DOI: 10.14746/linpo.2024.66.2.5

Bartholomae's law revisited and remodelled

Ondřej Šefčík

Masaryk University, Brno
sefcik@phil.muni.cz | ORCID: 0000-0001-6368-9421

Abstract: The present paper deals with Bartholomae's Law in Indo-Iranian languages. After a new examination of the data, it concludes that in the case of Bartholomae's Law, there is no assumed 'transfer of aspiration' or any other similar process but that the attested plosives are the result of a process of plosivization of the original Indo-Iranian voiced fricatives Δ (< IE $*D^h$). Thus, the process described by Bartholomae is not an exception in developing of plosive clusters but a regular process affecting the original fricatives, plosives in the outcome clusters being of secondary origin.

Keywords: Bartholomae's Law, voiced aspirates, voiced spirants; Indo-European; Indo-Iranian

1. On Bartholomae's Law in general

Observing the development of the Indo-European clusters formed by two obstruents into Indo-Iranian,[1] we see that the typical assimilation process affecting these clusters is **regressive** in its orientation, the left[2] standing obstruent being assimilated both in voice and aspiration to the right standing obstruent. However, the clusters formed by the left IE voiced aspirate $*D^h$ and a voiceless plosive on the right are remarkable exceptions since they are subject to the assimilation process of a **progressive** orientation where the right unaspirated voiceless plosive becomes voiced in both Indo-Iranian branches and also aspirated in Indic, the process described by **Bartholomae's Law**.[3] In Iranian, even the

[1] Though some authors consider the Law to be operating already in IE (cf. Kuryłowicz 1935: 50-51; Lubotsky 2018: 1879), we support the idea that the Law is exclusively Indo-Iranian (e.g., Szemerényi 1990: 107; Hoffmann & Forsmann 1996: 95-96). Noteworthy is that the possible validity of Bartholomae's Law for Germanic was examined in recent years, especially by Görtzen (1998: 444-448) and Hill (2003: 218-220).

[2] The terms *left* and *right* are here used purely conventionally to describe both an earlier (left) and later (right) pronounced element.

[3] Named after Christian Bartholomae, who described the mechanism first (for details and history of the law, see below).

right sibilant become voiced as well (the question of original aspiration of both types of right obstruents in Common Indo-Iranian will be also discussed).

NB: For simplicity, we use the traditional IE triad **T – *D – *D^h* (used since Lehmann 1952) as purely algebraic symbols, without any attempt to attach any phonetic values to them, as we are willing to refuse to use any of many alternative models (‘glottalic’, ‘ejective’ etc.). What is remarkable both **T* and **D* behave in the examined clusters in the same way, with the same outcomes, unlike **D^h*; hence, the unique symbol *T*/*D* will be used in formulae.

Our analysis will focus only on clusters formed by the right-standing **t-* and **s/š-*[4] (‘Bartholomaean clusters’) since these are generally the most common both in derivative and inflective morphs; the examples we will use are those of the verbal derivation and inflexion since securely attested and synchronically productive.

Analogical clusters formed by a right standing **d^h-*, though not strictly Bartholomaean,[5] will be examined as well since they represent the functional background for the above-mentioned Bartholomaean clusters; hence, the clusters we will examine are:

i. formed by an IE left obstruent (**T/D*,[6] **D^h*);

ii. followed by a right obstruent: **t-*, **d^h-*, **s/š-*).

There are six possible combinations, including either Bartholomaean or non-Bartholomaean clusters: **T/D + *t/d^h/s* and **D^h + *t/d^h/s*.

2. Bartholomae’s Law in Indo-Iranian

As we wrote above, Bartholomae’s law is well attested as a synchronic process in both Old Indic and Iranian (Avestan). However, the two branches differ in the number of clusters affected by the process and the outcomes.

NB: Old Persian does not have any attested ‘Bartholomaean outcomes’, the cluster **D^{h}t* has only a non-Bartholomaean regressive outcome *TT* (cf. OP ppp. *basta-* derived from the √*band-* ‘bind’ cf. LIV^2 75-76; Cheung 2007: 4-6; Brust 2018: 265; ppp. *gasta-* from √*gant-* ‘stink’; cf. Cheung 2007: 103-104; Brust 2018: 177-178), the cluster **D^{h}S* has no known outcomes either Bartholomaean or not. In Old Persian attested clusters **T/Dd^h* and **D^{h}d^h* are naturally not subject to Bartholomae’s Law, resulting from the (expected) regular regressive process (cf. OP adv. *azdā* if from **√ad^h-*; cf. LIV^2 222; Lipp 2009b: 87; Cheung 2007: 153; Brust 2018: 132-133).

The differences between the two branches are as follows:

[4] Both sibilants are just positional (according to the *ruki*-rule/*Pedersen’s Law*) variants of a single sibilant.

[5] Non-Bartholomaean clusters with **d^h-* are subject to regressive assimilation but share outcomes with the Bartholomaean **t-* clusters, as shown below.

[6] OIA voiceless aspirates never enter the clusters in the left position, being always separated from the right obstruents by an inserted vowel (cf. Šefčík 2012).

In **Indic**, only clusters resulting from **D^ht* were affected (marked **bold**). The clusters **D^hs* have, unlike in Avestan, newly created regressive non-Bartholomaean outcomes (marked *cursive*):[7]

Table 1

OIA	**t-*	**s-*	**d^h-*
*-*T/D*	Tt	Ts	Dd^h
-D^h*	**Dd^h**	*Ts*	Dd^h

On the contrary, Bartholomae's Law affects two types of clusters (marked **bold**) in **Avestan**: **D^ht* and **D^hs* (see the table with the analogous non-Bartholomaean clusters):[8]

Table 2

Av.	*t-*	*s-*	*d^h-*
*-*T/D*	Θt	(Θ)s	Dd
-D^h*	**Δd**	**Δz**	Dd

However, Avestan also exhibits a large number of analogous regressive outcomes besides the regular Bartholomaen (*Tt* and *Ts* instead of *Δd* and *Δz*); parallelism, on the contrary, is entirely unknown in Indic, which always has only one type of output.[9]

Another essential difference between the two branches is the one affecting the location of the left plosive: in Iranian, the left peripheral (velar or labial) plosive is fricativized before **t-* but in Old Indic, the plosive is preserved. In Iranian, the left central (dental or originally palatovelar) plosive is sibilantized; in Old Indic, only palatovelars are realized as sibilants (as in other *satəm*-languages).

