > **bd**				
g^h**d**^{h} > γδ > **gd** (?)				
ǵ^h**d**^{h} > ɟδ > **žd**	(SpT)	vel	**ǵ**^{h}**t** > d$^{\check{z}}$d$^{(h)}$ > **žd** (?)	(AfT)
d^h**d**^{h} > δδ > **zd**	(SpT)	vel	**d**^{h}**t** > d^{z}d$^{(h)}$ > **zd**	(AfT)
b^h**d**^{h} > βδ > **bd** (?)				
sd^h > **zd**				
šd^h > **žd**				
Ks > kš > **xš**				
Ḱs > çš > šš > **0š**	(SpT)	vel	**Ḱs** > t$^{\check{s}}$š > šš > **0š**	(AfT)
Ts > ϑs > ss > **0s**	(SpT)	vel	**Ts** > t^{s}s > ss > **0s**	(AfT)
Ps > ps > φs > **fs/fš**				
g^h**s** > **γž**				
ǵ^h**s** > ɟž > žž > **0ž**	(SpT)	vel	**ǵ**^{h}**s** > d$^{\check{z}}$ž > žž > **0ž**	(AfT)
d^h**s** > δz > zz > **0z**	(SpT)	vel	**d**^{h}**s** > d^{z}z > zz > **0z**	(AfT)
b^h**s** > βz > **βž**				
ss > **0s**				
šs > šš > **0š**				

iii. Pan-chronic overview of the Nūristānī development:

Kt > kt > tt > **0t**				
Ḱt > çt > **št**	(SpT)	vel	**Ḱt** > t$^{\check{s}}$t > **št**	(AfT)
Tt > ϑt > tt > **0t**	(SpT)	vel	**Tt** > t^{s}t > tt > **0t**	(AfT)
Pt > pt > tt > **0t**				
st > st > **st/št**				
št > št > **ṣṭ** (/> ṭṭ > **0ṭ** ?)				
šd^h > žd$^{(h)}$ > **žd** (/> ḍḍ > **0ḍ** ?)				
Ḱs > çš > ϑš > **ts**	(SpT)	vel	**Ḱs** > t$^{\check{s}}$š > tš > **ts**	(AfT)
Ts > ϑs > ϑs > **tš** (?)	(SpT)	vel	**Ts** > t^{s}s > **tš** (?)	(AfT)

iv. Pan-chronic overview of the Baltic[268] development:

K$^{(u̯)}$t > **kt**				
Ḱt > çt > **št**	(SPT)	vel	**Ḱt** > > t^{š}t > **št**	(AFT)
Tt > ϑt > **st**	(SPT)	vel	**Tt** > t^{s}t > **st**	(AFT)
Pt > **pt**				
K$^{(u̯)}$s > **ks**				
Ḱs > çš > šš > **0š**	(SPT)	vel	**Ḱs** > t^{š}š > šš > **0š**	(AFT)
Ts > ϑs > ss > **0s**	(SPT)	vel	**Ts** > t^{s}s > ss > **ts**	(AFT)
Ps > **ps**				

st > **st**
št > **št**

ss > **0s**
šs > **0š**

v.: Pan-chronic overview of the Old Church Slavonic development:[269]

K$^{(u̯)}$ti̯ > xti̯ > çt > **št**	(SPT)	vel	**K$^{(u̯)}$ti̯** > tti̯ > **št**	(GET)
K$^{(u̯)}$t > xt > ht > **0t**	(SPT)	vel	**K$^{(u̯)}$t** > tt > **0t**	(GET)
Ḱt > çt **>** ϑt **>** **st**	(SPT)	vel	**Ḱt** > t^{š}t > št > **st**	(AFT)
Tt > ϑt > **st**	(SPT)	vel	**Tt** > t^{s}t > **st**	(AFT)
Pt > φt > ht > **0t**	(SPT)	vel	**Pt** > tt > **0t**	(GET)
Pt > φt > **st**	(SPT)	vel	**Pt** > ? > **st**	(GET)
K$^{(u̯)}$s > xx/šš > **0x/0š**	(SPT)	vel	**K$^{(u̯)}$s >** kš > šš > **0x/0š**	(GET)
Ḱs > çs **>** ϑs > ss > **0s**	(SPT)	vel	**Ḱs** > t^{š}s > šs > ss > **0s**	(AFT)
Ts > ϑs > ss > **0s**	(SPT)	vel	**Ts** > t^{s}s > ss > **0s**	(AFT)
Ps > φs > ss > **0s**	(SPT)	vel	**Ps** > ss > **0s**	(GET)

st > **st**
št > **st**

ss > **0s**
šs > > šš > **0š**

vi. Pan-chronic overview of the Armenian development:

K$^{(u̯)}$t > xϑ > hϑ > **0t**ʿ
Ḱt > çt > śt > **st**
Tt > ϑt > ht > **u̯t**
Pt > φϑ > hϑ > **0t**ʿ

K$^{(u̯)}$s > xš > šš > **0š**[270]
Ḱs > çs > ϑs > **c**ʿ
Ts > ϑs (?) > **c**ʿ
Ps > φs > hs > **0s**[271]

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268 Here demonstrated on the Lithuanian data.
269 The "strategy of simplification", since trivial, is omitted in this overview.
270 Alternativelly with the same frame: **K$^{(u̯)}$s** > xš > hš > **0š**.
271 Alternatively within the same frame: **Ps** > φs > ss > **0s**.

St > **st**

Ss > **0s**

vii. Pan-chronic overview of the Albanian development:

K$^{(u̯)}$t > kt > xt > ht > **0t**
Ḱt > çt > xt > ht > **0t**
Tt > ϑt > ϑϑ > c > **0s** (SPT) vel **Tt** > t^{s}t > cc > 0c > **0s** (AFT)
Pt > pt > φt > ht > **0t**

K$^{(u̯)}$s > ks > xs > hs > 0s > **0š**[272]
Ḱs > çs > xs > hs > **0š**[273]
Ts > ϑs > ss > 0s > **0š** (SPT) vel **Ts** > t^{s}s > ss > 0s > **0š** (AFT)
Ps > ps ⇒ sp > hf > **0f**

St > st > **št**

Ss > ss > 0s > **0š**

viii. Pan-chronic overview of the Ancient Greek development:

K$^{(')}$t > **kt**
K$^{u̯}$t > **pt**
Tt > ϑt > ϑϑ > **ss** (SPT) vel **Tt** > t^{s}t > tst > **st** (AFT)
Pt > **pt**

Kd^h > gd^h ⇒ Kt^h > **k^{h}t^h**
K$^{u̯}$d^h > g$^{u̯}$d^h ⇒ K$^{u̯}$t^h > **p^{h}t^h**
Td^h > > δd^h ⇒ tt^h > ϑt^h > **st^h** (SPT) vel **Td^h** > d^{z}d^h ⇒ t^{s}t^h > tst^h > **st^h** (AFT)
Pd^h > bd^h ⇒ pt^h > **p^{h}t^h**

K$^{(')}$s > **ks**
K$^{u̯}$s > **ps**
Ts > ϑs > ss > **0s** (SPT) vel **Ts** > t^{s}s > tss > ss > **0s** (AFT)
Ps > **ps**

st > **st**

sd^h > zd^h ⇒ st^h > **st^h**

ss > **0s**

ix. Pan-chronic overview of the Mycenaean development:

K$^{(')}$t > **kt**
K$^{u̯}$t > **k$^{u̯}$t**
Tt > ϑt > ϑϑ > **ss** (SPT) vel **Tt** > t^{s}t > tst > **st** (AFT)
Pt > **pt**

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[272] In the case of the validity of the *ruki*-rule for Proto-Albanian: ***K$^{u̯}$s*** > *kš* > *hš* > ***0š***.
[273] If we assume that Albanian was affected by *ruki*-rule, the development will be: ***Ḱs*** > *kš* > *xš* >*hš* > ***0š***.

Kd^{h} > gd^{h} ⇒ Kt^{h} > **k^{h}t^{h}**
K$^{u̯}$d^{h} > g$^{u̯}$d^{h} ⇒ K$^{u̯}$t^{h} > **k$^{u̯h}$t^{h}**
Td^{h} > > δd^{h} ⇒ tt^{h} > ϑt^{h} > **st^{h}** (SPT) vel **Td^{h}** > d^{z}d^{h} ⇒ t^{s}t^{h} > tst^{h} > **st^{h}** (AFT)
Pd^{h} > bd^{h} ⇒ pt^{h} > **p^{h}t^{h}**

K$^{(\prime)}$s > **ks**
K$^{u̯}$s > **k$^{u̯}$s**
Ts > ϑs > ss > **0s** (SPT) vel **Ts** > t^{s}s > tss > ss > **0s** (AFT)
Ps > **ps**

st > **st**

sd^{h} > zd^{h} ⇒ st^{h} > **st^{h}**

ss > **0s**

x. Pan-chronic overview of the Latin development:
K$^{(\prime)}$t > **kt**
K$^{u̯}$t > **kt**
Tt > ϑt > ϑϑ > (**s**)**s** (SPT) vel **Tt** > t^{s}t > tss > (**s**)**s** (AFT)
Pt > **pt**

K$^{(\prime)}$s > **ks**
K$^{u̯}$s > **ks**
Ts > ϑs > (**s**)**s** (SPT) vel **Ts** > t^{s}t > tss > (**s**)**s** (AFT)
Ps > **ps**

st > **st**

ss > (**s**)**s**

xi. Pan-chronic overview of the Sabellic development:
K$^{(\prime)}$t > xt > **ht** (/> 0**t**)
K$^{u̯}$t > kt > xt > **ht**
Tt > ϑt > ϑϑ > (**s**)**s** (SPT) vel **Tt** > t^{s}t > tss > (**s**)**s** (AFT)
Pt > > φt > **ft**[274]

K$^{(\prime)}$s > xs > hs > **0s**
K$^{u̯}$s > ks > xs > hs > (**s**)**s**
Ts > ϑs > (**s**)**s** (SPT) vel **Ts** > t^{s}t > tss > (**s**)**s** (AFT)
Ps > > φs > hs > **0s**

st > **st**

ss > (**s**)**s**

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[274] Umbrian: **Pt** > φt > xt > **ht**

xii.: Pan-chronic overview of the Brythonic development:

K$^{(\prime)}$t > xt (> ht) > **i̯t**
K^{u}t > xt (> ht) > **i̯t**
Tt > ϑt > ϑϑ > **ss** (SPT) vel **Tt** > t^{s}t > tsts > **ss** (AFT)
Pt > φt > (ft > ht >) **i̯t**

K$^{(\prime)}$s > xs > xx > **0x**
K^{u}s > xs > xx > **0x**
Ts > ϑs > **ss** (SPT) vel **Ts** > t^{s}s > tsts > **ss** (AFT)
Ps > φs > xx > **0x**

st > sϑ > ϑϑ > **ss** (SPT) vel **st** > ts > **ss** (AFT)

xiii. Pan-chronic overview of the Goidelic development:

K$^{(\prime)}$t > **x**t
K^{u}t > **xt**
Tt > ϑt > ϑϑ > **ss** (SPT) vel **Tt** > t^{s}t > tsts > **ss** (AFT)
Pt > φt > (ft >) **xt**

K$^{(\prime)}$s > xs > **ss**
K^{u}s > xs > **ss**
Ts > ϑs > **ss** (SPT) vel **Ts** > t^{s}s > tsts > **ss** (AFT)
Ps > φs > **ss**

st > sϑ > ϑϑ > **ss** (SPT) vel **st** > ts > **ss** (AFT)

xiv. Pan-chronic overview of the Gallic development:

K$^{(\prime)}$t > **x**t
(**K^{u}t** > **xt**)
Tt > ϑt > ϑϑ > **đđ/ss** (SPT) vel **Tt** > t^{s}t > tsts > **đđ/ss**[275] (AFT)
Pt > φt > (ft >) **xt**

K$^{(\prime)}$s > **xs**
(**K^{u}s** > **xs**)
Ts > ϑs > ϑϑ > **đđ/ss** (SPT) vel t^{s}s > t^{s}t > tsts > **đđ/ss** (AFT)
Ps > φs > **xs**

st > ϑs > ϑϑ > **đđ/ss** (SPT) vel **st** > ts > **đđ/ss** (AFT)

xv.: Pan-chronic overview of the Gothic development:

K$^{(\prime)}$t > kt > xt > **ht**
K^{u}t > kt > xt > **ht**
Tt > ϑt > ϑϑ > **ss** (SPT) vel **Tt** > t^{s}t > tsts > **ss** (AFT)
Pt > pt > φt > **ft**

K$^{(\prime)}$s > ks > xs > **hs**
K^{u}s > ks > xs > **hs**
Ts > ϑs > **ss** (SPT) vel **Ts** > t^{s}s > tss > **ss** (AFT)

[275] Here *đđ* marks two dental affricates, probably voiceless.

