



Universiteit  
Leiden  
The Netherlands

## Bartholomae's law

Pronk, T.C.; Kloekhorst, A.

### Citation

Pronk, T. C. (2026). Bartholomae's law. In A. Kloekhorst (Ed.), *Leiden Studies in Indo-European* (pp. 145-158). Leiden: Brill.  
doi:10.1163/9789004750449\_010

Version: Publisher's Version

License: [Licensed under Article 25fa Copyright Act/Law \(Amendment Taverne\)](#)

Downloaded from: <https://hdl.handle.net/1887/4291479>

**Note:** To cite this publication please use the final published version (if applicable).

# Bartholomae's Law

*Tijmen Pronk*

## 1 Introduction

Bartholomae's Law describes the assimilation of PIE voiceless dental obstruents (\*t, \*s) to a preceding *media aspirata* (\*D<sup>h</sup>) in Indo-Iranian. The law is named after Christian Bartholomae, who described the law in detail in 1882. The following examples from Sanskrit and Avestan show the operation of Bartholomae's Law:<sup>1</sup>

Vedic

*buddhá-* ta-ptc. 'awake' < \*b<sup>h</sup>ud<sup>h</sup>-ta-  
*áriḍha-* ta-ptc. 'lick' < riḷd<sup>h</sup>a- < \*rij<sup>h</sup>-ta-  
*ruṇádḍhi* 3sg.act.pres. 'restrain' < \*runad<sup>h</sup>-ti  
*dágdhar-* 'who burns' < \*d<sup>h</sup>ag<sup>h</sup>-tar-

Old Avestan

*aogədā* 3sg.mid.inj.pres. 'announce' < \*aug<sup>h</sup>-ta  
*-aogəžā* 2sg.mid.inj. pres. 'announce' < \*aug<sup>h</sup>-sa  
*-ruzda-* ta-ptc. 'grow' < \*rud<sup>h</sup>-ta-  
*gərəždā* 3sg.mid.inj. pres. 'complain' < \*grj<sup>h</sup>-ta

In Vedic Sanskrit, Bartholomae's Law was a productive morphophonological rule. In Old Avestan, Bartholomae's Law is well-preserved (no counterexamples are attested<sup>2</sup>), but in the rest of Iranian it ceased to be productive and in transparent morphological categories the voiceless obstruent was reintroduced, e.g.

- 1 The absence of examples in which the voiceless obstruent is not a dental may be due to the scarcity of suffixes beginning with a voiceless stop that is not a dental. Good examples of the suffix *-ka* directly after a *media aspirate* seem to be lacking in the earliest sources. Wackernagel (1954: 537) cites a form *asamitka-* from the Sūtras. It is derived from *samidh-* 'firewood' and does not show the effect of Bartholomae's law. The earliest example of Bartholomae's law affecting a following voiceless aspirate is *alabdhās* 2du.imperf.mid. 'to grasp' < \*a-labh-thās in the Maitrāyaṇi-Saṃhitā (Schindler 1976: 624).
- 2 OAv. *daḷšniia-* 'to be deceived' < \*dabž- < \*d<sup>h</sup>ab<sup>h</sup>-s- shows regular devoicing of a sibilant before -n- (Hoffmann & Forssman 2004: 102).

YAv. *aoxta* for OAv. *aogədā*. In other Iranian languages, examples are scarce.<sup>3</sup> In Sanskrit, unlike in Avestan, voiced \*z had not become phonemic and it eventually became voiceless, also devoicing the preceding stop: *dīpsati* 3sg.act.desid. ‘to deceive’ < \**d<sup>hi</sup>-d<sup>h</sup>b<sup>h</sup>-s-* (cf. Av. inf. *diβžaidiāi*). The fact that it was once affected by Bartholomae’s Law and at least partly voiced after *mediae aspiratae* is shown by the fact that in clusters of *media aspirata* + \*s + *tenuis*, the *tenuis* is voiced and aspirated (Bartholomae 1882: 23):