For the reconstructed Common Indo-Iranian state, we assume that:

i. there was an original IE triad **T*, **D*, **D^h*,[10] attested still later as a triad in Indic and with its third member neutralized on *D* in Iranian; however, Bartholomae's Law shows that Indo-Iranian had this triad still preserved (and probably accompanied by a newly created **T^h*) and the fusion of both voiced classes is a secondary and later feature of Iranian; The old Indo-European triad **T*, **D*, **D^h* was still retained in Indo-Iranian regarding the number of opposition members, plus the addition of the newly formed Indo-Iranian **T^h*. However, for IE **D^h*, we assume a different phonetic value in Indo-Iranian, namely **Δ*, as shown below. Later, in Iranian, IE **D* and **D^h* merged into a single syllable (Ir. **D*), and **T^h* became a spirant (Ir. **Θ*). In Indo-Iranian, on the other hand, the phonemic status of IE

[7] For the given clusters and their OIA outcomes, see Appendix I.

[8] For the given clusters and their Avestan outcomes, see Appendix II.

[9] Here, we are setting aside unique outcomes of the root √*dhā-* 'put' as: pr. imp. *dhattá*(*na*), impf. *ádhattam*, etc., areexceptions in otherwise regular OIA developments.

[10] These symbols are used purely algebraically and used here only to distinguish between three modal classes.

*D^h was reshaped to complement the new Indo-Iranian *T^h as a new fourth member in a system of oppositions based on voicing and aspiration.

ii. Iranian *Δz* from IE *D^hs represents an older state of arts; Indic outcome *Ts* for the same input is a later levelling according to the regressive neutralization (similar neutralization of Bartholomaean clusters appears in Iranian as well as variants to the Bartholomaean development); hence both clusters *D^ht and *D^hs were subject to Bartholomae's Law.

Table 3

InIr	t-	s-	d^h-
-T/D	Tt	Ts	Dd^h
-D^h	**Dd^h**	**Dz**	Dd^h

NB: For simplicity, we leave the question of the fricativization of the left plosives (of the dental and old palatovelars series) aside at this moment, just stating that:

i. the development of dentals was already the Late Indo-European and Indic state of arts (with the left dental plosive) is a secondary archaization, not an older state of arts;

ii. the development of palatovelars was already common for all *satəm*-languages.

3. Previously used models of Bartholomae's Law

As noted above, the progressive direction of Bartholomae's Law goes contrary to the prevailing tendency of Indo-European (and Aryan as well) clusters to be assimilated in a regressive manner (note that the outcomes of the Law are often later analogically levelled on ʿregular' regressive outcomes – regularly in Indic for clusters *D^hS to point out a very remarkable example, however very often analogical regressive outcomes are present in Avestan beside regular progressive outcomes, according to Bartholomae's Law).[11]

The law was first described by Bartholomae (1882), who later returned to it many times (Bartholomae 1883: 48; Bartholomae 1885: 206; Bartholomae 1895-1901: 21-23), and the law was repeatedly investigated, revalued and remodelled since. For further references to older literature, see especially Collinge 1985: 7-11 and Mayrhofer 1986: 115--118; Szemerényi 1990: 106-109; Mayrhofer 2004: 46).

Bartholomae stated that the result of the concatenation of any left voiced aspirated obstruent and any right voiceless unaspirated obstruent would be a cluster of a voiced and a voiced aspirated obstruent (including aspirated sibilant), schematically: *D^hT > *DD^h, *D^hS > *DZ^h. His description only observes the inputs and outputs; there is no detailed process model.

Other authors proposed different models:

i. Anderson (1970: 388) assumes two phases: in the first, a cluster of two voiced aspirated plosives are created, and the second phase is a deaspiration of the first plosive (*D^hT > D^hD^h > DD^h*);

[11] Cf. IE *ts* > OIA *ts*, Av. *0s*; IE *d^hs* > OIA *ts*, Av. *0z*; IE *Ḱs* > OIA *kṣ*, Av. *0š*; IE *$ǵ^hs$* > OIA *kṣ*, Av. *0ž*.

ii. the deaspiration as a second step of the whole process is accepted by Schindler (1976), who assumes that an obstruent becomes aspirated (and inherently voiced) after a voiced aspirate, though other authors assume that Indian aspirates are of biphonematic nature (cf. Ejerhed 1981);
iii. Sag (1974: 593) states there is a paradox: Bartholomae's law (and subsequent deaspiration) should, according to him, precede Grassmann's Law in case of *bhotsya-* but Grassman's Law should precede Bartholomae's Law in case of *buddha-* (also cf. Sag 1976);
iv. 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;
v. D. G. Miller (1977) assumes 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;
vi. Lombardi (1991: 140) tries to explain 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;
vii. Kobayashi (2004: 117-125) speaks about the 'aspiration throw-back', using the instrumentality of the Optimality theory and following the morphemic structure of clusters;
viii. De Angelis (2006) recalls older Schindler's opinion (Schindler 1976: 629), assuming that the input cluster **D*^{h}*T* aims to preserve the aspiration by shifting it on the left plosive. Again, this model is based only on Indic data and does not explain why the assumed shift of aspiration on the **T* is accompanied by the shift of voice, especially since Indic has *T*^{h}, the possible cluster hence could avoid, if there is any need for the 'shift of aspiration', the basic least marked form is †*TT*^{h}, not attested *DD*^{h}.[12]

Previous models often focus only on OIA data, and thus only on clusters **D*^{h}*T*, and therefore usually omit the parallel cluster **D*^{h}*S* (since its outcome in the Indic is 'regular regressive' *TS*, unlike in the Iranian). Similarly, they usually ignore parallel clusters **TD*^{h} and **D*^{h}*D*^{h}, both sharing the same outcome with **D*^{h}*T*-clusters (i.e., Indic *DD*^{h}, Iranian *DD*), which makes them a functional background for Bartholomae's Law (the same outcome is the result of two processes in opposite directions).

As we can see, the typically used model generally assumes a shift of aspiration from the left plosive to the right plosive, accompanied, if considered at all, by various more or less complicated processes and a shift of voice. Such models are implausible, even twice: aspiration and voicedness are **marked** values of obstruents and unaspirated and voiceless are, on the contrary, unmarked values, and the typical assimilation of these values proceeds in the opposite direction, i.e. from marked to non-marked and in a regressive direction.

[12] Again, cf. Šefčík (2012) shows that OIA **T*^{h} is never synchronically neutralized or created, unlike other modal classes of plosives.