Ps > ps > φs> **fs**

st > **st**
ss > **ss** (?)

xvi. Pan-chronic overview of the Hittite development:

$\mathbf{K^{(\acute{})}t}$ > **kt**
$\mathbf{K^{\text{u̯}}t}$ > **kt / ⇒** $\mathbf{k^{\text{u̯}}t}$
Tt > $t^{s}t$ > $\mathbf{t\underset{\smile}{st}}$
Pt > **pt**

$\mathbf{K^{(\acute{})}s}$ > **ks**
$\mathbf{K^{\text{u̯}}s}$ > (ks ?) **/** ⇒ $\mathbf{k^{\text{u̯}}s}$
Ts > $t^{s}s$ > **ts**
Ps > **ps**

st > **st**

ss > **ss**

xvii. Pan-chronic overview of the Tocharian development:

$\mathbf{K^{(\acute{})}t}$ > **kt**
$\mathbf{K^{\text{u̯}}t}$ > **kt**
Tt > $t^{s}t$ > $\mathbf{t^{s}t^{s}/tt^{s}}$
Pt > **pt**

$\mathbf{K^{(\acute{})}s}$ > **ks**
$\mathbf{K^{\text{u̯}}s}$ > (**ks** ?)
Ts > $t^{s}s$ > **ts**
Ps > **ps**

st > **st**

ss > **ss**

Abbreviations of languages

Aeol. – Aeolic
Alb. – Albanian
Arc. – Arcadian
Arm. – Armenian
Att. – Attic
Av. – Avestan
B. – Bulgarian
Br. – Breton
Bryth. – Brythonic
Celt. – Celtic
Corn. – Cornish
CS – Common Slavic
Cypr. – Cypriotic
Cz. – Czech
Dor. – Dorian
Gal. – Gaulish
Germ. – Germanic
Goid. – Goidelic
Goth. – Gothic
Gr. – Greek
Hitt. – Hittite
Hom. – Homeric
IE – Indo-European
Ir. – Irish
L. – Latin
Latv. – Latvian
Lith. – Lithuanian
Luw. – Luwian
MBr. – Middle Breton
MCorn. – Midle Cornish
MIr. – Middle Irish
MHG – Middle High German
MW. – Middle Welsh
N. – Nūristānī
NP – New Persian
OAlb. – Old Albanian
OAv. – Old Avestan
OBr. – Old Breton
OCorn. – Old Cornish
OCS– Old Church Slavonic
OE – Old English (Anglo-Saxon)
OGeg. – Old Gegh
OHG – Old High German
OIA – Old Indo-Aryan
OIr. – Old Irish
OL. – Old Latin
OLith. – Old Lithuanian
ON – Old Norse
OP – Old Persian
OPol. – Old Polish
OS – Old Saxon
Os. – Oscan
PAlb. – Proto-Albanian
PAnat. – Proto-Anatolian
PArm. – Proto-Armenian
PCelt. – Proto-Celtic
PGerm. – Proto-Germanic
PGr. – Proto-Greek
Phl. – Pahlavi
PItal. – Proto-Italic
Pol. – Polish
PPAlb. – Pre-Proto-Albanian
Pruss. – (Old) Prussian
PSab. – Proto-Sabellian
Ru. – Russian
RuCS – Russian Church Slavonic
Sab. – Sabellian
SCr. – Serbo-Croatian
Slk. – Slovakian
Sln. – Slovenian
Toch. – Tocharian
Uk. – Ukrainian
Um. – Umbrian
W. – Welsh
YAv. – Young Avesta

Literature

Adams, Douglas Q. 1988. *Tocharian Historical Phonology and Morphology*. New Haven: American Oriental Society.

Adams, Douglas Q. 2013². *A Dictionary of Tocharian B*. *Revised and Greatly Enlarged*. Volume 1. Volume 2. Amsterdam – New York: Rodopi.

Allen, W. Sidney. 1968. *Vox Graeca. A Guide to the Pronunciation of Classical Greek*. Cambridge: Cambridge University Press.

Allen, W. Sidney. 1978. The PIE velar series: Neogrammarian and other solutions in the light of attested parallels. *Transactions of the philological society* 76. 87–110.

Andersen, Hennig. 1968. IE **s* after *i, u, r, k* in Baltic and Slavic. *Acta Linguistica* 11, 171–190.

Anderson, Stephen R. 1970. On Grassmann's Law in Sanskrit. *Linguistic Inquiry* 1(4). 387–396.

Andreev, Nikolai D. 1957. Periodizacija istorii indoevropejskogo prajazyka. *Voprosy jazykoznanija* 2. 3–18.

Arumaa, Peeter. 1976. *Urslavische Grammatik. II. Band. Konsonantismus.* Heidelberg: Carl Winter-Universitätsverlag.

Aura Jorro, Francisco / Adrados, Francisco R. 1985. *Diccionario griego-español. Anejo 1. Diccionario micénico. Volumen 1.* Madrid: Consejo Superior de Investigaciones Cientifícas.

Aura Jorro, Francisco / Adrados, Francisco R. 1993. *Diccionario griego-español. Anejo 2. Diccionario micénico. Volumen 2.* Madrid: Consejo Superior de Investigaciones Cientifícas.

Baldi, Philip. 1991. Lachmann's Law in the Light of the Glottalic Theory of PIE Consonantism. In: Coleman, Robert (ed.). *New Studies in Latin Linguistics: Selected Papers from the 4th International Colloquium on Latin Linguistics, Cambridge, April 1987*. Amsterdam / Philadelphia: John Benjamins. 3–21.

Baldi, Philip. 1999. *The Foundations of Latin*. Berlin / New York: Mouton de Gruyter.

Bammesberger, Alfred. *Der Aufbau des germanischen Verbalsystems*. Heidelberg: Carl Winter Universitätsverlag.

Bartholomae, Christian. 1882. Die arische Vertretung von med. Asp. + *t* und med. Asp. +*s*. Arische Forschungen I. 3–24. Halle: Niemeyer.

Bartholomae, Christian. 1883. *Handbuch der altiranischen Dialekte*. Leipzing: Breitkopf & Härtel.

Bartholomae, Christian. 1885. Θυγάτερ. *KZ* 27. 206–207.

Bartholomae, Christian, 1887. Die Vertretung des altitalischen ss im oskischen (etc.). *Bezzenbergers Beiträge* 12. 80–92.

Bartholomae, Christian. 1895–1901. I. Vorgeschichte der iranischen Sprachen. II. Awestasprache und Altpersisch. In: Geiger, Wilhelm / Kuhn, Ernst (eds.). *Grundriß der iranischen Philologie.* Erster Band. I. Abteilung. Strassburg: Karl J. Trübner: 1–248.

Bartoněk, Antonín 2003. *Handbuch des mykenischen Griechisch*. Heidelberg: Universitätsverlag C. Winter.

Beekes, Robert S. P. 1988. *A Grammar of Gatha-Avestan*. Leiden: Brill.

Beekes, Robert S. P. 2003. Historical phonology of Classical Armenian. In: Kortlandt, Fredrik. *Armeniaca. Comparative Notes*. Ann Arbor: Caravan Books, 133–211.

Beekes, Robert S. P. 2011. *Comparative Indo-European Linguistics*. Armsterdam/Philadelphia: John Benjamins Publishing Company.

Beekes, Robert, S. P. 2016a. *Etymological dictionary of Greek*. *Volume one*. Leiden: Brill.

Beekes, Robert, S. P. 2016b. *Etymological dictionary of Greek. Volume two*. Leiden: Brill.

Bernabé Pajares, Alberto. 1971. Aportaciones al estudio fonológico de las guturales indoeuropeas, Emérita, Revista de Lingüística y Filología Clásica, XXXIX, 63–107.

Bezzenberger, Adalber. 1890. Die indogermanischen Gutturalreihen. *Beiträge zur Kunde der* indogermanischen *Sprachen*. 16, 234–260.

Belić, Aleksandar. 1921. Srpskohrvatske glasovne grupe *-jt-, -jd-* i praslovansko *-kti-*, *-gdi-*, *-hti-* [The Serbo-Croatian phonemic clusters *-jt-, -jd-* and Pre-Slavic *-kti-*, *-gdi-*, *-hti-*]. *Južnoslovenski Filolog* 5. 217–226.

de Bernardo Stempel, Patrizia. 1999. *Nominale Wortbildung der älteren Irischen. Stammbildung und Derivation*. Tübingen: Niemayer.

Blažek, Václav. 1999. *Numerals*. Brno: Masarykova univerzita.

Blažek, Václav 2009. On the position of Gaulish within Celtic from the point of view of glottochronology. *Indogermanische Forschungen* 114: 257−299.

Blažek, Václav / Hegedüs, Irén. 2012: On the position of Nuristani within Indo-Iranian. In: Sukač, Roman / Šefčík, Ondřej (eds.). *The Sound of Indo-European 2*. München: Lincom Europa, 40–66.

Bloch, Jules. 1965. *Indo-Aryan from Vedas to Modern times.* (translated by Master, Alfred). Paris: Librairie d'Amérique et d'Orient. Adrien – Maisonneuve.

Bloomfield, Leonard. 1911. The Indo-European Palatals in Sanskrit. *The American Journal of Philology* 32/1. 36–57.

Blust. Robert. 2009. *The Austronesian Languages*. Canberra: Pacific Linguistics. Research School of Pacific and Asian Studies. The Australian National University.

Bousquette, Joshua / Salmons, Joseph. 2017. Germanic. In: Kapović, Mate (ed.). *The Indo-European Languages*. New York: Routledge, 387–420.

von Bradke, Peter. 1890. *Über Methode und Ergebnisse der arischen Alterthumswissenshaft*. Giessen: J. Ricker'che Buchhandlung.

Brandenstein, Wilhelm / Mayrhofer, Manfred. 1964. *Handbuch des Altpersichen*. Wiesbaden: Harrassowitz.

Braune, Wilhelm / Ebbinghaus, Ernst A. 1981. *Gotische Grammatik mit Lesestücken und Wörterverzeichnis*. Tübingen: Max Niemeyer.

Braune, Wilhelm / Heidermanns, Frank. 2004. *Gotische Grammatik mit Lesestücken und Wörterverzeichnis*. Tübingen: Max Niemeyer.

(von) Brücke, Ernst. 1856. *Grundzüge der Physiologie und Systematik der Sprachlaute für Linguisten und Taubstummenlehrer*. Wien: Carl Gerold´s Sohn.

Brugmann, Karl. 1880. Die lautgruppe dentale explosive + *t* im indogermanischen. In: Osthoff, Hermann / Brugmann, Karl. *Morphologische Untersuchungen auf dem Gebiete der indogermanischen Sprachen. Teil. 3*. Leipzig: S. Hirzel, 131–147.

Brugmann, Karl. 1885. *Handbuch der klassischen Altertums-Wissenschaft in systematischer Darstellung mit besonderer Rücksicht auf Geschichte und Methodik der einzelnen Disziplinen*. Nördlingen: C.H. Beck'schen Buchhandlung.

Brugmann, Karl. 1886. *Grundriss der vergleichenden Grammatik der indogermanischen Sprachen. Erster Band: Einleitung und Lautlehre.* Strassburg: Karl. J. Trübner.

Brugmann, Karl. 1890. *Handbuch der klassischen Altertums-Wissenschaft in systematischer Darstellung mit besonderer Rücksicht auf Geschichte* und *Methodik der einzelnen Disziplinen*. Nördlingen : C.H. Beck'schen Buchhandlung.

Brugmann, Karl. 1897. *Vergleichende Laut-, Stammbildungs- und Flexionslehre der indogermanischen Sprachen. Zweite Bearbeitung. Erster Band: Einleitung und Lautlehre. Zweite Hälfte.* Strassburg: Karl. J. Trübner.

Brugmann, Karl. 1900. *Handbuch der klassischen Altertums-Wissenschaft in systematischer Darstellung mit besonderer Rücksicht auf Geschichte und Methodik der einzelnen Disziplinen*. Nördlingen: C.H. Beck'schen Buchhandlung.

Brugmann, Karl. 1913. Zu den Ablautverhältnissen der sogenannten starken Verba des Germanischen. *Indogermanische Forschungen* 32: 179–195.

Brugmann, Karl. 1913/1914. Gotisch *usstagg* 'stich aus'. *Indogermanische Forschungen* 33: 284–285.

Brugmann, Karl/Thumb, Albert. 1913. *Griechische Grammatik. Lautlehre, Stammbildungs- und Flexionslehre, Syntax*. München: C.H. Beck'schen Buchhandlung.

Brust, Manfred. 2018. *Historische Laut- und Formenlehre des Altpersischen : mit einem etymologischen Glossar*. Innsbruck: Institut für Sprachen und Literaturen der Universität Innsbruck, Bereich Sprachwissenschaft.

Bubenik, Vit. 1996. *The Structure and Development of Middle Indo-Aryan Dialects*. Delhi: Motilal Banarsidass.

Bubenik, Vit. 2017. The Phonology of Greek. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.1*). Berlin / Boston: Walter de Gruyter, 637–653.

Buck, Carl D. 1904. *A Grammar of Oscan and Umbrian with a Collection of Inscriptions and a Glossary*. Boston: The Athenæum Press, Ginn & Company.

Buck, Carl D. 1933. *Comparative Grammar of Greek and Latin*. Chicago: The University of Chicago Press.

Buddruss, Georg. 1977. Nochmals zur Stellung der Nuristan-Sprachen des Afghanistanischen Hindukusch. *Münchener Studien zur Sprachwissenschaft* 36. 19–38.

Bugge, Sophus. 1889. *Beiträge zur etymologischen Erläuterung der armenischen Sprache*. . Leipzig: Breitkopf und Härtel.

Bugge, Sophus. 1893. Beiträge zur etymologischen Erläuterung der armenischen Sprache. *Zeitschrift für vergleichende Sprachforschung* 32, 1–87.

Burrow, Thomas. 1955. *The Sanskrit Language*. London: Faber and Faber.

Çabej, Eqrem. 1972. Über einige Lautrefeln des Albanischen. *Die Sprache* 18, 132–154.

Camaj, Martin. 1966. *Albanische Wortbildung*. Wiesbaden: Otto Harrassowitz.

Cantera, Alberto. 2017. The phonology of Iranian. In: Klein, Jared / Joseph, Brian / Fritz Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics*. Berlin/Boston: De Gruyter Mouton. 481–503.

Cardona, George / Jain, Dhanes. 2003. General introduction. In: Cardona, George/Jain, Dhanesh (eds). *The Indo-Aryan Languages*. 1–45. London: Routledge.

Cardona, George 2017. The documentation of Indic. In: Klein, Jared / Joseph, Brian / Fritz Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics*. Berlin/Boston: De Gruyter Mouton. 309–325.

Carling, Gerd [et al.]. 2009. *Dictionary and Thesaurus of Tocharian A. Volume 1: A–J.* Wiesbaden: Harrassowitz Verlag.

Carlton, Terence. R. 1991. *Introduction to the Phonological History of the Slavic Languages*. Columbus: Slavica Publishers.

Cavoto, Fabrice. 2001. Did PIE have Three Velar series? *MSS* 61, 29–56.

Čekman, Valerij M. (1974): O reflexach indoevropejskix **ḱ*, **ǵ* v balto-slavjanskom jazykovom areale. *Balto-slavjanskie issledovanija.* 116–135

CHD L–N = Günterbock, Hans G. / Hoffner, Harry. A. et al. 1989. *The Hittite Dictionary of the Oriental Institute of the University of Chicago.* L – N. Chicago: The University of Chicago.