Vedic

*ārabdha* 3sg.mid.aor. ‘to grasp’ < \**a-rab<sup>h</sup>-s-ta*

*āpi gdha* 3sg.mid.inj. ‘to eat’ < \**-g<sup>h</sup>-s-ta*

*sá-gdhi-* ‘communal meal’ < \**sa -g<sup>h</sup>-s-ti-*

In such clusters, the medial sibilant was eventually regularly lost, similar to the loss of the intrusive sibilant in clusters with two dentals, e.g. *vrddhá-* ‘grown’ < \**vr<sup>dh</sup>dh<sup>z</sup>-ta-* < \**ur<sup>dh</sup>-to-*, cf. OAv. *varəzda-*. A cluster-internal laryngeal did not prevent Bartholomae’s Law from taking place either (Lubotsky 2018: 1879). This can be seen in two examples, both from Avestan:

Old Avestan

*dugədar-* < \**d<sup>h</sup>ug<sup>h</sup>Htar-* < PIE \**d<sup>h</sup>ugh<sub>2</sub>ter-*

*dazdē* 3sg.mid.pres. ‘puts’ < \**d<sup>h</sup>e-d<sup>h</sup><sub>1</sub>-toi* (next to *dastē* with restored *-t-*)

In Sanskrit, however, such clusters are voiceless in forms of the root *dhā-* that reflect PIE \**-d<sup>h</sup><sub>1</sub>-t-*: Skt. 3sg.mid.pres. *dhatté* < \**d<sup>h</sup>ed<sup>h</sup><sub>1</sub>toi* (cf. the Old Avestan forms above). There are two possible explanations for these facts. First, the \**-t-* of the ending of the Sanskrit word may have been restored (Lubotsky 2018: 1879; only in Indic, before the laryngeal was dropped): \**dha-dhH-dhai* >> \**dha-dhH-tai* > *dhatté* (with the same late devoicing of the cluster as before *-s-*).<sup>4</sup> The second possible explanation, which was suggested to me by Alwin Kloekhorst, is to assume that *dhatté* is the regular Vedic outcome of \**d<sup>h</sup>ad<sup>h</sup>Htai*, while the

3 An often cited example is Old Persian *azdā*, Sogd. ‘zd’ ‘known’ < \**ad<sup>h</sup>-ta*, Skt. *addhá* ‘certainly’.

4 Restoration of the ending *-te* might have involved introduction of the stem of 2sg.mid.pres. *dhatsé* (cf. also 2sg.ipv.mid. *dhatsva*), where initial *dh-* is either regular (see above) or analogical (Schindler 1976: 629) due to an early merger with \**datse* (unattested, but. cf. 3sg.mid.pres. *datte*). It seems less likely to me that the desire to restore initial *dh-* motivated the replacement of \**daddhe* by *dhatté* (thus Vennemann 1978: 567). Other forms of the same paradigm preserve unaspirated initial *d-*, e.g. 1sg. *dadhé* and 3pl. *dadhre*, instead of introducing a neo-stem \**dhat-* on the basis of 2sg. *dhatsé*. Therefore, only the opaqueness of a hypothetical \**daddhe* can have been the motive for analogical restructuring to *dhatté*.

cluster became voiced in Avestan after the loss of the laryngeal.<sup>5</sup> The implication of this scenario would be that Bartholomae's Law was still productive for some time in Iranian. Note that other Iranian forms reflect *\*duxtār-* (e.g., Persian *duxtar*), with a voiceless cluster that is traditionally explained by reintroduction of the suffix *\*-tar-* (Bartholomae 1882: 10). If Kloekhorst's suggestion is correct and if it is assumed that the voicing is specifically Avestan, the other Iranian forms may also reflect the regular outcome of PIIr. *\*d<sup>h</sup>ug<sup>h</sup>Htar-* if in these dialects Bartholomae's Law was no longer productive after the intervocalic laryngeal had dropped.