4. The proposed alternative model

The reconstructed phonetic value of IE and/or Indo-Iranian *D^h needs to be re-evaluated and clarified.[13] In the following lines, we will use IE *D^h as a purely algebraic sign without any comments on its properties in Indo-European. The traditionally reconstructed IE 'voiced aspirates' are realized in Indic as breathy voiced plosives,[14] in Iranian, they are merged with plain voiced plosives (similarly as in Celtic and Balto-Slavic). However, the voicedness is the essential property of Indo-Iranian *D^h (as we can assume for Celtic, Balto-Slavic and even Germanic and Armenian but not for Proto-Greek or Italic).

We assume that IE *D^h was realized in Common Indo-Iranian as a voiced spirant *Δ, not as an aspirated voiced stop. This idea was suggested already by von Brücke (1856: 59-60), later also by Walde (1887: 466), Prokosch (1918-1919; Prokosch 1939: 39-41) and Hammerich (1967: 839-849), although not specifically for the Bartholomaean clusters but in general for IE *D^h in any position.[15]

Our proposed model for the development of the IE *D^ht/*D^hs‖*TD^h/*D^hD^h clusters (the first pair is Bartholomaean, and the second is parallel to it) follows the trajectory of two steps: the early spirantization of the IE *D^h in Indo-Iranian on *Δ in all positions and the subsequent processes of further assimilations and lenitions in clusters. To the development of individual clusters:

1. We assume the following trajectories for ***D^hT*** clusters with the following steps:
   a. the left IE plosive (= *D^h) being an Aryan voiced spirant (Δ) caused the following *t* to become also a voiced spirant;
   b. 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 ($\Delta\Delta$ > DD^h)[16] in Indic,[17] both plosives are realized as unaspirated plosives in Iranian:

i. IE $*D^h+T > \Delta+T > \Delta\Delta > DD^h$ (Indic)
ii. IE $*D^h+T > \Delta+T > \Delta\Delta > DD$ (Iranian)

[13] For the phonetic value of IE *D^h cf. Kümmel (2012: 293), who successfully argued against 'voiced aspirated' value. From the phonemic point of view, the triad $T - D - D^h$, though many times attacked as 'typologically improbable' (cf. Jakobson 1958: 22-23 and Hopper 1973: 141), is well attested in Madurese, Kelabit and probably also in Bintulu (cf. Blust 2009: 174-175, 182).

[14] The phonetic value of Indo-Aryan D^h is "breathy voiced", but phonologically, the position of D^h is clear: it is in the proportional opposition to T^h as *T* is to *D* (i.e., the opposition of voice), and as much in the proportional opposition to *D* as *T* is to T^h (i.e., the opposition of aspiration). Moreover, breathy and aspirated stops are indeed acoustically similar in that there is a delay in the onset of full voicing. Thus the phonetic proximity between breathy phonation and aspiration is apparent.

[15] Brixhe (1997) assumes that Paleo-Balkan languages (including Proto-Greek!) underwent the change IE *D^h > *Δ.

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

[17] Either directly due to the same process or later, Walde (1897) assumes aspiration as a later feature for OIA and Greek aspirates.

2. *Simili modo*, the trajectories for the development of the IE ***D^hS*** **(**InIr. *ΔS) clusters are modelled with steps:
   a. the left voiced spirant caused the left sibilant also to become voiced;
   b. the intermediate ΔZ cluster became a plosive in the left part of it in Iranian; *TS* replaces the expected †*DZ* due to analogy with regressive clusters in Indic, the Iranian state is assumed to be archaic, hence:

i. IE $*D^h+S > \Delta+S > \Delta Z$ (→ TS) (Indic)
ii. IE $*D^h+S > \Delta+S > \Delta Z > DZ$ (Iranian)

NB: 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 'exotic' voiced aspirated sibilants (Z^h) at all.

The development of both analogical clusters can be modelled in the following way:

3. For the development of IE ***T/D+D^h*** cluster, we simply assume that:
   a. the left plosive took the voice and is spirantized due to the right Δ (< IE $*D^h$);
   b. both spirants were subject to a fortition both in Indic and Iranian:

i. IE $*T/D+D^h > T+\Delta > \Delta\Delta > DD^h$ (Indic)
ii. IE $*T/D+D^h > T+\Delta > \Delta\Delta > DD$ (Iranian)

4. The development of ***D^hD^h*** clusters we model as follows:
   a. an Aryan left voiced spirant (= IE $*D^h$) forms a homorganic cluster with a right voiced spirant;
   b. in the second phase, both spirants became a subject of fortition into plosives; a left spirant became a voiced plosive, the right spirant changed into a voiced aspirate ($\Delta\Delta > DD^h$) in Indic, the right plosive is unaspirated plosive in Iranian:

i. IE $*D^h+D^h > \Delta+\Delta > DD^h$ (Indic)
ii. IE $*D^h+D^h > \Delta+\Delta > DD$ (Iranian)

The fortition of Indo-Iranian voiced spirants on plosives is significantly rarer than lenition from the typological point of view but not impossible. Here, we have to mention the fortition of loanwords in Goidelic. Even in Indic, we have modern synchronic alternations of $*\Delta$ and $*D^h$ in Gujarati: intervocalic /b^h, g^h, d^h) have variants [β, γ, δ] (Masica 1991: 103). Similarly, in Marathi, there is a tendency to spirantize postvocalic /b^h, d^h) and intervocalic /j^h/ (Lambert 1943). The phonetic differences between D^h and Δ almost negligible and phonologically unusable: there is no Indic language with both classes together, though Sindhi and Siraiki have another series of implosives) (cf. Masica 1991: 103; Ladefoged & Maddieson 1996: 57-60, 83). Generally, aspiration is very unusual with fricatives (and more often with sibilants than spirants). In Younger Avestan, there is a synchronic alternation between voiced fricatives and stops ($\Delta \sim D$); this process can

be both an innovation or a preservation of the older state. Especially for Indic is fortition of fricatives, even the synchronic process, affecting OIA sibilants, which regularly change to plosives before IE **s/š* (see Appendix 3 for examples).

NB: The development of clusters **TT*, **TS* is without any special features of interest for our current research.

NB: De Angelis (2006) proposed that the paradigmatic pressure from Bartholomae´s Law forced all IE clusters of two voiced dentals **ddh* to remain as such, with only two exceptions with inserted ^{z}, namely *dehí*, *dhehí* (< **dᶻdh*). However, our model does not require any inserted sibilant within the two-dental clusters, assuming the first plosive spirantization in both Bartholomaean and non-Bartholomaean clusters.