CHD P = Günterbock, Hans G. / Hoffner, Harry. A. et al. 1997. *The Hittite Dictionary of the Oriental Institute of the University of Chicago.* P. Chicago: The University of Chicago.

CHD Š = Günterbock, Hans G. / Hoffner, Harry. A. et al. 2019. *The Hittite Dictionary of the Oriental Institute of the University of Chicago.* Š. Chicago: The University of Chicago.
Cheung, Johny. 2007. *Etymological Dictionary of the Iranian Verb*. Leiden: Brill.
Clackson, James. 1994. *The Linguistic Relationship between Armenian and Greek.* Oxford: Blackwell.
Cocchia, Enrico. 1883: Questioni di fonologia Latina. *Rivista di filologia e d´instrutione classica* XI. 16–101.
Coleman, Robert. 1992. Italic [numerals]. In: Gvozdanović, Jadranka (ed.). *Indo-European Numerals*. Berlin/New York: Mouton de Gruyter, 389–445.
Collinge, Neville E. 1985. *The Laws of Indo-European*. Amsterdam/Philadelphia: John Benjamins.
Collins, Daniel. 2017. The Phonology of Slavic. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.3*). Berlin / Boston: Walter de Gruyter, 1414–1538.
Comrie, Bernard. 1992. *Balto-Slavonic [Numerals].* In: Gvozdanović, Jadranka. *Indo-European Numerals.* Berlin / New York. 717–834.
Cowgill, Warren. 1980 : The Etymology of Irish *guidid* and the Outcome of *g^{uh} in Celtic. In: Marhofer, Manfred / Peters, Martin / Pfeiffer, Oscar E. (eds.) *Lautgeschichte und Etymologie*. Wiesbaden: Reichert. 49–78.
Curtius, Georg. 1853. Die aspîraten der indogermanischen sprachen. *KZ* 2. 321–336.
Darden, Bill. J. 1978. On the Slavic reflexes of Indo-European **pt*. *GL* 18, 10–13.
Degener, Almuth 2002. The Nuristani Languages. In: Sims-Williams, Nicolas (eds.). *Indo-Iranian Languages and Peoples.* 103–117. Oxford: Oxford University Press.
Delamarre, Xavier. 2003. *Dictionaire de la langue gauloise. Une approche linguistique du vieux-celtique continental.* Paris: Editions Errance.
Demiraj, Bardhyl. 1997: *Albanische Etymologie (Untersuchungen zum albanischen Erbwortschatz)*. Amsterdam/Atlanta: Rodopi.
Demiraj, Shaban. 1993: *Historische Grammatik der albanischen Sprache*. Wien: Verlag der Österreichischen Akademie der Wissenschaften.
Derksen, Rick. 2008. *Etymological dictionary of the Slavic Inherited Lexicon*. Leiden: Brill.
Derksen, Rick. 2015. *Etymological Dictionary of the Baltic Inherited Lexicon*. Leiden/Boston: Brill.
Deshayes, Albert. 2003. *Dictionnaire étymologique du breton*. Douarnenez: Le Chasse-Marée.
de Vaan, Michiel. 2008. *Etymological Dictionary of Latin and the other Italic Languages*. Leiden / Boston: Brill.
de Vaan, Michiel. 2018. The phonology of Albanian. In: Klein, Jared / Joseph, Brian / Fritz, Matthias (eds.) *Handbook of Comparative and Historical Indo-European Linguistics Volume 3* (*HSK 41.3*). Berlin/Boston: De Gruyter Mouton, 1732–1748.
Dini, Pietro U. 2014. *Foundations of Baltic Languages*. Vilnius: Eugrimas.
Dottin, Georges. 1920. *La langue gauloise. Grammaire, textes et glossaire*. Paris: Librairie C. Klincksieck.
Dressler, Wolfgang. 1976. Das Altarmenische und die Phonologietheorie. *Handes Amsorya* 90. 901–976.
Drinka, Bridget. 1991. Lachmann’s Law: A Phonological Solution. *Indogermanische Forschungen* 91. 52–74.
Džaukjan[276], Gevork B. 1967. *Očerki po istorii dopis′mennogo perioda armjanskogo jazyka*. Erevan: Izdatel´stvo Akademii nauk armjanskoj SSR.

[276] Name is also transliterated as: J̌ahukyan, Djahukian. Since the quoted work is in Russian, we use the transliteration of the Russian variant of transliteration..

Ėdeľman, Džoj I. 1973. K tipologii indoevropejskich guttural′nyx. *Izvestija Akademii Nauk SSSR. Serija Literatury i Jazyka* 32. 540–546.
Ėdeľman, Džoj I. 1994. K predposylkam v etapam perexoda i.-e. **s* v *š* v jazykax grupy satem. *Baltistica Priedas 4*, 56–66.
Eichner, Heiner. 1973. Die Etymologie von heth. *mēhur*. *Münchener Studien zur Sprachwissenschaft* 31, 53–107.
Eichner, Heiner. 1980. Phonetik und Lautgesetze des Hethitischen – ein Weg zur ihrer Entschlüsselung. In: Mayrhofer, Manfred / Peters, Martin, Pfeiffer, Oskar E. (eds.), *Lautgeschichte und Etymologie*. Akten d. VI. Fachtagung d. Indogermanischen Gesellschaft, Wien, 24.-29. September 1978. Wiesbaden: Reichert. 120-165.
Eichner, Heiner. 1992. Anatolian [numerals]. In: Gvozdanović, Jadranka (ed.). *Indo-European Numerals*. Berlin/New York: Mouton de Gruyter, 29–96.
Ejerhed, Eva I. 1981. The Analysis of Aspiration in Sanskrit Phonology. *Nordic Journal of Linguistics* 4(2). 139–159.
Elbourne, Paul. 1998. Proto-Indo-European Voiceless Aspirates. *HF* 111. 1-30.
Elbourne, Paul. 2000. Plain voiceless stop plus laryngeal in Indo-European. *HF* 113. 2-28.
Emmerick, Ronald E. 1992a. *Old Indian* [*Numerals*]. In: Gvozdanović, Jadranka (ed.). *Indo-European Numerals*. Berlin/New York: Mouton de Gruyter, 163–198.
Emmerick, Ronald E. 1992b. *Iranian* [*Numerals*]. In: Gvozdanović, Jadranka (ed.). *Indo-European Numerals*. Berlin/New York: Mouton de Gruyter, 289–345.
Endzelin(s), J(ānis). 1923. *Lettische Grammatik*. Heidelberg: Carl Winter's Universitätsbuchhandlung.
Endzelin(s), Jānis. 1939. Über den slavisch-baltischen Reflexe vom idg. *sḱ*. *ZfslPh* 16, 107–115.
Endzelin(s), J(ānis). 1944. *Altpreussische Grammatik*. Rīga: Verlag Latvju Grāmata.
Erhart, Adolf. 1956. Zum ie. Wechsel Media : Media aspirata. *Sborník prací Filozofické fakulty brněnské univerzity. A* 5. 5– 18.
Erhart, Adolf. 1980. *Struktura indoíránských jazyků* [The Structure of the Indo-Iranian Languages]. Brno: Univerzita J. E. Purkyně.
Erhart, Adolf. 1982. *Indoevropské jazyky – srovnávací fonologie a morfologie* [Indo-European Languages – the Comparative Phonology and Morphology]. Praha: Academia.
Erhart, Adolf. 1984: *Baltské jazyky* [Baltic Languages]. Brno: Univerzita J. E. Purkyně.
ESJS = Erhart, Adolf / Eva Havlová / Ilona Janyšková (eds.), 1989–2018. *Etymologický slovník jazyka staroslověnského*, 1–19 [Etymological dictionary of Old Church Slavonic Language, 1–19]. Praha: Academia/ Brno: Tribun.
Eska, Joseph F. 1998. Tau Gallicum. *Studia Celtica* 32. 115–127.
Eska, Joseph F. 2010. The Emergence of the Celtic Languages. In: Ball, Martin J. / Müller, Nicole (eds.). *The Celtic Languages*. London: Routledge. 22–27.
Evans, D. Ellis. 1967. *Gaulish Personal Names*. Oxford: Clarendon Press.
EWAi = Mayrhofer, Manfred. 1992. Etymologisches Wörterbuch des Altindoarischen I. + Mayrhofer, Manfred. 1996. Etymologisches Wörterbuch des Altindoarischen II. + Mayrhofer, Manfred. 2001. Etymologisches Wörterbuch des Altindoarischen III. Heidelberg: Carl Winter.
Heidelberg: Carl Winter.
Fahs, Achim. 1989. *Grammatik des Pali*. Leipzig: VEB Verlag Enzyklopädie.
Fallon, Paul. D. 2002. *The synchronic and diachronic Phonology of Ejectives.* New York & London: Routledge.
Fellner, Hannes A. 2006. On the Development of Labiovelars in Tocharian. In: Jones-Bley, Karlene / Huld, Martin E. / Della Volpe, Angela (eds). *Proceedings of the seventeenth annual UCLA Indo-European conference, Los Angeles, October 27-28, 2005*. 51–65.

Forssman, Berthold. 2001. *Lettische Grammatik*. München: J. H. Röll Verlag.
Fortunatov, Filipp. F. 1888. Phonetische Bemerkungen veranlasst durch Miklosich's Etymologisches Wörterbuch der slavischen Sprachen. *Archiv für Slavische Philologie* 11. 561–575.
Fraenkel, Ernst. 1950a. *Die baltischen Sprachen.* Heidelberg: Carl Winter Universitätsverlag.
Fraenkel, Ernst. 1950b. Slavisch *gospodъ*, lit. *viẽšpats*, preuss. *Waispattin* und Zubehör. *Zeitschrift für slavische Philologie* 20. 51–89.
Fraenkel LEW = Fraenkel, Ernst. 1962. *Litauisches etymologisches Wörterbuch I.* Heidelberg/Göttingen: Carl Winter Universitätsverlag/Vandenhoeck & Ruprecht + Fraenkel, Ernst. 1965. *Litauisches etymologisches Wörterbuch II.* Heidelberg/Göttingen: Carl Winter Universitätsverlag/Vandenhoeck & Ruprecht.
Friedrich, Johannes. 1974. *Hethitisches Elementarbuch I.* Heidelberg: Carl Winter Universitätsverlag.
Friedrich, Johannes. 1990. *Kurzgefaßtes Hethitisches Wörterbuch.* Heidelberg: Carl Winter Universitätsverlag.
Frisk, Hjalmar. 1960. *Griechisches etymologisches Wörterbuch*. *Band I, A-Ko*. Heidelberg: Carl Winter Universitätsverlag.
Frisk, Hjalmar. 1970. *Griechisches etymologisches Wörterbuch*. *Band II, Kr-Ō*. Heidelberg: Carl Winter Universitätsverlag.
Frisk, Hjalmar. 1972. *Griechisches etymologisches Wörterbuch*. *Band III, Nachträge, Wortregister, Corrigenda, Nachwort.*. Heidelberg: Carl Winter Universitätsverlag.
Fussman, Gérard. 1972. *Atlas linguistique des parlers dardes et kafirs. II. Commentaire*. Paris: École française d'Extrême-Orient.
Gallée, Johan H. *Altsächsische Grammatik*. *Dritte Auflage mit Berichtigungen und Literaturnachträgen von Heinrich Tiefenbach*. Tübingen: Max Niemeyer.
Gamkrelidze, T. V. / Ivanov Vyacheslav V. 1972. Lingvističeskaja tipologija i rekonstrukcija sistemy indoevropejskix smyčnyx. In: Bernštein, Samuil B. et al. (eds). *Konferencija po sravnitelno-istoričeskoj grammatike indoevropejskix jazykov*. Moskva: Institut slavjanovedenija i baltistiki AN SSSR. 15–18.
Gerullis, Georg. 1922. *Die altpreußischen Ortsnamen: gesammelt und sprachlich behandelt*. Berlin: Vereinigung wissenschaftlicher Verleger Walter de Gruyter & Co.
Gippert, Jost. 2002. Neues zu "Slavisch *st* aus älterem *pt*"?. In: Anreiter, Peter / Ernst, Peter/ Hausner, Isolde (eds.): *Namen Sprachen und Kulturen. Imena, Jeziki i Kulture. Festschrift für Heinz Dieter Pohl zum 60. Geburtstag*. Wiedn: Edition Praesens, 239–256.
Godel, Robert. 1975. *An Introduction to the Study of Classical Armenian.* Wiesbaden: Dr. Ludwig Reichert Verlag.
Görtzen, Jens. 1998. *Die Entwicklung der indogermanischen Verbindungen von dentalen Okklusiven mit besonderer Berücksichtigung des Germanischen.* Innsbruck: Institut für Sprachwissenschaft der Universität Innsbruck.
Götze, Albert. 1928. *Madduwattaš*. Leipzig: Hinrichs.
GPC = [eds]. 1997–2002. *Geriadur Prifysgol Cymru.* Aberystwyth: Gwasg Prifysgol Cymru.
Greene, David. 1992. Celtic [numerals]. In: Gvozdanović, Jadranka (ed.). *Indo-European Numerals*. Berlin/New York: Mouton de Gruyter, 498–554.
Greenberg, Marc. L. 2017. Slavic. In: Kapović, Mate (ed.). *The Indo-European Languages*. New York: Routledge, 519–5151.
von Grienberger, Theodor. 1900. *Untersuchungen zur gotischen Wortkunde.* Wien: Gerold.
Griffen, Toby D. 1989. Nostratic and Germano-European. *General Linguistics* 29/3. 139–149.
Gunnarsson, Jón. 1971. On the Indo-European "dental spirants". *Norsk Tidskrift for Sprogvidenskap* 24. 21–82.