There are two aspects of Bartholomae's Law that are not fully clear: the underlying phonetic process and the time depth at which it took place.<sup>6</sup> Both questions were already raised by Bartholomae himself. In the following, they will be addressed and it will become clear that the questions cannot be separated completely.

## 2 The Phonetics of Bartholomae's Law: The Role of Aspiration

The main question about the phonetics of Bartholomae's Law is whether Bartholomae's Law is primarily a transfer of voice or of aspiration from the first obstruent to the second. Traditionally, the focus of the phonetic explanations of Bartholomae's Law has been on the aspiration, due to the simple fact that the *mediae* are also voiced in Indo-Iranian but do not cause Bartholomae's Law. Instead, they are reflected as voiceless before a voiceless dental:

Vedic

*bhaktá-* *ta-ptc.* 'share' < *\*b<sup>h</sup>ag-ta-* (cf. OAv. *baxšaitī* 3sg.act.aor.inj.)

*rāṣṭi* 3sg.act.pres. 'rule' < *\*rāj-ti*

*iṣṭi-* 'worship' < *\*ij-ti-*

*bhettár-* 'breaker' < *\*b<sup>h</sup>aid-tar-*

5 Unlike cases where there was no intermediate laryngeal, in which voice assimilation is pan-Iranian in view of Old Persian *azdā*, Sogd. *ʒd'* 'known' < *\*ad<sup>h</sup>-ta*.

6 Few Indo-European sound laws have generated so much discussion among scholars of autosegmental theory and other generative theories as Bartholomae's law, often in combination with Grassmann's law (Zwicky 1965; Kiparsky 1965; Anderson 1970; Mey 1972; Phelps 1975; Sag 1974; 1976; Ejerhed 1981; Borowsky & Mester 1983; Kaye & Lowenstamm 1985; Janda & Joseph 1989; 2002; Lombardi 1994; Struijke 2002; Kobayashi 2004; Calabrese & Keyser 2006). Ejerhed (1981: 145) commented that Bartholomae's law "is responsible for the gainful employment of many linguists". Nevertheless, the largely theoretical debates in these works have little relevance for the present discussion.

Most scholars have analyzed Bartholomae's Law as a spread of voicing and aspiration (or murmur/breathy voice) at the same time (Schindler 1976: 623; Kobayashi 2004: 106), which is of course what it is descriptively in Sanskrit. Some have, however, focussed on the role of aspiration in Bartholomae's Law. Kuryłowicz (1935: 50–51) argued that Bartholomae's Law was a spread of aspiration that must have taken place when the *\*D<sup>h</sup>*-series was not yet (distinctively) voiced. Kortlandt (1978: 117–118) hypothesized that the aspiration “which characterized the medial part of the cluster, weakened the following fortis stop”. 25 years later, however, Kortlandt (2003: 259) had apparently abandoned this view when he questioned the antiquity of the aspiration of the *mediae aspiratae*, suggesting that the aspiration was an innovation of Indic. We will return to that idea in the following section, after discussing the interaction between Bartholomae's Law and Grassmann's Law in Indic.

It has often been assumed that the clusters consisting of *media aspirata* + *s* were at some point aspirated, because they triggered Grassmann's Law (Bartholomae 1882: 23; Schindler 1976: 630):

Vedic

*bapsati* 3pl.act.pres. ‘to chew’ < *\*b<sup>he</sup>-b<sup>hs</sup>-*

*jákṣat-* ptc.act.pres. ‘to laugh’ < *\*g<sup>he</sup>-g<sup>hs</sup>-*

*dīpsati* 3sg.act.desid. ‘to deceive’ < *\*d<sup>hi</sup>-d<sup>hb<sup>h</sup></sup>-se/o-* (in the Jaiminīya-Brāhmaṇa with an aspirate: *dhīpsati*)