5. Conclusions

We therefore conclude with the following statements:

i. the progressive direction of the Bartholomaean Law is not in opposition to the regular regressive development of plosives: the voiced spirants were subject to their assimilation process that requires each adjacent plosive of a voiced spirant, either from left or from right, to be assimilated to a voiced spirant. The Bartholomaean outcomes are then not exceptions in the regular regressive development of plosives since plosives do not trigger them, although they were affected them;

ii. both Indic and Iranian outcomes with voiced plosives are later innovations resulting from a later parallel fortition, not the inherited Indo-Iranian phonemes. The Indic outcomes with voiced and voiced aspirated plosives are not results of a further dissimilation; the left spirant was never ‘aspirated’, hence could not lose an aspiration. The Iranian outcomes with a single voiced plosive are also the later innovation; the attested existence of voiced spirants as allophones of voiced plosives in Avestan can be an indirect proof of the older existence of voiced spirants;

iii. suppose IE **D^{h}* was a voiced spirant and not an aspirated voiced plosive (a phoneme which does not phonetically exist as such!). In that case, we do not have to assume the existence of any exotic **DZ^{h}* clusters as Bartholomaean outcomes in the Common Indo-Iranian period both in IE dental and palatovelar series. The aspirated sibilants do exist, cf. Amerindian (mutually unrelated) Siouan language Ofo (/s^{h}/ and /f^{h}/), and in the (central?) Chumash languages (/s^{h}/ and /ʃ^{h}/) usually voiceless (*S^{h}*). There is no need to shift an aspiration and create only positional aspirated sibilant if there is no aspiration at all;

iv. the process of fricative fortition, though relater rare, is well documented in Indic for IE sibilants (**s/š*) and palatovelars (probably this is also the reason why IE **Tt* is always OIA *Tt*, unlike other Indo-European languages).

Summarizing: the exceptional development of Bartholomae’s Law is not unique at all if we consider the development of its parallel clusters. There were no shifts of aspiration or creation of specific and exotic voiced aspirated sibilants; the whole process is just a part of the development of clusters containing voiced spirants without regard to their relative *right–left* position.

Appendix i: the Indic outcomes

Table 4

Indic	*t-	*s-	*dʰ-
-*t/d	tt	ts	(d)dʰ
-*dʰ	**ddʰ**	*ts*	ddʰ
-*ḱ/ǵ	ṣṭ	kṣ	(ḍ)ḍʰ
-*ǵʰ	**0ḍʰ**	*kṣ*	0ḍʰ
-*k/g	kt	kṣ	gdʰ
-*gʰ	**gdʰ**	*kṣ*	†gdʰ
-*p/b	pt	ps	†bdʰ
-*bʰ	**bdʰ**	*ps*	†bdʰ

NB: Bartholomaean outcomes are marked in **bold**. Outcomes due to a secondary levelling of originally Bartholomaean clusters are marked *cursive*. Directly unattested outcomes are marked by †. Examples of clusters resulting from **T/Dt*, **T/Ds* are willingly omitted.

Examples of Bartholomae's clusters (Dʰt*, **Dʰs*):**

pr. *inddhé*, ppp. *iddhá-* (√*idh-* 'kindle'; cf. pr. *indháte*, *indhaté*; < IE *√*H₂e̯id*ʰ-; cf. Gr. αἴθω 'I kindle'; cf. Whitney 1885: 8; MacDonell 1916: 371-372; IEW: 11-12; EWAi II: 267; LIV²: 259);

ppp. *baddhá-*, gd. *baddhvā́*, ft. *bhantsyáti* (√*bandh-* 'bind'; cf. pr. *badhnáte*; < IE *√*bʰendʰ*-; cf. Goth. *band* 'bond'; cf. Whitney 1885: 105; MacDonell 1916: 400; IEW: 127; EWAi II: 208; LIV²: 75);

ppp. *buddhá-*, ao. *ábhutsi*, fut. *bhotsáti* B (√*budh-* 'wake'; cf. pr. *bódhati*; < IE *√*bʰeu̯dʰ*-; cf. Gr. πεύθομαι 'I give notice', OCS *bljudǫ* 'beware'; cf. Whitney 1885: 106-107; MacDonell 1916: 400-401; IEW: 150-152; EWAi II: 233-235; LIV²: 82-83; NIL: 36-37);

ppp. *yuddhá-*, gd. *yuddhvī́*, pr. *yótsi*, des. *yúyutsati* (√*yudh-* 'fight'; cf. pr. *yúdhyate*; < IE *√*Hi̯eu̯dʰ*-; cf. OL *ioubē* 'I command'; cf. Whitney 1885: 133; MacDonell 1916: 410; IEW: 511-512; EWAi II: 418-419; LIV²: 225-226).

pr. *léḍhi* B (√*lih-* 'lick'; cf. caus. *leháyati*; < IE *√*le̯i̯ǵʰ*-; cf. Gr. λείχω, OCS *ližǫ* 'I lick'; cf. Whitney 1885: 148; MacDonell 1916: 414; IEW: 668; EWAi II: 463; LIV²: 404);

ppp. *rūḍhá-*, gd. *rūḍhvā́*, ao. *rukṣās*, *árukṣat*, fut. *rokṣyáti* B, ds. *rúrukṣati* (√*ruh-* 'ascend'; cf. pr. *róhati*; < IE *√*H₁le̯u̯dʰ*-; cf. Gr. Hom. ἤλυθον 'I came; cf. Whitney 1885: 143--144; MacDonell 1916: 414; IEW: 306-307, 684-685; EWAi II: 467-469; LIV²: 248--249; NIL: 245-246);

ppp. *ūḍhá-*, inf. *vóḍhum*, ao. *ávākṣur*, fut. *vakṣyáti* (√*vah-* 'carry'; cf. pr. *váhati*; < IE *√*u̯e̯ǵʰ*-; cf. L *uehō*, OCS *vezǫ* 'I carry'; cf. Whitney 1885: 157; MacDonell 1916: 417; IEW: 1118-1120; EWAi II: 535-537; LIV²: 661-662);

ppp. *rabdhá-*, ds. *rípsate* B (√*rambh-* 'grasp'; cf. pr. *rábhate*; < IE *√*lembʰ*-; cf. Gr. λάφῡρα 'spoils of war'; cf. Whitney 1885:136; MacDonell 1916: 411; IEW: 652; EWAi II: 434-435; LIV²: 411-412); etymologically the same root as the following one;

ppp. *labdhá-*, gd. *labdhvā́*, ds. álapsata, fut. *lapsyáti*, des. *lípsate* AV, ps. *lipsyáte* B (√*labh-* ‘take’; cf. pr. *lábhate*; < IE *√*lemb*^{h}-; cf. Gr. λάφῡρα ‘spoils of war’; cf. Whitney 1885: 145-146; MacDonell 1916: 414; IEW: 652; EWAi II: 434-435; LIV^{2}: 411-412);

ppp. *dabdhá-*, ds. *dípsati* (√*dabh-* ‘harm’; cf. pr. *dábhati*; < IE *√*d*^{h}*eb*^{h}-; cf. Hitt. *tepnuzzi* ‘downsize’, Lith. *dóbiu* ‘invalidate’; cf. Whitney 1885: 70; MacDonell 1916: 388; IEW: 240; EWAi II: 694-696; LIV^{2}: 132-133; NIL: 85-86).