Hackstein, Olav. 2017. The Phonology of Tocharian. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.2*). Berlin / Boston: Walter de Gruyter, 1304–1335.
Haider, Hubert 1985. The Fallacy of Typology. Remarks on the PIE Stop-System. *Lingua* 65. 1–27.
Hammerich, Louis L. 1955. Die germanische und die hochdeutsche Lautverschiebung. *Beiträge zur Geschichte der deutschen Sprache und Literatur (PBB(T))* 77. 1–29, 165–203.
Hammerich, Louis L. 1967. Ketzereien eines alten Indogermanisten. In: *To Honor of Roman Jakobson* II. The Hague: Mouton. 839–849.
Hamp, Eric P. 1961a. Albanian *be, besë* “oath”. *Zeitschrift für vergleichende Sprachforschung auf dem Gebiete der indogermanischen Sprachen* 77/3–4. 252–253.
Hamp, Eric P. 1961b. IE **bhend-* in Albanian. *Zeitschrift für vergleichende Sprachforschung auf dem Gebiete der indogermanischen Sprachen* 77/3–4. 253–254.
Hamp, Eric P. 1961c. Albanien *natë* “night”. *Zeitschrift für vergleichende Sprachforschung auf dem Gebiete der indogermanischen Sprachen* 77/3–4. 254–256.
Hamp, Eric P. 1967. On IE **s* after *i*, *u* in Baltic. *Baltistica* 3. 7–11.
Hamp, Eric. 1976. *gweiH- ‘live’. In: Davies, Anna Morpurgo / Meid, Wolfgang (eds.). *Studies in Greek, Italic and Indo-European Linguistics offered to Leonhard R. Palmer.* Innsbruck: University of Innsbruck, 87–91.
Hamp, Eric P. 1992. Albanian [numerals]. In: Gvozdanović, Jadranka (ed.). *Indo-European Numerals*. Berlin/New York: Mouton de Gruyter, 835–921.
HED 1–2 = Puhvel, Jaan. 1984. *Hittite Etymological Dictionary. Vol. 1, Words Beginning with A*. *Hittite Etymological Dictionary. Vol. 2, Words Beginning with E and I*. Berlin / New York / Amsterdam: Mouton.
HED 3 = Puhvel, Jaan. 1991. *Hittite Etymological Dictionary. Vol. 3, Words Beginning with H*. Berlin / New York: Mouton.
HED 4 = Puhvel, Jaan. 1997. *Hittite Etymological Dictionary. Vol. 4, Words Beginning with K*. Berlin / New York: Mouton.
HED 5 = Puhvel, Jaan. 2001. *Hittite Etymological Dictionary. Vol. 5, Words Beginning with L*. *Indices to volumes 1–5*. Berlin / New York: Mouton.
HED 6 = Puhvel, Jaan. 2004. *Hittite Etymological Dictionary. Vol. 6, Words Beginning with M*. Berlin / New York: Mouton.
HED 7 = Puhvel, Jaan. 2007. *Hittite Etymological Dictionary. Vol. 7, Words Beginning with N*. Berlin / New York: Mouton.
HED 8 = Puhvel, Jaan. 2011. *Hittite Etymological Dictionary. Vol. 8, Words Beginning with PE*, *PI*, *PU*. Berlin / New York: Mouton.
HED 9 = Puhvel, Jaan. 2013. *Hittite Etymological Dictionary. Vol. 9, Words Beginning with PA*. Berlin / New York: Mouton.
HED 10 = Puhvel, Jaan. 2017. *Hittite Etymological Dictionary. Vol. 10, Words Beginning with SA*. Berlin / New York: Mouton.
Hegedüs, Irén. 2012. The *RUKI*-rule in Nuristani. In: Nielsen Whitehead, Benedicte et al. (eds). *The Sound of Indo-European. Phonetics, Phonemics, and Morphophonemics.* 145–167. Copenhagen: Museum Tusculanum Press.
Hiersche, Rolf. 1964. *Untersuchungen zur Frage der Tenues Aspiratae im Indogermanischen.* Wiesbaden: Otto Harrassowitz.
Hill, Eugen. 2003. *Untersuchungen zum inneren Sandhi des Indogermanischen. Der Zusammenstoß von Dentalplosiven im Indoiranischen, Germanischen, Italischen und Keltischen*. Bremen: Hempen Verlag.
Hillmarsson, Jörundur. 1993a. Development of labiovelars (and tectals plus u̯) in initial position in Tocharian (an overview). *Die Sprache* 35/2. 176–186.

Hillmarsson, Jörundur. 1993b. The fate of *TTR/RTT* in Indo-European. In: Meiser, Gerhard (ed.) *Indogermanica et italic. Festschrift für Helmut Rix zum 65. Geburtstag*. Innsbruck: Innsbrucker Beiträge zur Sprachwissenschaft 72. 209–222.

Hirt, Hermann. 1899. Zur Lösung der Gutturalfrage im Indogermanischen. *BB* 24. 218–291.

Hirt, Hermann. 1912. *Handbuch der griechischen Laut- und Formenlehre*. Heidelberg: Carl Winter´s Universitätsbuchhandlung.

Hirt, Hermann. 1927. *Indogermanische Grammatik. Teil 1, Einleitung. 1. Etymologie. 2. Konsonantismus*. Heidelberg: Carl Winter´s Universitätsbuchhandlung.

Hirt, Hermann. 1939. *Die Hauptprobleme der indogermanischen Sprachwissenschaft.* Halle: Max Niemeyer Verlag.

Hock, Wolfgang. 2004. Forschungsbericht: Baltoslavisch. I. Teil: Phonologie. *Kratylos* 49. 1-32.

Hock, Wolfgang. 2005. Zur Vorgeschichte des albanischen Lautsystems. In: Meiser, Gerhard/Hackstein, Olav (eds.). *Sprachkontakt und Sprachwandel. Akten der XI. Fachtagung der Indogermanischen Gesellschaft, 17.—23. September 2000, Halle an der Saale.* Wiesbaden: Dr. Ludwig Reichert Verlag, 261–274.

Hoffmann, Karl. 1956. Notizen zu Wackernagel–Delbrunner, Altindische Grammatik II.2. *MSS* 8. 5–24.

Hoffmann, Karl / Forssman, Bernard. 1996. *Avestische Laut- und Flexionslehre*. Innsbruck: Institut für Sprachwissenschaft der Universität Innsbruck.

Hoffner, Harry A. / Melchert, H. Craig. 2008. *A Grammar of the Hittite Language*. *Part 1. Reference Grammar*. Winona Lake: Eisenbrauns.

Holst, Jan Henrik. 2001. *Lettische Grammatik*. Hamburg: Helmut Buske Verlag.

Hopper, Paul. 1973. Glottalized and murmured Occlusives in Indo-European. *Glossa* 7. 141–166.

Horrock, Geoffrey. 2017. The Evolution of Greek. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.1*). Berlin / Boston: Walter de Gruyter, 717–745.

Hrozný, Bedřich. 1917. *Die Sprache der Hethiter*. Leipzig: Hinrichs.

Hübschmann, Heinrich. 1883. *Armenische Studien I. Grundzüge der armenischen Etymologie.* Leipzig: Breitkopf und Härtel.

Hübschmann, Heinrich. 1897. *Armenische Grammatik I. Armenische Etymologie.* Leipzig: Breitkopf und Härtel.

Hujer, Oldřich. 1913. Skupina *kt* ve slovanštině [The Cluster *kt* in Slavic]. *Časopis moderních filologů* 3. 356–360.

Huld, Martin E. 1984. *Basic Albanian Etymologies*. Columbus, Ohio: Slavica Publishers.

Huld, Martin E. 1986. On the unacceptability of the Indo-European Voiced stops as Ejectives. IF 91, 67–78.

Huld, Martin E. 1997. Satəm, centum and Hokum. In: Adams, Douglas Q. (ed.), *Festschrift for Eric P. Hamp* I. Washington: Institute for the study of Man. 115–138.

Insler, Stanley. 1972. Some irregular Vedic imperatives. Language 48/3. 551–565.

Insler, Stanley. 1975. The Vedic type *dheyām*. Sprache 21/1. 1–22.

Jackson, Kenneth. 1953. *Language and History in Early Britain*. Edinburgh: Edinburgh University Press.

Jakobson, Roman / Morris Halle. 1956. *Fundamentals of Language*. ‘S-Gravenhage: Mouton & Co.

Jakobson, Roman. 1958. Typological Studies and their Contribution to Historical comparative linguistics. In: Sievertsen (ed.): *Proceedings of the Eighth International Congress of Linguists.* Oslo: Oslo University Press. 17–35.

Jamison, Stephanie W. 1997. Syntactic Constraints on Morphological Change: the Vedic Imperatives *bodhí*, *dehí* and *dhehí*. In: Pirart, Eric (ed.). *Syntaxe des langues indo-iraniennes anciennes: colloque inernational.* 63–80. Barcelona: Universidad de Barcelona.

Jannaris, Antonius N. 1897. *An Historical Greek Grammar, Chiefly of the Attic Dialect as Written and Spoken from Classical Antiquity Down to the Present Time: Founded upon the Ancient Texts, Inscriptions, Papyri and Present Popular Greek*. London: Macmillan.

Jasanoff, Jay. 2002. The Vedic Imperatives *yódhi* "fight" and *bódhi* "heed". *Journal of the American Oriental Society* 122/2. 290–295.

Jasanoff, Jay. 2004. *Plus ça change...* Lachmann's Law in Latin. In: Penney, J. H. W. (ed.). *Indo-European Perspectives: Studies in Honour of Anna Morpurgo Davies*. Oxford: Oxford University Press. 405–416.

Job, Michael. 1995. Zum Lautwandel im Armenischen: Probleme einer relativen Chronologie. In: Smoczyński, Wojciech (ed.). *Kuryłowicz Memorial Volume. Part One.* Cracow: Universitas, 291–311.

Johansson, Karl F. 1903. Arische Beiträge. *Indogermanische Forschungen* 14: 265–339.

Johansson, Karl F. 1906. Arische Beiträge. *Indogermanische Forschungen* 19: 112–139.

Jokl, Norbert. 1923. *Linguistisch-kulturhistorische Untersuchungen aus dem Bereiche des Albanischen*. Berlin/Leipzig: Walter de Gruyter & Co.

Jokl, Norbert. 1937. Ein Beitrag zur Lehre von der alb. Vertretung der idg. Labiovelare. In: Hjelmslev, Louis (ed.). *Mélanges linguistiques offerts à M. Holger Pedersen à ľoccasion de son soixante-dixième anniversaire*. København : Universitetsforlaget i Aarhus Levin & Munksgaard, 127–161.

Jokl, Norbert. 1963. Die Verwandtschaftsverhältnisse des Albanischen zu den übrigen indogermanischen Sprachen. *Die Sprache* 9. 113–156.

Kapović, Mate. 2017. Proto-Indo-European Phonology. In: Kapović, Maté. (ed.). 2017: *The Indo-European Languages.* London – New York: Routledge. 13–60.

Karaliūnas, Simas. 1966. *K voprosu ob i.-e. *s posle i, u v litovskom jazyke*. *Baltistika* 1, 113–126.

Karulis, Konstantīns. 1992a. *Latviešu etimoloģijas vārdnīca I. A – O.* Rīga: Avots.

Karulis, Konstantīns. 1992b. *Latviešu etimoloģijas vārdnīca II. P – Ž.* Rīga: Avots.

Kausen, Ernst. 2012. *Die indogermanischen Sprachen.* Hamburg: Helmut Buske Verlag.

Kellens, Jean. 1976. Un prétendu present radical. *Münchener Studien zur Sprachwissenschaft* 34. 59–71.

Kellens, Jean. 1989. Avestique. In: Schmitt, Rüdiger (ed.). *Compendium linguarum Iranicarum.* 32–55.Wiesbaden: Dr. Ludwig Reichert Verlag.

Kellens, Jean. 1984. *Le verbe avestique*. Wiesbaden: Dr. Ludwig Reichert Verlag.

Kellens, Jean. 1995. *Liste du verbe avestique*. Wiesbaden: Dr. Ludwig Reichert Verlag.

Kent, Roland G. 1928. Lachmann's Law of Vowel Lengthening. *Language* 4. 181–190.

Kent, Roland G. 1932a. The Development of the Indo-European Dental Groups. *Language* 8/1. 18–26.

Kent, Roland G. 1932b. The Sounds of Latin. A Descriptive and Historical Phonology. *Language* 8/3. (*Language Monograph* 12). 11–13, 15-216.

Kent, Roland G. 1936. Assimilation and dissimilation. *Language* 12/4: 245–258.

Kent, Roland G. 1950. *Old Persian. Grammar. Texts. Lexicon*. New Haven: American Oriental Society.

Kim, Ronald. 1999. The development of labiovelars in Tocharian: a closer look. *Tocharian and Indo-European Studies 8*. 139–187.