*dudukṣan* 3pl.inj.act.desid. ‘to milk’ < *\*d<sup>hu</sup>-d<sup>hug<sup>h</sup></sup>-se/o-* (but in the *s*-aorist often with *-dh-*, already in the Ṛgveda, e.g. 3pl.mid. *ádhluk-ṣata*)

There are also many forms with *\*-D<sup>h</sup>s-* in which Grassmann's Law did not take place. In such cases, it is usually assumed that the initial aspirates have been restored for morphological reasons (Vennemann 1978: 566; Schindler 1976: 631–632). The model for the restoration of initial aspiration in forms like *ádhluk-ṣata* would, according to Vennemann and Schindler, be forms in which the root-final *\*D<sup>h</sup>* was either word-final (e.g., imperf. *ádhluk* ‘milked’ from *√dugh-*) or in a word-final cluster (e.g., *s*-aor. *adhāk* ‘burnt’ < *\*-d<sup>h</sup>ēg<sup>wh</sup>s* from *√dagh-*). The infrequency of such forms in some of the relevant paradigms presents a problem for Vennemann's and Schindler's explanation, e.g. in the following cases:

Vedic

*aghukṣat* 3sg.act.aor. from *√guh-* (replacing an older *s*-aorist or analogical after the nom.sg. *\*ghuk* of the root noun?)

*ábhuts-* aor.mid. from  $\sqrt{budh-}$  (analogical after an unattested act. s-aorist or the nom.sg. *uṣar-bhut* 'awake at dawn'?)<sup>7</sup>

*bībhatsú-* 'detesting' from  $\sqrt{bādh-}$  (analogical after the nom.sg. *\*bhāt* of the root noun?)

This raises the question whether the regular phonetic outcome of *\*D<sup>h</sup>VD<sup>h</sup>s-* was not in fact *\*D<sup>h</sup>VTs-* in Vedic, i.e. the opposite of what Schindler argues to be the case. Cases like reduplicated *bapsati*, desiderative *dudukṣan* and aorist *-adukṣat* can easily be analogical through generalization of the initial media (cf. 3sg.act.pres. *bábhasti*, ta-ptc. *dugdhá-*). The only potentially problematic form in this respect is perhaps *jákṣat-* ptc.act.pres. 'to laugh' < *\*g<sup>he</sup>-g<sup>h</sup>s-*. This form points to the prior existence of a present paradigm 3sg. *\*jahasti*, 3pl. *\*jakṣati* (with analogical *j-* from the rest of the paradigm) from which the initial *j-* could easily have been introduced. Note that the participle is also attested in the dialectal feminine form *jajjhatī-* in Vedic (cf. also Pali 3sg.pres. *-jagghati* 'laughs'), from a dialect in which *\*s* did not devoice the cluster (Hoffmann 1975: 306). It is unclear whether in these dialects, initial *j-* is also the result of restoration or due to the regular operation of Grassmann's Law.

It seems to be the case that it is easier to explain the Vedic forms if it is assumed that *\*s* blocked Grassmann's Law. It is relevant in this context that not all categories show variation between forms with and without an initial aspirate. Schindler (1976: 632) observed that the only verbal forms in which *\*D<sup>h</sup>VD<sup>h</sup>s-* is reflected with initial aspiration are aorists and desideratives, "categories whose formation is not governed by a single straightforward rule. In contrast, fully predictable forms like futures in *-ṣya-* and athematic second persons in *-si-*, *-se-*, *-sva-* are never attested in their old form."<sup>8</sup> This is an argument that can easily be reversed: the, from a Sanskrit perspective, remarkable initial aspiration in a form like *ádhuḁṣata* was less problematic in categories where it formed a regular pattern, like the future paradigm. It is precisely in the categories that are not so predictable that speakers got confused.

7 Forms like ins.pl. *bhūdabhiḥ* and 2pl.pres.ipv. *bhuddhvam* are attested late and probably secondary (Schindler 1976: 634–635).