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

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

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

Examples of parallel (non-Bartholomaean’s) clusters (**T/DD*^{h}, **D*^{h}*D*^{h}):

pr. *addhí* (√*ad-* ‘eat’; cf. pr. ádmi; < IE *√*H*$_{1}$*ed-*; cf. Hitt. ēdmi, L *edō* ‘I eat’; cf. Whitney 1885: 3; MacDonell 1916: 370; IEW: 287-289; EWAi I: 61-62; LIV^{2}: 230-231; NIL: 208-220);

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

pr. *dehí*,[18] *daddhí* (√*dā-* ‘give’; cf. pr. *dádāti*; < IE *√*deH*$_{3}$-; cf. Gr. δίδωμι, L *dō* ‘I give’, OLith. *duosti* ‘give’; cf. Whitney 1885: 71-72; MacDonell 1916: 388-389; IEW: 223--225; EWAi I: 713-715; LIV^{2}: 105-106; NIL: 60-69);

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

int. *nenigdhí* (√*nij-* ‘wash’; cf. ao. *ánijam*; < IE *√*nei̯g*^{u}-; cf. Gr. νίζω ‘I wash’, OIr. *-nenaig* ‘wash’; cf. Whitney 1885: 90; MacDonell 1916: 395; 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* ‘I harness’, OCS *igo* ‘yoke’; cf. Whitney 1885: 132-133; MacDonell 1916: 410; IEW: 508-510; EWAi II: 417-418; LIV^{2}: 316; NIL: 397-404);

pr. *indhvám* (*-dd^{h}-)[19] (√*idh-* ‘kindle’; cf. pr. *indháte*; < IE *√*H*$_{2}$*ei̯d*^{h}-; cf. Gr. αἴθω ‘kindle’; cf. Whitney 1885: 8; MacDonell 1916: 371-372; IEW: 11-12; EWAi II: 267; LIV^{2}: 259);

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

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

[19] However, clusters *nCC* of this type are often simplifed independently.

ao. *yodhí* (*-dd^{h}-) (√*yudh-* 'fight'; cf. pr. *yúdhyate*; < IE *√*Hi̯eu̯d^{h}-*; cf. OL *ioubē* 'I command'; cf. Whitney 1885: 133; MacDonell 1916: 410; 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', OLith. *dest*(*i*); cf. Whitney 1885: 82; MacDonell 1916: 392-393; IEW: 235-239; EWAi I: 783-786; LIV^{2}: 136-138; NIL: 99-117);

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

Appendix ii: the Iranian outcomes

Table 5

Iranian	*t-	*s-	*d^{h}-
-*t/d	st	0s	zd
-*d^{h}	**zd**	**0z**	zd
-*ḱ/ǵ	št	0š	žd
-*ǵ^{h}	**žd**	**0ž**	†žd
-*k/g	xt	xš	gd
-*g^{h}	**gd**	**γš**	†gd
-*p/b	pt[21]	fš	bd
-*b^{h}	**bd**	**βž**	†bd

NB: Directly not attested outcomes are marked in *cursive*. The non-Bartholomaean outcomes parallel to the Bartholomaean are not listed. Directly not attested outcomes are marked by †. In the examples, outcomes of clusters resulting from **T/Dt*, **T/Ds* are willingly omitted again.

Examples of Bartholomae's clusters (D^{h}t*, **D^{h}s*):**

pr. OAv. *dazdā* but without Bartholomae's Law: YAv *dasta* (√*dā-* 'put'; cf. impf. YAv. *ādadaṯ*; < IE *√*d^{h}eH$_{1}$-*; cf. Gr. τίθημι 'I put', OLith. *desti* 'put'; cf. IEW: 235-236; Kellens 1995: 29; LIV^{2}: 136-137; Cheung 2007: 45-46);

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

[21] This outcome is unusual and unexpected, since we can expect †*ft*. It is a matter of debate, if attested *pt* is an archaism or re-archaization. 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* (< OIranian **hafta*). The question is whether 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*, *pisrē*, YAv. *pisre*. The form *tā* is easy to be explained 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 & Forssman (1996: 94) otherwise 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 (1942; also cf. Lipp 2009a: 158-160 with further references).

ppp. OAv. *vərəzda-* (√*vard-* ‘grow’, OAv. pr. *varədaitī*; < IE *√*Hu̯eRd*^{h}-; cf. OIA *várdhate* ‘they grow’; cf. IEW: 1167; Kellens 1995: 51; LIV^{2}: 228; Cheung 2007: 208);

ppp. OAv. *bazda-* but without Bartholomae’s Law: YAv. *basta-* (√*band-* ‘bind’; cf. ps. YAv. *baṇdaiiatati*; < IE *√*b*^{h}*end*^{h}-; cf. OIA *bandhati*, Goth. *bindan* ‘bind’; cf. Kellens 1995: 37; LIV^{2}: 75-76; Cheung 2007: 4-6);

ppp. YAv. *niuruzda-* but without Bartholomae’s Law: YAv. *urusta-* (√*raud-* ‘grow bigger’; cf. pr. *raoδahe*; < IE *√*H*$_{1}$*leu̯d*^{h}-; cf. Gr. Hom. ἤλυθον ‘I came’; cf. IEW: 306-307, 684-685; Kellens 1995: 59; LIV^{2}: 248-249; NIL: 245-246; Cheung 2007: 193-194);