Kim, Ronald I. 2016. Studies in Armenian Historical Phonology I: Aspiration and Spirantization of PIE Voiceless Stops. In: Byrd, Andrew M. / DeLiss, Jessica / Wenthe,

Mark (eds.). *Tavet Tat Satyam. Studies in Honor of Jared S. Klein on the Occasion of his Seventieth Birthday.* Ann Arbor/New York: Beech Stave Press, 151–167.
Kim, Ronald. 2018. Greco-Armenian: The persistence of a myth. *Indogermanische Forschungen* 123/1, 247–271.
Kimball, Sara. 1999. *Hittite Historical Phonology*. Innsbruck: Innsbrucker Beiträge zur Sprachwissenschaft.
Kimball, Sara. 2017. The Phonology of Anatolian. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.1*). Berlin / Boston: Walter de Gruyter, 249–256.
Kirchhoff, Adolf. 1877. *Studien zur Geschichte des griechischen Alphabets*. Berlin: Ferd. Dümmler´s Verlags-Buchshandlung.
Klingenschmitt, Gert. 1982. *Das altarmenische Verbum.* Wiesbaden: Dr. Ludwig Reichert Verlag.
Kloekhorst, Alwin. 2008. *Etymological Dictionary of the Hittite Inherited Lexicon*. Leiden / Boston: Brill.
Kloekhorst, Alwin. 2019. The spelling of clusters of dental stop + sibilant in Hittite. *Münchener Studien zur Sprachwissenschaft.* 73/1. 55–72.
Kobayashi. Masato. 2004. *Historical Phonology of Old Indo-Aryan Consonants*. Tokyo: Research Institute for Languages and Cultures of Asia and Africa. Tokyo University of Foreign Studies.
Kobayashi. Masato. 2017. The phonology of Indic (Old Indo-Aryan). In: Klein, Jared / Joseph, Brian / Fritz Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics 4.1*. Berlin/Boston: De Gruyter Mouton. 325–344.
Ködderitzsch, Rolf. 1991. Historische Phonologie des Albanischen: Probleme und Aufgaben. In: Breu, Walter / Ködderitzsch, Rolf / Sasse, Hans-Jürgen (eds). *Aspekte der Albanologie: Akten des Kongresses „Stand und Aufgaben der Albanologie heute". 3.–5. Oktober 1988, Uniersität Zu Köln*. Wiesbaden: Otto Harrassowitz. 121–130.
Kögel, Rudolf. 1879. Ueber einige germanische dentalverbindungen. *Beiträge zur Geschichte der deutschen Sprache und Literatur* 7. 171–201.
Kortlandt, Frederik. 1975. A Note on the Armenian Palatalization. *Zeitschrift für vergleichende Sprachforschung* 89. 43–45.
Kortlandt, Frederik. 1976. Notes on Armenian Historical phonology I. *Studia Caucasica* 3, 91–100 (also in: Kortlandt/Beekes 2003: 1–9).
Kortlandt, Frederik. 1978a. Notes on Armenian Historical phonology II. *Studia Caucasica* 4, 9–16 (also in: Kortlandt/Beekes 2003: 20–25).
Kortlandt, Frederik. 1978b. I.-E. palatovelars before Resonants in Balto-Slavic. In: Fisiak, Jack (ed): *Recent developments in historical phonology*. The Hague: Mouton. 237–243.
Kortlandt, Frederik. 1978c. PIE obstruents. *Indogermanische Forschungen* 78. 107–120.
Kortlandt, Frederik. 1978d. Comment on W. Winter's paper. In: Fisiak, Jack (ed.). *Recent developments in historical phonology*. The Hague: Mouton., 447.
Kortlandt, Frederik. 1980a. On the Relative Chronology of Armenian Sound Changes. *Studia Caucasica* 4, 9–16 (also in: Kortlandt/Beekes 2003: 26–33).
Kortlandt, Frederik. 1980b. Albanian and Armenian. *Zeitschrift für vergleichende Sprachforschung* 94/1–2, 243–251 (also in: Kortlandt/Beekes 2003: 13–19).
Kortlandt, Frederik. 1981. More Evidence for Italo-Celtic. *Ériu* 32.1–22.
Kortlandt, Frederik 1982. IE. **pt* in Slavic. *Folia Linguistica Historica* 3 (1). 25–28.
Kortlandt, Frederik. 1985. Proto-Indo-European glottalic stops: the comparative evidence. *Folia Linguistica Historica* VI/2. 183–201.

Kortlandt, Frederik. 1986. Armenian and Albanian. In: Leroy, Maurice / Mawet, Francine (eds.). *La place de l'arménien dans les langues indo-européennes*. Leuven: Peeters, 38–47 (also in: Kortlandt/Beekes 2003: 68–74).

Kortlandt, Frederik. 1987. PIE **s* in Albanian. Studies in Slavic and General Linguistics 10. 219–226.

Kortlandt, Frederik. 1988. Reflexes of Indo-European Consonants in Albanian. *Orpheus. Journal of Indo-European and Thracian Studies* 8 (Georgiev Memorial Volume). 35–37.

Kortlandt, Frederik. 1989. Lachmann's Law. In: Vennemann, Theo (ed.). *The New Sound of Indo-European (Essays in Phonological Reconstruction)*. Berlin: Mounton de Gruyter. 103–105.

Kortlandt, Frederik H. H. 1994a. From Proto-Indo-European to Slavic. *The Journal of Indo-European Studies* 22. 91–112.

Kortlandt, Frederik. 1994b. Proto-Armenian Numerals. In: Rasmussen, Jens E. (ed.) *In honorem H. Pedersen. Kolloquium der Indogermanischen Gesellschaft vom 25. bis 28. März 1993 in Kopenhagen.* Wiesbaden: Reichert, 253–257. (also in: Kortlandt/Beekes 2003: 98–101).

Kortlandt, Frederik. 1995. The Sigmatic Forms of the Armenian Verb. *Annual of Armenian LInguistics* 16, 13–17. (also in: Kortlandt/Beekes 2003: 107–109).

Kortlandt, Frederik. 1996. Proto-Armenian Verbal System. In: Sakayan, Dora (ed.) *Proceeding of the 5th International Conference on Armenian Linguistics.* Delmar, N.Y.: Caravan Books, 35–43. (also in: Kortlandt/Beekes 2003: 110–116).

Kortlandt, Frederik. 1999. Lachmann's Law Again. In: Polomé, Edgar C.; Justus, Carol F. (eds.). *Language Change and Typological Variation: In Honor of Winfred P. Lehmann on the Occasion of his 83rd Birthday. Vol. 1 : Language change and phonology*. Washington, D.C.: Institute for the Study of Man. 246–248.

Kortlandt, Frederik / Beekes, Robert S. P. 2003. *Armeniaca. Comparative Notes*. Ann Arbor: Caravan Books

Krahe, Hans / Meid, Wolfgang. 1969. *Germanische Sprachwissenschaft. I. Eingleitung und Lautlehre*. (Sammlung Göschen Band 238). Berlin: Walter de Gruyter & Co.

Kräuter, Johann F. 1877. *Zur Lautverschiebung*. Strassburg: Karl J. Trübner.

Krause, Wofgang 1952. *Westtocharische Grammatik. Band I. Das Verbum.* Heidelberg: Carl Winter Universitätsverlag.

Krause, Wofgang / Thomas, Werner. 1960. *Tocharisches Elementarbuch. Band I. Grammatik.* Heidelberg: Carl Winter Universitätsverlag.

Kronasser, Heinz. 1956. *Vergleichende Laut- und Formenlehre des Hethitischen*. Heidelberg: Carl Winter Universitätsverlag.

Kroonen, Gus. 2013. *Etymological Dictionary of Proto-Germanic*. Leiden/Boston: Brill.

Kümmel, Martin J. 2007. *Konsonantenwandel: Bausteine zu einer Typologie des Lautwandels und ihre Konsequenzen für die vergleichende Rekonstruktion*. Wiesbaden: Reichert.

Kümmel, Martin J. 2012. *Typology and reconstruction*. In: Nielsen Whitehead, Benedicte / Olander, Thomas / Olsen, Birgit A. / Rasmussen, Jens E. (eds.): *The Sound of Indo-European*. Copenhagen: Museum Tusculanum Press. 291–329.

Kurschat LDW = Kurschat, Alexander et al. 1968. *Litauisch-deutsches Wörterbuch. Thesaurus Linguae Lituanicae I.* Göttingen: Vandenhoeck & Ruprecht. + Kurschat, Alexander et al. 1970. *Litauisch-deutsches Wörterbuch. Thesaurus Linguae Lituanicae II.* Göttingen: Vandenhoeck & Ruprecht.

Kuryłowicz, Jerzy. 1927. *ə* indo-européen et *ḫ* hittite. In: *Symbolae grammaticae in honorem Ioannis Rozwadowski I*. Kraków. 95–104.

Kuryłowicz, Jerzy. 1935. *Études indoeuropéennes I.* Kraków: Skład główny w księgarni Gebethnera i Wolffa.

Kuryłowicz, Jerzy. 1951. Le VII^e aoriste indien. In: Kuryłowicz, Jerzy 1973. 126–130.
Kuryłowicz, Jerzy. 1956. *L´apophonie en indo-européen*. *Prace językoznawcze 9*. Wrocław: Polska Akademia Nauk.
Kuryłowicz, Jerzy. 1964. *The inflectional Categories of Indo-European*. Heidelberg: Carl Winter Universitätsverlag.
Kuryłowicz, Jerzy. 1968. A Remark on Lachmann's Law. *Harvard Studies in Classical Philology* 72. 295–299.
Kuryłowicz, Jerzy. 1973. *Esquisses linguistiques I*. München: Fink.
Kuryłowicz, Jerzy. 1977. *Problèmes de linguistique indo-européenne*. *Prace językoznawcze 90*. Wrocław/Warszawa/Kraków/Gdańsk: Polska Akademia Nauk.
Kuiper, Franciscus B. J. 1967. The Sanskrit Nom. Sg. *víṭ*. *Indo-Iranian Journal* 10. 103–125.
Lachmann, Karl. 1850. *Lucretius: De rerum natura* (reprinted 1979. New York/ London: Garland Publ.).
Lambert, Pierre-Yves. 1994. *La langue gauloise*. Paris: Editions Errance.
Lambert, Pierre-Yves / Pinault, Georges-Jean (eds). 2007. *Gaulois et Celtique continental*. Paris: Droz.
Lamprecht, Arnošt. 1987. *Praslovanština* [*The Pre-Slavic language*]. Brno: Univerzita J. E. Purkyně.
Langston, Keith. 2017. The Documentation of Slavic. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.3*). Berlin / Boston: Walter de Gruyter, 1397–1413.
Larson, Jenny H. / Bukelskytė-Čepelė, Kristina. 2018. The documentation of Baltic. In: Klein, Jared / Joseph, Brian / Fritz Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* 4.3. Berlin/Boston: De Gruyter Mouton. 1621–1639.
Lehmann, Winfred P. 1952. *Proto-Indo-European Phonology*. Austin: The University of Texas Press/Linguistic Society of America.
Lehmann, Winfred P. 1986. *A Gothic Etymological Dictionary, based on the third edition of Vergleichendes Wörterbuch der Gotischen Sprache by Sigismund Feist*. Leiden: E. J. Brill.
LEIA = Vendryès, Joseph. 1959–. *Lexique étymologique de l'irlandais ancien*. Paris: Centre national de la recherche scientifique.
Lejeune, Michel. 1947. *Traité de phonétique grecque.* Paris: Librairie C. Klincksieck.
Lejeune, Michel. 1972. *Phonétique historique du mycénien et du grec ancien.* Paris: Éditions Klincksieck.
Leumann, Manu. 1942. Idg. *sḱ* im Altindischen und Litauischen. *Indogermanische Forschungen* 58. 1–26, 113-130.
Leumann, Manu. 1977. *Lateinische Laut- und Formenlehre*. München: C. H. Beck´sche Verlagsbuchandlung.
Lewis, Charlton Th. / Short, Charles / Freund, Wilhelm / Andrews, Ethan Allen. 1879. *A Latin dictionary : founded on Andrews' edition of Freund's Latin Dictionary, rev., enl. and in great part rewritten by Charlton T. Lewis and Charles Short*. Oxford: Clarendon, 1879.
Lewis, Henry / Pedersen, Holger. 1937. *A Concise Comparative Celtic Grammar*. Göttingen: Vandenhoeck & Ruprecht.
Liddell, Henry G. / Scott, R. (/ Jones, Henry S.), 1996. *A Greek-English Lexicon*. A new edition. Oxford: Clarendon Press.
Lindemann, Fredrik O. 1965. Note phonologique sur hittite *eku-* 'boire'. *Revue hittite et asianique* 23. 29–32.
Lipp, Reiner. 2009a. *Die indogermanischen und einzelsprachlichen Palatale im Indo-iranischen.* Band I: *Neurekonstruktion, Nuristan-Sprachen, Genese der indoarischen Retroflexe, Indoarisch von Mitanni.* Heidelberg: Universitätsverlag Winter.

Lipp, Reiner. 2009b. *Die indogermanischen und einzelsprachlichen Palatale im Indo-iranischen.* Band II: *Thorn-Problem, indoiranische Laryngalvokalisation.* Heidelberg: Universitätsverlag Winter.

LIV[2] = Rix, Helmut / Kümmel, Martin J. / Zehnder, Thomas / Lipp, Reiner / Schirmer, Brigitte. 2001. *Lexikon der indogermanischen Verben.* Wiesbaden: Dr. Ludwig Reichert Verlag.

Lombardi, Linda. 1991. *Laryngeal Features and Laryngeal Neutralization*. Dissertation, University of Massachusetts.

Lubotsky, Alexander. 1995. Sanskrit *h* < **dh, bh*. In: Gurov, Nikita V. / Vasil'kov, Yaroslav V. (eds). *Sthāpakaśrāddham. Professor G. A. Zograf Commemorative Volume.* 124–144. St. Petersburg: Peterburgskoe Vostokovedenie.

Lubotsky, Alexander. 2018. The phonology of Proto-Indo-Iranian. In: Klein, Jared / Joseph, Brian / Fritz Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics*. Berlin/Boston: De Gruyter Mouton. 1876–1888.

Macak, Martin. 2018. The Phonology of Classical Armenian. In: Klein, Jared / Joseph, Brian / Fritz, Matthias (eds.) *Handbook of Comparative and Historical Indo-European Linguistics Volume 2* (*HSK 41.2*). Berlin/Boston: De Gruyter Mouton, 1037–1079.

MacAulay, Donald (ed). 1992. The Celtic Languages: an Overview. In: MacAulay, Donald (ed). *The Celtic Languages*. Cambridge: Cambridge University Press. 1–8.

MacDonell, Arthur A. 1910: *Vedic Grammar*. Strassburg: Karl J. Trübner.

MacDonell, Arthur A. 1916: *A Vedic Grammar for Students*. Oxford: Clarendon Press.

Malzahn, Melanie. 2007a. Tocharian Texts and Where to Find Them. In: Malzahn, Melanie (ed.). *Instrumenta Tocharica*. Heidelberg: Universitätsverlag Winter. 79–112.

Malzahn, Melanie. 2007b. A Tocharian Brahmi Chart. In: Malzahn, Melanie (ed.). *Instrumenta Tocharica*. Heidelberg: Universitätsverlag Winter. 223–354.

Malzahn, Melanie. 2010. *The Tocharian Verbal System*. Leiden / Boston: Brill.

Maniet, Albert. 1956. La "loi de Lachmann" et les antinomies de l´allongement compensatoire. In : *Hommages à Max Niedermann*. Bruxelles: Latomus. 230–237.

Mann, Stuart E. 1952. The Indo-European Consonants in Albanian. *Language* 28/1. 31–40.

Mann, Stuart E. 1963. *Armenian and Indo-European (Historical Phonology)*. London: Lusac & Co. Ltd.