8 For those forms which show variants with and without initial aspiration, attempts have been made to determine their distribution in the Rgveda. Scharfe (1996) observed that forms without initial aspiration are common in books 1, 2, 3, 7 and 10. This distribution is not in contradiction with the idea that these forms are innovations. Cardona argued (1991) that the distribution coincides with certain families of poets, but this is contradicted by the fact that *abhutsmahi* with aspiration and *dudukṣan* without aspiration are ascribed to the same author (Vasiṣṭha in book 7, Kobayashi 2004: 123).

I conclude that there was no stage at which Proto-Indo-Iranian or Proto-Indic had a phonetic or phonemic aspirated sibilant  $z^h$  or  $ž^h$ , as is usually assumed (e.g., Bartholomae 1882; Burrow 1973: 95; Szemerényi 1990: 107; Kobayashi 2004: 106; Cantera 2017: 20) and that Grassmann's Law was blocked if the second *mediae aspiratae* was followed by *-s-* in Vedic. If it is assumed that the *mediae aspiratae* were plain voiced in Proto-Indo-Iranian (see below), these stops did not become aspirated/murmured/breathy voice in Vedic if they were followed by *\*s*. Also, Grassmann's Law was then a purely Indic innovation.

### 3 The *mediae aspiratae* in Proto-Indo-Iranian

The idea that the aspiration of the *mediae aspiratae* is an innovation of Indic is based on two arguments. The first argument is a comparative argument: Indic is the only branch of Indo-European to have murmured stops as a reflex of the *mediae aspiratae*, apart from some western and central dialects of Armenian. Whether the murmured reflex in these Armenian dialects is an archaism or an innovation is disputed (see the discussion in Sayeed & Vaux [this volume, Ch. 19]). If the stop system of Classical Armenian—*T<sup>h</sup>*, *T*, *D*—is old, as is argued by, a.o., Sayeed & Vaux, Indic is the only branch that would preserve the murmured stops of PIE. This is not in itself impossible, but requires special pleading in view of the fact that the reflex of the PIE *mediae aspiratae* is a plain voiced stop in seven of the other branches (Iranian, Balto-Slavic, Germanic, Celtic, Armenian, Phrygian, Albanian).

The second argument is of a typological nature. Sanskrit distinguished between voiceless stops, voiced stops, voiceless aspirates and voiced aspirates or murmured stops. It is widely accepted that the voiceless aspirates reflect a combination of a tenuis and a following laryngeal: *\*TH* > *\*T<sup>h</sup>*.<sup>9</sup> The Iranian equi-

9 Very few Indo-Europeanists nowadays reconstruct voiceless aspirates as a separate set of phonemes for PIE. Exceptions are Rasmussen (1989) and De Decker (2015), who reconstruct a marginal phoneme *\*t<sup>h</sup>* for the following etyma (alternative reconstructions in brackets): PIE *\*k<sup>w</sup>ent<sup>h</sup>-* (Greek πένθος 'grief', PIE *\*b<sup>h</sup>end<sup>h</sup>-*, Beekes 2010: 1156), *\*skeh<sub>1</sub>t<sup>h</sup>-* (Greek ἀσκηθής 'unhurt'), *\*ret<sup>h</sup>-* (Sanskrit *rátha-* 'wagon', PIE *\*(H)ret-h<sub>2</sub>-*, Wodtko et al. 2008: 575), *\*leit<sup>h</sup>-* (Young Avestan *iriθ-* 'to die', *\*leitH-*, cf. Tocharian A, B *lit<sup>a</sup>-* 'to fall, abandon', Hackstein 2002: 9), *\*mat<sup>h</sup>-*, *\*ment<sup>h</sup>-* (Sanskrit *math-* 'to rob', *manth-* 'to stir', PIE *\*mentH-*, Pronk 2019: 143), *\*t<sup>h</sup>eng<sup>h</sup>-* (Young Avestan *ṣanǰ-* 'to pull', and PIE *\*teng<sup>h</sup>-* (de Vaan 1999: 15–17), perhaps with analogical Avestan *ṣ-* after *ṣanu-* 'bow' (Lubotsky, personal communication)). Greek ἀσκηθής 'unhurt' seems to be the only form that shows a unique correspondence that could in theory be projected back to a separate phoneme in PIE, if the word is indeed related to Old Irish *scith* 'weary' and Old High German *scado* 'harm'. This is too small a basis for any conclusions about the PIE stop system.