(?) pr. YAv. *uruuāza-* (√*uruuād-* ‘be proud’; no secure IE cognate; cf. Kellens 1995: 60; Cheung 2007: 438);

pr. OAv. *gərəždā* (√*garz-* ‘complain, pr. OAV. *gərəzōi*; < IE *√*g*$^{(u)}$*eRǵ*^{h}-; cf. OIA *gṛhate* ‘he complains’; cf. IEW: 350-351; Kellens 1995: 19-20; LIV^{2}: 187; Cheung 2007: 111-112);

subs. OAv *važdra-*, YAv. *važdri-* but without Bartholomae’s law: ppp. YAv. *vašta-*, subs. *vaštar-* ‘drag animal’ (?)+ ao. YAv. *uzuuažaṯ* (√*vaz-* ‘drive’, pr. YAv. *vazaiti*; < IE *√*u̯eǵ*^{h}-; < IE *√*u̯eǵ*^{h}-; cf. L *uehō*, OCS *vezǫ* ‘I carry’; cf. IEW: 1118-1119; Kellens 1995: 52; LIV^{2}: 661-662; Cheung 2007: 429-432);

pr. OAv. *aogᵊdā* but. pr. YAv. *aoxte* (√*aoj-* ‘say’; cf. pr. OAv. *aojōi*; < IE *√*H*$_{1}$*eu̯g*$^{(u)h}$- (?); cf. Gr. εὔχομαι ‘I pray’, L *uoueō* ‘I vow’; cf. IEW: 348; Kellens 1995: 9; Cheung 2007: 169-170);

subs. YAv. *dugəd*(*a*)*r-*, YAv. *duγδ*(*a*)*r-* ‘daughter’ (< IE **d*^{h}*ugH*$_{2}$*ter-*;[22] cf. OIA *duhitar-*, Gr. θῠγάτηρ, Goth. *daúhtar* ‘daughter’; cf. IEW: 277; NIL: 126-130);

ds. OAv. *dīdraγžō.duiiē* (√*draṇj-* ‘fix’; cf. caus. *drəṇjaiieiti*; < IE *√*dreg*^{h}-; cf. Gr. δράσσομαι ‘I grasp’, OCS *drьžǫ* ‘I hold’; cf. IEW: 254; Kellens 1995: 32; LIV^{2}: 126; Cheung 2007: 76);

pr. OAv. *paⁱrii-aoγžā* (√*aoj-* ‘say’; cf. pr. OAv. *aojōi*; < IE *√*H*$_{1}$*u̯eg*$^{(u)h}$- (?); cf. Gr. εὔχομαι ‘I pray’, L *uoueō* ‘I vow’; cf. IEW: 348; Kellens 1995: 9, 14; LIV^{2}: 253; Cheung 2007: 169-170);

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

ds. OAv *diβžaidiiāi* (√*dab-* ‘deceive’; cf. pr. OAv. *dəbənaotā*; < IE *√*d*^{h}*eb*^{h}-; cf. Lith. *dóbiu* ‘subdue’; cf. IEW: 240; Kellens 1995: 27; LIV^{2}: 132-133; NIL: 85-86; Cheung 2007: 42-43);

subs. YAv. *vaβžaka-* ‘scorpion’ (< IE *u̯ob*^{h}*sā*; cf. L *uespa*, OHG *wafsa*; ‘wasp’ cf. IEW: 1179).

Examples of parallel (non-Bartholomaean’s) clusters (*T/DD^{h}, *D^{h}D^{h}):

pr. imp. YAv. *dazdi*, OAv. *mąz-dazdūm* (√*dā-* ‘give’; cf. pr. OAv. *dadē*; < IE *√*deH*$_{3}$-; cf. Gr. δίδωμι, L *dō* ‘I give’, OLith. *duosti* ‘give’; cf. IEW: 223-225; Kellens 1995: 29; LIV^{2}: 105-106; NIL: 60-69; Cheung 2007: 43-45);

[22] From IE **gH*$_{2}$*t*, probably merged with **g*^{h}*t* already before the Common Indo-Iranian period, since the first plosive was deaspirated according to Grassmann’s Law, hence IE **gH*$_{2}$*t* > **g*^{h}*t*.

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

inf. YAv. *dazdiiāi* (√*dā-* 'put'; cf. impf. YAv. *ādadaṯ*; < IE *√*dʰeH₁-*; cf. Gr. τίθημι 'I put', OLith. *desti* 'put'; cf. IEW: 235-236; Kellens 1995: 29; LIV²: 136-137; NIL: 99-11; Cheung 2007: 45-46);

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

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

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

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

Appendix iii: the development of the **SDʰ* clusters in Indic

That Indic was subject to a regular de-spirantization is evident from the development of clusters **SDʰ* > OIA *0Dʰ/DDʰ* (cf. OIA imp. pr. *edhí* = √*as-* 'be' + *dhi*, OIA imp. pr. *ādhvam* = √*ās-* 'sit' + *dhvam*; OIA imp. pr. *viviḍḍhi* = √*viṣ-* 'be active' + *dhi*, OIA imp. pr. *rīḍhvam* = √*riṣ-* 'be hurt' + *dhvam*), since root-final sibilant was either lenited (de-buccalized and elided) or became a plosive in the position before a voiced plosive. Similarly, in clusters of two sibilants, the root-final usually became a plosive (cf. OIA ds. *jíghatsati* = √*ghas-* 'eat' + *sa-*, OIA *ávatsyat* в. = √*vas-* 'shine' + *sya-*; OIA inj. ao. *dvikṣát* = √*dviṣ-* 'hate' + *sá-*; OIA pr. *vívekṣi* = √*viṣ-* 'be active' + *si*).[23]

Avestan preserved the original left sibilant, which was lost before a following sibilant, this state of arts is an archaic feature, replaced by a new creation in Indic.

Trajectories we assume for the development of these clusters are:

ia. S + Dʰ > ZΔ > i̯Dʰ	(Indic)
ib. S + Dʰ > ZΔ > ΔΔ > DDʰ	(Indic)
ii. S + Dʰ > ZΔ > ZD	(Iranian)
i. S + S > Θs > TS	(Indic)
ii. S + S > SS > 0S	(Iranian)

[23] OIA *ási* from √*as-* is probably the old IE simplification of clusters, cf. L. *es*. OIA *śāssi* = √*śās-* + *si* is a unique example of the (restituted?) cluster.