Mareš, František V. 1969[1]. *Diachronische Phonologie des Ur- und Frühslavischen.* München: Verlag Otto Sagner.

Mareš, František V. 1999[2]. *Diachronische Phonologie des Ur- und Frühslavischen.* Frankfurt am Main: Peter Lang.

Markey, Thomas L. 1980. Delabialization in Germanic. *Folia Linguistica Historica* 1/2. 235–293.

Marsh, Gordon H. 1941. The Voiced Sibilants in Sanskrit. *JAOS* 61. 45–50.

Martinet, André. 1951. Concerning some Slavic and Aryan reflexes of IE **s*. Word 7. 91–95.

Martinet, André. 1952. Langues à syllabes ouvertes: le cas du slave commun. *Zeitschrift für Phonetik* 6. 145–163.

Martinet, André. 1953. Remarques sur le consonantisme sémitique. *Bulletin de la Société de Linguistique de Paris* 49, 67–78.

Martinet, André. 1955. *Économie des changements phonètiques. Traité de phonologie diachronique.* Berne: A. Francke.

Martirosyan, Hrach, K. 2010. *Etymological Dictionary of the Armenian Inherited Lexicon.* Leiden: Brill.

Martirosyan, Hrach, K. 2013. The Place of Armenian in the Indo-European language family: the relationship with Greek and Indo-Iranian. *Journal of Language Relationship* 10, 85–137.

Masica, Colin P. 1991. *The Indo-Aryan Languages*. Cambridge: Cambridge University Press.

Matasović, Ranko. 2009. *Etymological Dictionary of Proto-Celtic*. Leiden/Boston: Brill.

Matzinger, Joachim. 2006. *Der altalbanische Text Mbsuamae e krështerë (dottrina cristiana) des Lekë Matrënga von 1572: eine Einführung in die albanische Sprachwissenschaft.* Dettelbach: Röll.

Matzinger, Joachim. 2009. Die Albaner als Nachkommen der Illyrier aus der Sicht der historischen Sprachwissenschaft. In: Schmitt, Oliver J. / Frantz, Eva (eds.). *Albanische Geschichte. Stand und Perspektiven der Forschung*. München: R. Oldenburg Verlag, 13–35.

Matzinger, Joachim. 2012. Zwischensprachen – areallinguistische Bemerkungen ausdem Bereich des Balkanindogermanischen. In: Sadovski, Velizar / Stiffler, David (eds.). *Iranistische und indogermanistische Beiträge in memoriam Jochem Schindler (1944–1994)*. Wien: Verlag der Österreichischen Akademie der Wissenschaften, 137–159.

Mayrhofer, Manfred 1951. *Handbuch des Pali.* Heidelberg: Winter.

Mayrhofer, Manfred. 1984. Lassen sich Vorstufen des Uriranischen nachweisen? *Anzeiger der Österreichischen Akademie der Wissensschaften, Phil.-hist. Klasse,* 120: 249–255.

Mayrhofer, Manfred. 1986. *Indogermanische Grammatik I.2. Lautlehre*. Heidelberg: Winter.

Mayrhofer, Manfred. 1989. Vorgeschichte der iranischen Sprachen; Uriranisch. In: Schmitt, Rüdiger (ed.). *Compendium linguarum Iranicarum.* 4–24,Wiesbaden: Dr. Ludwig Reichert Verlag.

Mayrhofer, Manfred. 1997. L'Indo-iranien. In: Bader, Françoise (ed.). *Langues indo-européennes*. Paris: CNRS Edition. 101–122.

Mayrhofer, Manfred. 2004. *Die Hauptprobleme der indogermanischen Lautlehre seit Bechtel.* Wien: Verlag der österreichischen Akademie dr Wissenschaften.

Mažiulis, Vytautas. 2013: *Prūsų kalbos etimologijos žodynas*. Vilnius: Mokslo ir enciklopeidjų ledidybos centras.

McCone, Kim. *Towards a relative chronology of ancient and medieval Celtic sound change.* Maynooth: Department of Old Irish, St. Patrick's College.

Meillet, Antoine. 1893. De quelques difficultés de la théorie des gutturales indo-européeennes. *Memoires de la Société de Linguistique de Paris 8*. 8. 277–304.

Meillet, Antoine. 1902. *Études sur l'etymologie et le vocabulaire du vieux slave I*. Paris: Bouillon.

Meillet, Antoine. 1903. *Esquisse d´une grammarie comparée de l´Arménien classique*. Vienne: Imprimerie des PP. Mékhitharistes.

Meillet, Antoine. 1913. *Altarmenisches Elementarbuch*. Heidelberg: Carl Winters Universitäts-Buchhandlung.

Meillet, Antoine. 1922. *Les dialectes indo-européens.* Paris: Librairie ancienne Édouard Champion.

Meillet, Antoine. 1924. *Le slave commun*. Paris: Librairie ancienne Honoré Champion.

Meillet, Antoine. 1934. *Introduction a l'étude comparative des langues indo-européennes*. Paris: Librairie Hachette

Meillet, Antoine. 1936. *Esquisse d´une grammarie comparée de l´Arménien classique*.[2] Vienne: Imprimerie des PP. Mékhitharistes.

Meillet, Antoine / Vendryes, Joseph. 1924. *Traité de grammaire comparée des langues classiques*. Paris: Librairie Ancienne Édouard Champion.

Meiser, Gerhard. 1986. *Lautgeschichte der Umbrischen Sprache*. Innsbruck: Institut für Sprachwissenscahft der Universität Innsbruck.

Meiser, Gerhard. 1998. *Historische Laut- und Formenlehre der lateinischen Sprache.* Darmstadt: Wissenschaftliche Buchgesellschaft.

Meiser, Gerhard. 2017. The Phonology of Italic. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.2*). Berlin / Boston: Walter de Gruyter, 743–751.

Melchert, H. Craig. 1987. PIE Velars in Luvian. In: Watkins, Calvert (ed.) *Studies in Memory of Warren Cowgill*, 182-204. Berlin – New York: de Gruyter.

Melchert, H. Craig. 1994. *Anatolian Historical Phonology*. Amsterdam / Atlanta: Rodopi.

Melchert, H. Craig. 2012. Luvo-Lycian Dorsal Stops Revisited. In: Sukač, Roman / Šefčík, Ondřej (eds). *The Sound of Indo-European 2. Papers on Indo-European Phonetics, Phonemics and Morphophonemics*. Munich: Lincom Europa, 206–218.

Melchert, H. Craig. 2017. Anatolian. In: Kapović, Mate (ed.). *The Indo-European Languages*. New York: Routledge, 171–201.

Merlingen, Weriand. 1958. Idg. *x*. *Die Sprache* 4. 39–73.

Mey, Jacob L. 1972. Was Bartholomae really a Grassmann? *Norwegian journal of linguistics* 1. 81-89

Meyer, Gustav. 1891. *Etymologisches Wörterbuch der albanesischen Sprache*. Strassburg: Verlag von Karl. J. Trübner.

Michelson, Truman. 1911/1912. The alleged change of Indo-European *tst*(*h*) to *st*(*h*). *Indogermanische Forschungen* 29: 221–226.

Mikkola, Jooseppi J. 1942. *Urslavische Grammatik. II. Teil. Konsonantismus.* Heidelberg: Carl Winter-Universitätsverlag.

Miller, Brett. 2012. *Sonority and the Larynx.* In: Parker, Steve (ed.). *The Sonority Controversy*. Berlin: De Gruyter. 257–288.

Miller, D. Garry. 1977. Bartholomae's Law and an IE Root Structure Constraint. In: Hopper, Paul J. (ed.): *Studies in Descriptive and Historical Linguistics. Festschrift for W. P. Lehmann*. Amsterdam: John Benjamins. 365–392.

Miller, D. Garry. 2019. *The Oxford Gothic Grammar*. Oxford: Oxford University Press.

Morgenstierne, Georg. 1926. *Report on a Linguistic Mission to Afghanistan*. Oslo: H. Aschehou & Co.

Morgenstierne, Georg. 1942. Orthography and sound-system of the Avesta. *Norsk Tidsskrift for Sprogvidenskap* 12: 30–82.

Morgenstierne, Georg. 1945. Indo-European *ḱ* in Kafiri. *Norsk Tidsskrift for Sprogvidenskap* 13: 225–238.

Morgenstierne, Georg. 1965. Dardic and Kāfir Languages. In: Lewis, Bernard/ Pellat, Charles/Schacht Joseph (eds.) *Encyclopaedia of Islam II*. 138–139. Leiden: Brill.

Morpurgo Davies, Anna / Hawkins, J. David. 1988. A Luwian Heart. In: Imparati, Fiorella (ed.). *Studi di storia e di filologia anatolica dedicate a Giovanni Publiese Carratelli*. Firenze: Elite. 169–192.

Nedoma, Robert. 2017. The Documentation of Germanic. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.2*). Berlin / Boston: Walter de Gruyter, 875–888.

Nelson, David N. 1986. *The Historical Development of the Nuristani Languagues*. (Ph.D. thesis, University of Minnesota).

NIL = Wodtko, Dagmar S. / Irslinger, Britta / Schneider, Carolin. 2008. *Nomina im indogermanischen Lexikon*. Heidelberg: Winter Universitätsverlag.

Oettinger, Norbert. 1979. *Die Stammbildung des hethitischen Verbums*. Nürnberg: Hans Carl Verlag.

Ölberg, Hermann M. 1976. Zwei oder drei Gutturalreihen? Vom Albanischen aus gesehen. In: *Scritti in onore di Giuliano Bonfante II*. Brescia: Paideia Editrice. 561–570.

Olsen, Birgit A. 1999. The Noun in Biblical Armenian: Origin and Word-formation: with special emphasis on the Indo-European heritage. Berlin / New York: Mouton de Gruyter.

Olsen, Birgit A. 2018. The Morphology of Armenian. In: Klein, Jared / Joseph, Brian / Fritz, Matthias (eds.) *Handbook of Comparative and Historical Indo-European Linguistics Volume 2* (*HSK 41.2*). Berlin/Boston: De Gruyter Mouton, 1080–1099.
Olsen, Birgit A. 2017: Armenian. In: Kapović, Mate (ed.). *The Indo-European Languages*. New York: Routledge.
Orël, Vladimir. 1998. *Albanian Etymological Dictionary*. Leiden: Brill.
Orël, Vladimir. 2000. *A Concise Historical Grammar of the Albanian Language*. Leiden: Brill.
Osthoff, Hermann. 1884. *Zur Geschichte des Perfects im Indogermanischen: Mit besonderer Rücksicht auf Griechisch und Lateinisch*. Berlin: Karl I. Trübner.
Otkupščikov, Jurij V. 1984. Zakon Laxmana v svete indoevropeijskix dannyx. Gipotezy i fakty. *Voprosy Jazykoznanija* 2. 83–90.
Otrębski, Jan. 1954. Slavjano-baltiskoe jazykovoe jedinstvo. *Voprosy jayzkoznanija* 5, 27–42, 6, 28–46.
Otrębski, Jan. 1958. *Gramatyka języka litewskiego* I. Warszawa: Państwowe wydawnictwo naukowe.
Otrębski, Jan. 1963. Über die Vervollkommnung der Forschungsmethoden. *Lingua Posnanensis* 9. 7–28.
Patri, Sylvain. 2003. Les traitements contradictoires de */pt/ en slave commun (avec une note sur «þ» indo-européen). *Münchener Studien zur Sprachwissenschaft* 63. 121–137.
Pedersen, Holger. 1895. Das indogermanische *s* im Slavischen. *Indogermanische Forschungen* 5. 33–87.
Pedersen, Holger. 1896. Das indogermanische *s* im Slavischen. *Indogermanischen Forschungen* 5. 33–87.
Pedersen, Holger. 1897. *Aspirationen i Irsk*. Ph.D. Dissertation, Copenhagen. Leipzig: Spirgatis.
Pedersen, Holger. 1900a. Die Gutturale im Albanesischen. *Zeitschrift für vergleichende Sprachforschung auf dem Gebiete der indogermanischen Sprachen* 36/3, 277–340.
Pedersen, Holger. 1900b. Albanesisch und Armenisch. *Zeitschrift für vergleichende Sprachforschung auf dem Gebiete der indogermanischen Sprachen* 36/3, 340–341.
Pedersen, Holger. 1904. Armenisch und die nachbarsprachen. *Zeitschrift für vergleichende Sprachforschung* 39, 334–485.
Pedersen, Holger. 1908. Die idg.-semitische Hypothese. *Indogermanische Forschungen* 22. 341–365.
Pedersen, Holger. 1909. *Vergleichende Grammatik der keltischen Sprachen. Erster Band. Einleitung und Lautlehre*. Göttingen: Vanderhoeck und Ruprecht.
Pedersen, Holger. 1913. *Vergleichende Grammatik der keltischen Sprachen. Zweiter Band. Bedeutungslehre (Wortlehre)*. Göttingen: Vanderhoeck und Ruprecht.
Pedersen, Holger. 1926. La cinquième declinaison latine. *KDVS. Hist.-fil. Medd. XI*. 5.
Pedersen, Holger. 1951. *Die gemein-i.e. und die vorie. Verschusslaute*. Copenhagen: Acad.
Peeters, Christian 1971. A phonemic Definition of I-E *bh dh gh*. *KZ* 85/1. 1–4.
Penney, J. W. H. 2017. The Documentation of Tocharian. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.2*). Berlin / Boston: Walter de Gruyter, 1298–1303.
Peters, Martin. 1997. Der armenische Flexionstyp *gitem, gitacʿ* und das ion.-att. Plusquamperfekt. In: Lubotsky, Alexander (ed). *Sound Law and Analogy: Papers in honor of Robert S. P. Beekes on the occasion of his 60th Birthday*. Amsterdam/Atlanta: Rodopi, 209–217.
Petit, Daniel. 2018. The Phonology of Baltic. In: Klein, Jared / Joseph, Brian / Fritz Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* 4.3. Berlin/Boston: De Gruyter Mouton. 1640–1651.