valent of the Sanskrit voiceless aspirates are voiceless fricatives. These arose from  $*T$  before any consonant, including before  $*H$ :  $*T > *θ / \_C$ . The rise of the Iranian fricatives was thus a different process from the rise of the Indic voiceless aspirates. It follows that the original Indo-Iranian system did not have voiceless aspirates (Lubotsky 2018: 1879):  $*T$ ,  $*D$ ,  $*D^h$ . Martinet (1955: 115) and Jakobson (1958) have pointed out the difficulties of this system for PIE: the presence of voiced  $*D^h$  presupposes the presence of voiceless  $*T^h$ . This universal is still valid today (see Miller [this volume, Ch. 3]) and naturally also applies to Proto-Indo-Iranian. This typological problem can be resolved if it is assumed that the voiced aspirates of Sanskrit were originally unaspirated and only became (distinctly) aspirated after the voiceless aspirates had been introduced (Kloekhorst [this volume, Ch. 4]).

#### 4 The Phonetics of Bartholomae's Law: The Role of Voice

The reconstruction of Proto-Indo-Iranian without aspirates raises a number of questions. The first question is of course what distinguished the *mediae* from the *mediae aspiratae* if it is not aspiration/breathy voice. According to Kortlandt (1981), it is glottalization on the  $*D$ -series, which would, amongst others, be reflected in Sindhi in the form of implosives (see further de Vaan [this volume, Ch. 15]). Whether or not this is correct need not concern us here: the important point is that if aspiration was not a relevant feature in Proto-Indo-Iranian, Bartholomae's Law cannot be due to spread of aspiration. Note that Bartholomae's Law and especially its operation in Old Avestan has been one of the main arguments for postulating a voiced aspirate series of stops in early Iranian (Tremblay 2005: 675) or at least Indo-Iranian (Beekes 1988: 75).

The only viable alternative seems to be that Bartholomae's Law must have been a process of voicing of obstruent clusters that contained a voiced stop and that  $*D^h$  was a plain voiced stop (Miller 1977: 381–382). Note that  $*TD^h$ ,  $*DD^h$ ,  $*D^hD^h$  and  $*D^hT$  all have the same voiced outcome in Indo-Iranian (Vennemann 1978: 576; Schindler 1976). Only  $*D^hT^h$  would be a counterexample because of the voiceless cluster of 3sg.act.perf. *āttha* 'to say' (attested in the Brāhmanas) (Schindler 1976: 624). Unlike Schindler, I see no reason why an original  $*āddha$  could not have been restored to  $*ād(h)-tha > āttha$  within Indic before the sound law  $*dh > h$  took place.<sup>10</sup>