Examples:

Indic:

pr. *edhí* (√*as-* ‘be’; cf. pr. *ásat*; < IE *√H_1*es-*; cf. Gr. ἐστί, L *est* ‘is’; cf. Whitney 1885: 5; MacDonell 1916: 370-371; IEW: 340-341; EWAi I: 144; LIV²: 241-242; NIL: 235--238);

pr. *ā́dhvam* (√*ās-* ‘sit’; cf. pr. *ā́sāthe*; < IE *√H_1*eH$_1$*s-*; cf. Hith. ēsa, Gr. ἧσται ‘sits’; cf. Whitney 1885: 6-7; MacDonell 1916: 371; IEW: 342-343; EWAi II: 181; LIV²: 232);

pr. *śādhí*, pf. *śaśādhí* (√*śās-* ‘order’; cf. pr. *śā́smi*; < IE *√*ḱeHs-*; cf. Alb. *thom* ‘say’; cf. Whitney 1885: 172; MacDonell 1916: 423; IEW: 533; EWAi II: 632-633; LIV²: 318--319);

pf. *vivi̯ḍḍhí* (√*viṣ-* ‘be active’; cf. pr. *víveṣaḥ*; < IE *√*u̯ei̯ṣ-* 3; cf. Whitney 1885: 161; MacDonell 1916: 419; EWAi II: 585-586; LIV²: 672);

ao. *rīḍhvam* TA (√*riṣ-* ‘be hurt’; cf. pr. *ríṣyati*; < IE *√(H_1)*rei̯ṣ-*; cf. Whitney 1885: 140; IEW: 859; EWAi II: 462; LIV²: 505);

ds. *jíghatsati* AV (√*ghas-* ‘eat’; cf. pf. *jaghā́sa*; < IE *√*g$^{(u)h}$es-*; cf. OAv. *aγžōnuuamna-* ‘not consumable’; cf. Whitney 1885: 42; MacDonell 1916: 381; IEW: 452; EWAi I: 514; LIV²: 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; IEW: 86-87; EWAi II: 530-532; LIV²: 292-293; NIL: 357-367);

ao. *dvikṣát*, *dvikṣata* AV (√*dviṣ-* ‘hate’; cf. pr. *dvéṣat*; < IE *√*du̯ei̯ṣ-*; cf. OAv. *d^{ai}bišəṇtī*; cf. Whitney 1885: 81; MacDonell 1916: 392; IEW: 228; EWAi I: 770-771; LIV²: 131);

ao. *apikṣan* ŚB (√*piṣ-* ‘crush’; cf. pf. *pipéṣa*; < IE *√*pei̯ṣ-*; cf. Lith. *pisù* ‘I copulate’, OCS *рьхотъ* ‘I pushed’; cf. Whitney 1885: 97-98; MacDonell 1916: 398; IEW: 796; EWAi II: 169; LIV²: 466-467);

pr. *vívekṣi*, fut. *vekṣyáti* (√*viṣ-* ‘be active’; cf. pr. *víveṣaḥ*; < IE *√*u̯ei̯ṣ-* 3; cf. Whitney 1885: 161; MacDonell 1916: 419; EWAi II: 585-586; LIV²: 672).

Iranian:

pr. OAv. *zdī* (√*ah-* ‘be’; cf. pr. OAv. *ahmī*; < IE *√H_1*es-*; cf. Gr. ἐστί, L *est* ‘is’; 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* ‘he protects, saves’; cf. IEW: 1075; Kellens 1995: 27; LIV²: 646; Cheung 2007: 394);

inf. OAv. *sazdiiiāi*[24] (√*səṇh-* ‘declare’, pr. YAv. *saŋhaite*; < IE *√*ḱens-*; cf. L *cēnseō* ‘I judge’; cf. IEW: 566; Kellens 1995: 62; LIV²: 326; Cheung 2007: 334-335);

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

pr. (ao.?) OAv. *cīždī* (√*ciš-* ‘assign’; cf. pr. OAv. *cīšmahī* < IE *√*k^{u}ei̯ṣ-*; cf. OIr. *ad-cí* ‘see’; cf. IEW: 637; Kellens 1995: 22-23; LIV²: 381-382; Cheung 2007: 30);

inf. OAv. *būždiiāi* (√*būš-* ‘endeavour’; < IE *√*b^{h}eu̯H$_2$-s-*; cf. Lith. *bùs* ‘it will be’; cf. IEW: 146-147; Kellens 1995: 39-40; LIV²: 98-101; Cheung 2007: 25-26);

[24] This from can be from √*saṇd-* ‘appear”, cf. Cheung (2007: 334), but it seems to be doubtful. Kellens lists it as derived from √*səṇh-* ‘declare” without any doubts (Kellens 1995: 62).

part. inch. YAv. (*vī*)*usaitī-* f. (√*vah-* 'shine', < IE *√*u̯es-*; cf. Lith. *aũšti* 'break dawn'; cf. 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. IEW: 1029-1030; Kellens 1995: 64; LIV²: 597-598; Cheung 2007: 363-364);

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

Abbreviations

ao.	= aorist	inch.	= inchoative
co.	= conditional	inf.	= infinitive
ds.	= desiderative	int.	= intensive
fut.	= future	pf.	= perfect
gd.	= gerund	pr.	= present
imp.	= imperative	ppp.	= preterit passive participle
impf.	= imperfect	subs.	= substantive

Languages

Alb.	= Albanian	OAv.	= Old Avestan
Arm.	= Armenian	OCS	= Old Church Slavonic
Av.	= Avestan	OE	= Old English
Goth.	= Gothic	OIA	= Old Indo-Aryan
Gr.	= Greek	OIr.	= Old Irish
Hitt.	= Hittite	OL	= Old Latin
Hom.	= Homeric	OLith.	= Old Lithuanian
IE	= Indo-European	OP	= Old Persian
L	= Latin	YAv.	= Young Avestan
Lith.	= Lithuanian		

Symbols

D	= voiced unaspirated plosive	T	= voiceless unaspirated plosive
D^h	= voiced aspirated plosive	T^h	= voiceless aspirated plosive
Δ	= voiced spirant	Θ	= voiceless spirant
S	= voiceless sibilant	Z	= voiced sibilant
S^h	= voiceless aspirated sibilant	Z^h	= voiced aspirated sibilant

References

Anderson, Stephen R. 1970. On Grassmann's Law in Sanskrit. *Linguistic Inquiry* 1(4). 387-396.

Bartholomae, Christian. 1882. Die arische Vertretung von Med. Asp. + *t* und Med. Asp. + *s*. In Bartholomae, Christian. *Arische Forschungen I.*, 3-24. Halle: Niemeyer.

Bartholomae, Christian. 1883. *Handbuch der altiranischen Dialekte*. Leipzig: Breitkopf & Härtel.

Bartholomae, Christian. 1885. Θυγάτερ. *Zeitschrift für vergleichende Sprachforschung auf dem Gebiete der indogermanischen Sprachen* (*KZ*) 27 (Neue folge VII), 206-207.

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, 1-248. Strassburg: Karl J. Trübner.

Beekes, Robert S. P. 1988. *A grammar of Gatha-Avestan*. Leiden: Brill.