Peyrot, Michaël. 2008. *Variation and change in Tocharian B*. Amsterdam / New York: Rodopi.
Pinault, Georges-Jean. 1990. Notes sur le manuscripts de *Maitreyasamit*. *Tocharian and Indo-European Studies* 4. 119–202.
Pinault, Georges-Jean. 1999. Tokharien A *kapśañi*, B. *kektseñe*. In: Eichner, Heiner / Luschützky, Hans Chr. *Compositiones Indogermanicae in memoriam Jochem Schindler*. Praha: enigma corporation. 457–478.
Pisani, Vittore. 1947. Balto e Slavo. In: Pisani, Vittore. *Linguistica generale e indeuropea, saggi e discorsci I*. Milano: Libreria editrice scientifico universitaria. 65–82.
Pisani, Vittore. 1951. Studi sulla fonetica dell'armeno (II). *Ricerche linguistiche* 2, 47–74.
Pisani, Vittore. 1961. La ricostruzione dell´indoeropeo e del suo sistema fonetico. *Archivio glottologico italiano XLVI*. 1-31.
Pisani, Vittore. 1976. Sanskrit *dehí* und *dhehí*. *Sprache* 22/2. 166.
von Planta, Robert. 1892. *Grammatik der Oskisch-Umbrischen Dialekte*. *Erster Band. Einleitung und Lautlehre*. Strassburg: Verlag von Karl J. Trübner.
von Planta, Robert. 1897. *Grammatik der Oskisch-Umbrischen Dialekte*. *Zweiter Band. Formenlehre, Syntax, Sammlung der Inschriften und Glossen, Anhang, Glossar*. Strassburg: Verlag von Karl J. Trübner.
Pocetti, Paolo. 2017. The Documentation of Italic. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.2*). Berlin / Boston: Walter de Gruyter, 733–743.
Pohl, Hans D. 1980. Slavisch *st* aus älterem **pt*? In *Die Sprache* 26. 62–63.
Pokorny IEW = 1959. *Indogermanisches etymologisches Wörterbuch*. I. Band, A–KN. Bern: Francke Verlag; 1966. *Indogermanisches etymologisches Wörterbuch*. II. Band, KO–WR. Bern: Francke Verlag. 1969. *Indogermanisches etymologisches Wörterbuch*. III. Band. Bern: Francke Verlag.
Pokorny, Julius. 1969. *Altirische Grammatik*. Berlin: Walter de Gruyter & Co.
Porzig, Walter. 1984. *Die Gliederung des indogermanischen Sprachgebiets*. Heidelberg: Carl Winter.
Prokosch, Eduard. 1918–1919. Media Aspirata (I–IV). *Modern Philology* 15/10. 621–628, 16/2. 99–115, 16/6. 325–336, 16/10. 543–552.
Prokosch, Eduard. 1939. *A Comparative Germanic Grammar*. Philadelphia: Linguistic Society of America/University of Pennsylvania.
Rasmussen, Jens E. 1987. On the status of the aspirated tenues and the Indo-European Phonation Series. *Acta Linguistica Hafniensia 20*. 81-109.
Reichelt, Hans. 1909. *Awestisches Elementarbuch*. Heidelberg: Carl Winter's Universitätsbuchhandlung.
Reichelt, Hans. 1922. Die Labiovelare. *IF* 40. 40–81.
Rejzek, Jiří. 2008. K vývoji psl. *kt* [On the development of Pre-Slavic *kt*]. *Slavia* 77. 165–170.
Renou, Louis. 1996[3]. *Grammaire Sanscrite*. Paris: Librairie d'Amérique et d'Orient. Adrien Maisonneuve.
Ribezzo, Francesco. 1903: *Il problema capitale delle gutturali ie*. Rendiconti dell´Accademia di Napoli 17. Napoli : Stab. Tipografico della R. Universita A. Tessitore e figlio.
Ribezzo, Francesco. 1922–1923. Per la genesi delle tre serie gutturali ie. RIGI 6. 225–241, RIGI 7. 41–62.
Ribezzo, Francesco. 1929. La teoria Ascoliana delle gutturali ie. Allo stato presente della glottologia. AGI 22-23. 131–151.
Ringe, Don. 1996. *On the Chronology of Sound Changes in Tocharian*. *Volume 1. From Proto-Indo-European to Proto-Tocharian.* New Haven: American Oriental Society.
Ringe, Don. 2006. *From Proto-Indo-European to Proto-Germanic.* Oxford: Oxford University Press.

Rix, Helmut. 1992. *Historische Grammatik des Griechischen. Laut- und Formenlehre*. Darmstadt: Wissenschaftliche Buchgesellschaft.
Rix, Helmut. 2004. Ausgliederung und Aufgliederung der italischen Sprachen. In: Bammesberger, Alfred / Vennemann, Theo et al. (eds). *Languages in Prehistoric Europe*. Heidelberg : Universitätsverlag Winter, 147–172.
Ross, Alan S. C. / Berns, Jan. 1992. Germanic [numerals]. In: Gvozdanović, Jadranka (ed.). *Indo-European Numerals*. Berlin/New York: Mouton de Gruyter, 555–715.
Rozwadowski, Jan Michał. 1961. O pierwotnym stosunku wzajemnym języków bałtyckich i słowiańskich. In: Rozwadowski, J. M. *Wybór pism II. Językoznawstwo indoeuropejskie*. Warszawa: Państwowe wydawnictwo naukowe, 96–113.
Rusakov, Alexander. 2017. Albanian. In: Kapović, Mate (ed.). *The Indo-European Languages*. New York: Routledge, 552–608.
Sag, Ivan A. 1974: The Grassmann's Law Ordering Pseudoparadox. *Linguistic Inquiry* 5(4). 591–607.
Sag, Ivan A. 1976: Pseudosolutions to the Pseudoparadox: Sanskrtit Diaspirates Revisited. *Linguistic Inquiry* 7(4). 609–622.
Safarewicz, Jan. 1945. Pochodzenie trzech szeregów spólgłosek tylnojęzykowych w prajęzyku indoeuropejskim. *Sprawozdania z czynności i posiedzeń Polskiej akademii umiejętności XLVI*. Kraków. 37.
Salmons, Joseph C. 1993. *The Glottalic Theory*. McLean, VA: Institute for the Study of Man.
de Saussure, Ferdinand. 1877. La transformation latine de **tt* en *ss* suppose-t-elle un intermédiaire **st* ?. *Mémoires de la Société de linguistique de Paris* 3. 293–301 (quoted the version published in: de Saussure, Ferdinand. 1922. *Recueil des publications scientifiques de Ferdinand de Saussure*. Heidelberg: Carl Winters Universitätsbuchhandlung. 370–375).
de Saussure, Ferdinand. 1885. Sur un point de la phonétique des consonnes en i.-e. *Mémoires de la Société de linguistique de Paris* 6. 246–257.
de Saussure, Ferdinand. 1892. Contribution à l'histoire des aspirées sourdes. *BSL* 7. 118.
Schenker, Alexander M. 2002. Proto-Slavonic. In: Bernard Comrie / Greville G. Corbett (eds), *The Slavonic languages*, 60–121. London: Routledge.
Schindler, Jochem. 1967: Das idg. Wort für "Erde" und die dentalen Spiranten. *Die Sprache* 13. 191–205.
Schindler, Jochem. 1976: Diachronic and Synchronic Remarks on Bartholomae's Law and Grassmann's Law. *Linguistic Inquiry* 7(4). 622–637.
Schleicher, August. 1861[1]. *Compendium der vergleichenden Grammatik der indogermanischen Sprachen*. Weimar: Herman Böhlau.
Schleicher, August. 1866[2]. *Compendium der vergleichenden Grammatik der indogermanischen Sprachen*. Weimar: Herman Böhlau.
Schmidt, Gernot. 1973. Die iranischen Wörter für „Tochter" und „Vater" und die Reflexe des interkonsonantischen *H* (*ə*) in den idg. Sprachen. *Zeitschrift für Vergleichende Sprachforschung* 87. 36-83.
Schmidt, Johannes. 1881. Zwei arische *a*-Laute undi die Palatalen. *KZ* 25. 1–179.
Schmidt, József: 1912: Kisérlet az indogermán gutturális probléma medoldására [Essay at a resoluton to the IE guttural Problem]. Budapest: Acad.
Schmidt, Karl H. 1957. Die Komposition in gallischen Personennamen. *Zeitschrift für celtische Philologie*. 26/1-4. 33–301.
Schmidt, Karl H. 1980. Armenian and Indo-European. In: Greppin, John A.C. (ed.). *First International Conference on Armenian Linguistics.* New York: Caravan Books. 35–58.
Schmidt, Karl H. 1991. Latin and Celtic: Genetic Relationship and Areal Contacts. *Bulletin of the Board of Celtic Studies* 38. 1–19.

Schmidt, Wolfgang P. 1966. *Alteuropa und der Osten im Spiegel der Sprachgeschichte*. (Innsbrucker Beiträge zur Kulturwissenschaft, Sonderheft 22). Innsbruck: Institut für Sprachwissenschaft der Universität Innsbruck.

Schmitt, Rüdiger. 1989. Altpersisch. In: Schmitt, Rüdiger (ed.). *Compendium linguarum Iranicarum*. 56-85,Wiesbaden: Dr. Ludwig Reichert Verlag.

Schmitt, Rüdiger. 1989. Die Iranischen Sprachen im Überblick. In: Schmitt, Rüdiger (ed.). *Compendium linguarum Iranicarum*. 25-31,Wiesbaden: Dr. Ludwig Reichert Verlag.

Schmitt, Rüdiger. 2007. *Grammatik des Klassisch-Armenischen mit sprachlichen Erläuterungen*. Innsbruck: Institut für Sprachen und Literaturen der Universität Innsbruck.

Schmitt-Brandt, Robert. 1998. *Einführung in die Indogermanistik*. Tübingen: Francke.

Schrijver, Peter. 1995. *Studies in British Celtic Historical Phonology*. Amsterdam / Atlanta: Rodopi.

Schrijver, Peter. 2007. Some common developments of Continental and Insular Celtic. In: Lambert, Pierre-Yves / Pinault, Georges-Jean (eds). 2007. *Gaulois et Celtique continental*. Paris: Droz. 355–371.

Schumacher, Stefan. 2004. *Die Keltischen Primärverben. Ein vergleichendes, etymologisches und morphologisches Lexikon*. Innsbruck: Institut für Sprachen und Literaturen der Universität Innsbruck. Abteilung Sprachwissenschaft.

Schumacher, Stefan / Matzinger, Joachim. 2013. *Die Verben des Altalbanischen. Belegwörterbuch, Vorgeschichte und Etymologie*. Unter Mitarbeit von Anna-Maria Adaktylos (= *Albanische Forschungen* 33). Wiesbaden: Harrassowitz.

Schumacher, Stefan. 2013. Historische Phonologie. In: Schumacher, Stefan / Matzinger, Joachim. *Die Verben des Altalbanischen. Belegwörterbuch, Vorgeschichte und Etymologie*. Unter Mitarbeit von Anna-Maria Adaktylos (= *Albanische Forschungen* 33). Wiesbanden: Harrassowitz, 205–276.

Schwyzer, Eduard. 1934. Dissimilatorische Geminatenauflösung als Folge yon Übersteigerung, zunächst im Neugriechischen und im Spätaltgriechischen. *KZ* 61/3-4. 222–252.

Schwyzer, Eduard. 1939. *Griechische Grammatik auf der Grundlage von Karl Brugmanns griechischer Grammatik. Erster Band. Allgemeiner Teil, Lautlehre, Wortbildung, Flexion.* München: C. H. Beck'sche Verglasbuchhandlung.

Šefčík, Ondřej. 2012. On the Integration of Old Indo-Aryan Voiceless Aspirates into the system. In: Sukač, Roman / Šefčík, Ondřej (eds.): *Sounds of Indo-European 2*. München: Lincom Europa.

Šefčík, Ondřej. 2016. The problem of Proto-Balto-Slavic 'aspirates' revisited. 77/4. 300–315.

Šefčík, Ondřej 2017. Notes on the Function of the Indo-European Velar Series. In: Hansen, Bjarne Simmelksjær et al. (eds). *Etymology and the European Lexicon*. 401–414. Wiesbaden: Reichert Verlag.

Senn, Alfred. 1966. *Handbuch der litauischen Sprache I. Grammatik.* Heidelberg: Carl Winter.

Shevelov, George Y. 1964. *A Prehistory of Slavic: the Historical Phonology of Common Slavic*. Heidelberg: Carl Winter-Universitätsverlag.

Shields, Kenneth. 1981. A New Look at the Centum/Satem Isogloss, *KZ* 95, 203-213

Shields, Kenneth. 2002. On the distribution of velar consonants in the suffixes and endings of Indo-European. *Indogermanische Forschungen* 107. 96–105.

Sihler, Andrew L. 1995. *New Comparative Grammar of Greek and Latin*. Oxford: Oxford University Press.

Sihler, Andrew L. 1997. The Myth of Direct Reflexes of the PIE Palatal Series in Kati. In: Diesterherft, Dorothy / Huld, Martin / Greppin, John (eds.). *Studies in Honor of Jaan Puhvel. Part One. Ancient Languages and Philology*. Washington D. C.: Institute for the Study of Man. 187–194.

Sims-Williams, Patrick. 1981. The Development of the Indo-European Voiced Labiovelars in Celtic. *Bulletin of the Board of Celtic Studies* 29. 201–229.
Sims-Williams, Patrick. 2017. Iranian. In: Kapović, Mate (ed.). *The Indo-European Languages*. New York: Routledge, 352–386.
Sims-Wiliams Patrick. 2007. Common Celtic, Gallo-Brittonic and Insular Celtic. In: Lambert, Pierre-Yves / Pinault, Georges-Jean (eds). 2007. *Gaulois et Celtique continental*. Paris: Droz, 309– 353.
Sims-Williams, Patrick. 2017. Celtic. In: Kapović, Mate (ed.). *The Indo-European Languages*. New York: Routledge, 352–386.
Skjærvo, Prods Oktor. 2017. The documentation of Iranian. In: Klein, Jared / Joseph, Brian / Fritz Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics 4.1*. Berlin/Boston: De Gruyter Mouton. 472–481.
Sköld, Hannes 1924: Die indogermanischen Labiovelare. *KZ* 52, 147-151.
Smoczyński, Wojciech. 2001. *Język litewski w perspektywie porównawczej*. Kraków: Wydawnictwo uniwersytetu Jagiellońskiego.
Smoczyński, Wojciech. 2005. *Lexicon der altpreussischen Verben*. Innsbruck: Institut für Sprachen und Literaturen der Universität Inssbruck.
Smoczyński, Wojciech. 2007. *Słownik etymologiczny języka litewskiego*. Wilno: Uniwersytet Wileński, Wydział Filologiczny.
Solta, Georg R. 1960. *Die Stellung des Armenischen im Kreise der indogermanischen Sprachen: eine Untersuchung der indogermanischen Bestandteile des armenischen Wortschatzes*. Wien: Mechitharisten-Buchdruckerei.
Solta, Georg R. 1965. Palatalisierung und Labialisierung. *Indogermanische Forschungen* 70. 276–315.
Sommer, Ferdinand. 1914. *Handbuch der lateinischen Laut- und Formenlehre. Eine Einführung in das sprachwissenschaftliche Studium des Lateins.* Heidelberg: Carl Winter Universitätsverlag.
Specht, Franz. 1944. *Die Ursprung der indogermanischen Deklination*. Göttingen: Vandenhoeck & Ruprecht.
Stang, Christian S. 1966. *Vergleichende Grammatik der Baltischen Sprachen*. Oslo / Bergen / Tromsö: Universitetsforlaget.
Steensland, Lars 1973. *Die Distribution der urindogermanischen sogennanten Gutturale*. Uppsala: Almqvist & Wiksel.
Stempel, Reinhard. 1994. Zur Vertretung der drei indogermanischen Gutturalreihen im Armenischen. *HS (KZ)* 107. 298–309.
Stevens. Allan M. 1968. *Madurese phonology and morphology*. New Haven: American Oriental Society.
Stempel, Reinhard. 1994. Zur Vertretung der drei indogermanischen Gutturalreihen im Armenischen. Historische Sprachforschung 107/2. 298–309.
Stifter, David. 2017. The Phonology of Celtic. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.2*). Berlin / Boston: Walter de Gruyter, 1188–1202.
Stiles, Patrick V. 2017. The Phonology of Germanic. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.2*). Berlin / Boston: Walter de Gruyter, 888–912.
Stolz, Friedrich. 1894. *Historische Grammatik der Laterinischen Sprache. Erster Band. Einleitung, Lautlehre, Stammbildungslehre. Erste Hälfte. Einleitung und Lautlehre*. Leipzig: B. G. Teubner.
Strand, Richard F. 1973. Notes on Nūristāni and Dardic Languages. *Journal of the American Oriental Society* 93/3. 297–305.

Streitberg, Wilhelm. 1974. *Urgermanische Grammatik. Einführung in das vergleichende Studium der altgermanischen Dialekte.* Heidelberg: Carl Winter.

Stuart-Smith, Jane. 2004. *Phonetics and Philology. Sound Change in Italic*. Oxford: Oxford University Press.

Sturtevant, Edgar H. 1930. The Gutturals in Hittite and Indo-European. *Language* 6. 213–228.

Sturtevant, Edgar H. 1933a. Archaism in Hittite. *Language* 9. 1–11.

Sturtevant, Edgar H. 1933b. *A Comparative Grammar of the Hittite Language*. Philadelphia: Linguistic Society of America/University of Pennsylvania.

Sturtevant, Edgar H. / Hahn, E. Adelaide. 1951. *A Comparative Grammar of the Hittite Language*. New Haven: Yale University Press.

Sukač, Roman. 2013. *Introduction to Proto-Indo-European and Balto-Slavic Accentology*. Newcastle upon Tyne: Cambridge Scholars Publishing Szemerényi, Oswald. 1957. The Problem of Balto-Slav Unity. A Critical Survey. *Kratylos* 2.2. 97–123.

Szemerényi, Oswald. 1964. *Syncope in Greek and Indo-European and the Nature of Indo-European Accent*. Napoli: Istituto universitario orientale di Napoli.

Szemerényi, Oswald. 1967. The New Yook of Indo-European. Reconstruction and Typology. *Phonetica* 17. 65–99.

Szemerényi, Oswald. 1990. *Einführung in die vergleichende Sprachwissenschaft*. Darmstadt: Wissenschaftliche Buchgesellschaft.

Szemerényi, Oswald. 1996. *Introduction to Indo-European Linguistics,* Oxford: Clarendon Press.

Tischler, Johann. 1990. Hundert Jahre *kentum-satem* Theorie. *Indogermanische Forschungen* 95. 63–98.

Tedesco, Paul. 1968. Sanskrit *dehi* 'give'. *Language.* 44. 1–24.

Thompson, Rupert. 2017. Greek. In: Kapović, Mate (ed.). *The Indo-European Languages*. New York: Routledge, 287–316.

Thurneysen, Rudolf 1909. *Handbuch des alt-irischen Grammatik, Texte und Wörterbuch. I. Teil: Grammatik*. Heidelberg: Carl Winter's Universitätsbuchhandlung.

Townsend, Charles E. & Laura A. Janda. 1996. *Common and Comparative Slavic: Phonology and Inflection with Special Attention to Russian, Polish, Czech, Serbo-Croatian, Bulgarian*. Columbus: Slavica Publishers.

Trautmann, Reinhold. 1974^{2}. *Die altpreussischen Personennamen*. Göttingen: Vandenhoeck & Ruprecht.

Trubetzkoy, Nikolai S. 1939. *Grundüge der Phonologie.* Prag: Travaux du Cercle linguistique de Prague.

Turner, Ralph L. 1964. Sanskrit *buddhi-*. In: *Indo-Iraniaca: Mélanges présentés à G. Morgenstierne à l'occasion de son soixante-dixième anniversaire*. Wiesbaden : Harrasowitz. 174-176.

Turner, Ralph L. 1966. *A Comparative Dictionary of the Indo-Aryan Languages.* London: Oxford University Press.

Uhlenbeck, Christianus C. 1894. Etymologisches. 3 Flëhtan. *Beiträge zur Geschichte der deutschen Sprache und Literatur* 19. 517–519.

Untermann, Jürgen. 2000. *Wörterbuch des Oskisch-Umbrischen*. Heidelberg: Carl Winter.

Vaillant, André. 1950. *Grammaire comparée des langues slaves, tome I, phonétique*. Lyon & Paris: IAC.

Vasmer, Max. 1953–1958. *Russisches etymologisches Wörterbuch* 1–3. Heidelberg: Carl Winter-Universitätsverlag.

Vath, Bernd / Ziegler, Sabine. 2017. The Documentation of Celtic. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.2*). Berlin / Boston: Walter de Gruyter, 1169–1188.

Vendryès, Joseph. 1908. *Grammaire du Vieil-Irlandais.* Paris: Librairie orientale & américaine.
Verner, Karl. 1878. (rev. of) Zur lautverschiebung. Von J F Kräuter. Strassburg, Trübner 1877. [viii und] 154 ss. *Anzeiger für deutsches Altertum und deutsche Literatur* 21. 333–342.
Vey, Marc. 1931a. Slave *st* provenant d'i.-e- **pt*. *Bulletin de la Société de linguistique* 32. 65–67.
Vey, Marc. 1931b. [Procèses-verbaux des séances:] V. sl. *nestera*. *Bulletin de la Société de Linguistique* 32. XV.
Vey, Marc. 1953. Les noms de l' «autour» en slave. *Bulletin de la Société de linguistique* 49 (1). 24–40.
Vey, Marc. 1958. [Procèses-verbaux des séances :] Hypothèse sur l'etymologie de vieux russe *Stribogъ*. *Bulletin de la Société de Linguistique* 53 (1). XLI.
Voyles, Joseph B. 1992. *Early Germanic Grammar. Pre-, Proto-, and Post-Germanic languages*. San Diego/New York: Academic Press.
Waanders, Frederik M. J. 1992. Greek [numerals]. In: Gvozdanović, Jadranka (ed.). *Indo-European Numerals*. Berlin/New York: Mouton de Gruyter, 369–388.
Wackernagel, Jakob. 1896. *Altindische Grammatik. Band I. Lautlehre.* Göttingen: Vandenhoeck & Ruprecht.
Walde, Alois. 1897. Die Verbindungen zweier Dentale und tönendes *z* im Indo-germanischen. *KZ* 34: 461–536.
Wallace, Rex. 2017. Greek. In: Kapović, Mate (ed.). *The Indo-European Languages*. New York: Routledge, 317–351.
Watkins, Calvert. 1966. Italo-Celtic Revisited. In: Puhvel, Jaan / Birnbaum, Henrik (eds.). *Ancient Indo-European Dialects.* Berkeley / Los Angeles: University of California Press. 29–50.
Watkins, Calvert. 1970. A Further Remark on Lachmann's Law. *Harvard Studies in Classical Philology* 74. 55–65.
Weisgerber, Leo. 1935. Sprachwissenschaftliche Beiträge zu frührheinischen Siedlungs- und Kulturgeschichte, I. *Rheinisches Museum für Philologie, Neue Folge*, 84/4. 289–359.
Weiss, Michael. 2009. *Outline of the Historical and Comparative Grammar of Latin*. Ann Arbor / New York: Beech Stave Press.
Weiss, Michael. 2012. Italo-Celtica: Linguistic and Cultural Points of Contact Between Italic and Celtic. In: Jamison, Stephanie W. / Melchert, H. Craig / Vine, Bret (eds.). *Proceedings of the 23rd Annual UCLA Indo-European Conference.* Bremen: Hempen: 151-73.
Werba, Chlodwig H. 2016. Ur(indo)arisches im Nūristānī. Zur historischen Phonologie des Indoiranischen. In: Miller Andrew M./DeLisi Jessica/Wenthe Mark (eds.). *Tavet Tat Satyam. Studies in Honor of Jared S. Klein on the Occasion of His Seventieth Birthday*. Ann Arbor/New York: Beech Stave Press.
WH LEW = Walde, Alois / Hoffmann, Johann Baptist. 2007–2008[6]. *Lateinisches etymologisches Wörterbuch. Erster Band A – L. Zweiter Band M – Z. Registerband zusammengestellt von Elsbeth Berger*. Heidelberg: Carl Winter's Universitätsbuchhandlung.
Whatmough, Joshua. 1937. The development of the Indo-European labiovelars with special reference to the dialects of Ancient Italy. In: *Mélanges linguistiques offerts à M. Holger Pedersen : à l'occasion de son soixante-dixième anniversaire, 7 avril 1937.* København: Levin & Munksgaard. 45–56.
Whitney, William D. 1879. *A Sanskrit Grammar, including both the classical language and the older dialects of Veda and Brāhmana*. Leipzig: Breitkopf and Härtel.
Whitney, William D. 1885. *The roots, verb-forms and primary derivatives of the Sanskrit language: a supplement to his Sanskrit grammar*. Leipzig: Breitkopf and Härtel.

van Wijk. Nicolaas. 1931. *Geschichte der altkirchenslavischen Sprache. Erster Band. Laut- und Formenlehre*. Berlin / Leipzig: De Gruyter.
van Windekens, Albert J. 1976. *Le Tokharien confronté avec les autres langues indo-européennes. Volume 1. La phonétique et le vocabulaire*. Louvain: Centre International de Dialectologie Générale.
van Windekens, Albert J. 1986. Notes sur le traitement des dentales indo-européennes en tokharien. *Zeitschrift für vergleichende Sprachforschung* 99/1. 151–160.
Windfuhr, Gernot L. 1971. Diacritic and Distinctive Features in Avestan. *Journal of the American Oriental Society* 91/1: 104–124.
Winter, Werner. 1954. Problems of Armenian Phonology I. *Language* 30/2, 197–201.
Winter, Werner. 1955. Problems of Armenian Phonology II. *Language* 31/1, 4–8.
Winter, Werner. 1962a. Problems of Armenian Phonology III. *Language* 38/1, 254–262.
Winter, Werner. 1962b. Die Vertretung indogermanischer Dentale im Tocharischen. *Indogermanische Forschungen* 67. 16–35.
Winter, Werner. 1978. The distribution of short and long vowels in stems of the type Lith. *ė̃sti : vèsti : mèsti* and OCS *jasti : vesti : mesti* in Baltic and Slavic languages. In: Fisiak, Jack (ed.). *Recent developments in historical phonology*. The Hague: Mouton. 431-46.
Winter, Werner 1979: Zur "Überlänge" im Deutschen. In: Ezawa, Kennosuke – Rensch Karl. H. – Bethge Wolfgang (eds.): *Sprache und Sprechen.* Tübingen: Max Niemeyer. 197–200.
Winter, Werner. 1992a. Armenian [numerals]. In: Gvozdanović, Jadranka (ed.). *Indo-European Numerals*. Berlin/New York: Mouton de Gruyter, 347–367.
Winter, Werner. 1992b. Tocharian [Numerals]. In: Gvozdanović, Jadranka (ed.). *Indo-European Numerals*. Berlin/New York: Mouton de Gruyter, 97–164.
Winter, Werner. 2011. Vowel lengthening before distinctively voiced consonants. *Tocharian and IE Studies* 12. 221–238.
Woodhouse, Robert. 1998. On PIE tectals. *Indogermanische Forschungen* 103. 40-60.
Woodhouse, Robert 2005. Assibilative palatalization of tectals in Phrygian and the adequacy of bitectal frameworks for Proto-Indo-European. *Indogermanische Forschungen* 110. 205-234.
Young, Steven. 2017. Balto-Slavic. Baltic. In: Kapović, Mate (ed.). *The Indo-European Languages*. New York: Routledge, 497–518.
Zinko, Christian. 2017. The Documentation of Anatolian. In: Klein, Jared / Joseph, Brian / Fritz / Matthias (eds). *Handbook of Comparative and Historical Indo-European Linguistics* (*HSK 41.1*). Berlin / Boston: Walter de Gruyter, 239–249.
Zubatý, Josef. 1891. Slav. *pastorъkъ*. *Archiv für slavische Philologie* 13. 315–317.
Zupitza, Ernst. 1896. *Die germanische Gutturale.* Berlin: Weidmannsche Buchhandlung.
Zupitza, Ernst. 1899. Wortdeutungen. *Zeitschrift für Vergleichende Sprachforschung* 35. 265–270.

Contents