Blust. Robert. 2009. *The Austronesian languages*. Canberra: Pacific Linguistics. Research School of Pacific and Asian Studies–The Australian National University.

Brixhe C. 1997. Un "nouveau" champ de dialectologie grecque: Le macédonien. In Cassio, Albio C. (ed.), *Katà diálekton: Atti del III Colloquio Internazionale di Dialettologia Greca. Napoli – Fiaiano d'Ischia, 25-28 settembre 1996.* AIΩN XIX, 41-71. Napoli: Istituto Universitario Orientale.

von Brücke, Ernst. 1856. *Grundzüge der Physiologie und Systematik der Sprachlaute* für *Linguisten und Taubstummenlehrer*. Wien: Carl Gerold's Sohn.

Brust, Manfred. 2018. *Historische Laut- und Formenlehre des Altpersischen – mit einem etymologischen Glossar* (Innsbrucker Beiträge zur Sprachwissenschaft 161). Innsbruck: Institut für Sprachen und Literaturen der Universität Innsbruck, Bereich Sprachwissenschaft.

Cheung, Johny. 2007. *Etymological dictionary of the Iranian verb*. Leiden: Brill.

Collinge, Neville E. 1985. *The laws of Indo-European*. Amsterdam–Philadelphia: John Benjamins.

De Angelis, Alessandro. 2006. A. ind. *dhehí, dehí* e la legge di Bartolomae come processo di "terapia lingustica". *Archivio glottologico italiano*. 91(1). 3-30.

Ejerhed, Eva I. 1981. The analysis of aspiration in Sanskrit phonology. *Nordic Journal of Linguistics* 4(2). 139-159.

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.

Görtzen, Jens. 1998. *Die Entwicklung der indogermanischen Verbindungen von dentalen Okklusiven mit besonderer Berücksichtigung des Germanischen* (Innsbrucker Beiträge zur Sprachwissenschaft94). Innsbruck: Institut für Sprachwissenschaft der Universität Innsbruck.

Hammerich, Louis L. 1967. Ketzereien eines alten Indogermanisten. In *To honor Roman Jakobson: Essays on the occasion of his 70. birthday, 11. October 1966*, vol. 2, 839-849. The Hague: Mouton.

Hill, Eugen. 2003. *Untersuchungen zum inneren Sandhi des Indogermanischen: Der Zusammenstoß von Dentalplosiven im Indoiranischen, Germanischen, Italischen und Keltischen*. Bremen: Hempen Verlag.

Hoffmann, Karl & Forssman, Bernard. 1996. *Avestische Laut- und Flexionslehre*. Innsbruck: Institut für Sprachwissenschaft der Universität Innsbruck.

Hopper, Paul. 1973. Glottalized and murmured occlusives in Indo-European. *Glossa* 7. 141-166.

IEW = Pokorny, Julius 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.

Jakobson, Roman. 1958. Typological studies and their contribution to historical comparative linguistics. In Sievertsen, Eva (ed.), *Proceedings of the Eighth International Congress of Linguists,* 17-35. Oslo: Oslo University Press.

Kellens, Jean. 1995. *Liste du verbe avestique*. Wiesbaden: Dr. Ludwig Reichert Verlag.

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.

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*, 291-329. Copenhagen: Museum Tusculanum Press.

Kuryłowicz, Jerzy. 1935. *Études indoeuropéennes I*. Kraków: Skład główny w księgarni Gebethnera i Wolffa.

Ladefoged, Peter & Maddieson, Ian. 1996. *The sounds of the world's languages*. Malden MA: Blackwell Publishers.

Lambert, Hester M. 1943. *Marathi language course*. Calcutta–Oxford: Humphrey Milford.

Lehmann, Winfred P. 1952. *Proto-Indo-European phonology*. Austin: The University of Texas Press–Linguistic Society of America.

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*. University of Massachusetts. (Doctoral dissertation.)

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* (Handbooks of Linguistics and Communication Science 41.3), vol. 3, 1876-1888. Berlin–Boston: De Gruyter Mouton.

MacDonell, Arthur A. 1910. *Vedic grammar*. Strassburg: Karl J. Trübner.

MacDonell, Arthur A. 1916. *A Vedic grammar for students*. Oxford: Clarendon Press.

Masica, Colin. P. 1991. *The Indo-Aryan languages.* Cambridge: Cambridge University Press.

Mayrhofer, Manfred. 1986. *Indogermanische Grammatik I.2. Lautlehre*. Heidelberg: Winter.

Mayrhofer, Manfred. 2004. *Die Hauptprobleme der indogermanischen Lautlehre seit Bechtel.* Wien: Verlag der österreichischen Akademie der Wissenschaften.

Mey, Jacob L. 1972. Was Bartholomae really a Grassmann? *Norwegian Journal of Linguistics* 1. 81-89.

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*, 365-392. Amsterdam: John Benjamins.

Morgenstierne, Georg. 1942. Orthography and sound-system of the Avesta. *Norsk Tidsskrift for Sprogvidenskap* 12. 30-82.

NIL = Wodtko, Dagmar S. & Irslinger, Britta & Schneider, Carolin. 2008. *Nomina im indogermanischen Lexikon*. Heidelberg: Winter Universitätsverlag.

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.

Reichelt, Hans. 1909. *Awestisches Elementarbuch*. Heidelberg: Carl Winter's Universitätsbuchhandlung.

Sag, Ivan A. 1974. The Grassmann's Law ordering pseudoparadox. *Linguistic Inquiry* 5(4). 591-607.

Sag, Ivan A. 1976. Pseudosolutions to the pseudoparadox: Sanskrit diaspirates revisited. *Linguistic Inquiry* 7(4). 609-622.

Schindler, Jochem. 1976. Diachronic and synchronic remarks on Bartholomae's Law and Grassmann's Law. *Linguistic Inquiry* 7(4). 622-637.

Šefčík, Ondřej. 2012. On the integration of Old Indo-Aryan voiceless aspirates into the system. In Sukač, Roman & Šefčík, Ondřej (eds), *Sound of Indo-European 2*, 271-280. München: Lincom Europa.

Szemerényi, Oswald. 1990. *Einführung in die vergleichende Sprachwissenschaft*. Darmstadt: Wissenschaftliche Buchgesellschaft.

Walde, Alois. 1897. Die Verbindungen zweier Dentale und tönendes *z* im Indo-germanischen. *Zeitschrift für vergleichende Sprachforschung auf dem Gebiete der indogermanischen Sprachen* (*KZ*) 34 (Neue Folge 17). 461-536.

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.