10 Similarly, *alabdhās* 2du.imperf.mid. 'to grasp' (MS) <  $*a-labh-thās$ .

Kümmel (2022: 247) observed that, from a phonetic point of view, Bartholomae's Law "is even easier to motivate in a stage of PIE that had not yet developed aspiration and in which the "mediae" did not participate in the voicing (or fortis-lenis) contrast." Indeed, if Bartholomae's Law is in fact a voicing process, it must be dated at least as far back as a period during which the *mediae* were voiceless or at least not as voiced as the *mediae aspirata*, because *\*DT* clusters ended up voiceless (see section 2 above). This is compatible with a reconstruction of the *mediae* as ejectives (Miller 1977: 381–382; Kortlandt 1978: 117–118) or implosives<sup>11</sup> (Kümmel 2012), which apparently were not yet (distinctively) voiced when they lost their glottalic character before a following modal stop. There may have been an intermediate stage during which the laryngealization was realized on the preceding vowel. This process reminds us of Lachmann's Law in Latin (*\*VD > \*VT / \_T*), except that in Indo-Iranian the laryngealization did not produce long vowels. The same laryngealization may also have played a role in the loss of a laryngeal in *\*HDC*-clusters in Indo-Iranian (Lubotsky 1981).

## 5 Dating Bartholomae's Law

The time depth of Bartholomae's Law has generally been regarded as unclear. Bartholomae (1882) concluded that Bartholomae's Law was of at least Indo-Iranian date. The productiveness of the rule is neatly demonstrated by the Avestan word *dugədar-* 'daughter' < PIE *\*d<sup>h</sup>ugh<sub>2</sub>ter-*. The original *\*g* had merged with the reflex of *\*g<sup>h</sup>* due to the following laryngeal (Lubotsky 2018: 1882), after which this Indo-Iranian voiced stop caused voicing of the following *\*t*.

Although the conclusive evidence for Bartholomae's Law is limited to Indo-Iranian, many scholars believe that it may well go back to Proto-Indo-European (e.g., Miller 1977; Mayrhofer 1986: 115–117) while others have disputed this (e.g., Szemerényi 1990: 107; Yates 2019: 285, fn. 61). Several arguments have or can be brought forward to argue for (late) Proto-Indo-European origin:

1. Attempts have been made to find examples of Bartholomae's Law in other branches of the Indo-European family. If correct, this would strongly suggest that Bartholomae's Law is of Indo-European date, but none of the proposed examples appear to have found wide acceptance. For Greek, Bartholomae's Law has been proposed to be reflected in ἄχθος 'burden', βρόχθος 'throat', ῥόχθος 'roaring', ῥχθος 'bank, hill' (Miller 1977), see Beekes

11 It has been observed that in Eastern and Southern Oromo, implosive /d/, unlike modal /d/, does not trigger voice assimilation of a following voiceless stop (Lloret 1995: 260).

(2010) s.vv. for plausible alternative explanations. For Latin, it has been argued that  $*d^ht > *dzd^h > *sp > st$  in *aestus*, *aestās*, *custōs*, *hostus*, *hasta* and *īnfestus* (Meyer 1887: 166), but see Lubotsky (2004: 329–330) and de Vaan (2009) s.vv. for conceivable alternative explanations of these forms. The alleged Germanic examples are rightly dismissed by Bennett (1966) and the Hittite evidence adduced by Puhvel (1972) is no longer valid (Melchert fthc.).

2. It has been argued that the allomorphs of the PIE instrument suffixes  $*-tlo-$ / $*-d^hlo-$  and  $*-tro-$ / $*-d^hro-$  have arisen as a result of Bartholomae's Law (Leumann 1977: 312; Meier-Brügger 2003: 138). This is unlikely to be correct. Whatever the explanation of these allomorphs, a connection with Bartholomae's Law is implausible, because similar nominal suffixes in which  $*t$  is followed by vowel, like  $*-to-$ ,  $*-ti-$ ,  $*-tu-$ , and  $*-ter-$ , never show allomorphs with  $*d^h$ .
3. Looking at the stop systems of the other branches of Indo-European and the most widely accepted phylogeny of Indo-European, the following observations can be made. Anatolian and probably Tocharian, neither of which can be shown to have had distinctively voiced stops, are usually considered to have branched off at an early stage (Kloekhorst & Pronk 2019; Olander 2022). Armenian, Germanic and Phrygian also have voiceless reflexes of the *mediae* ( $*D$ ). The *mediae* are, however, reflected as voiced stops in Indo-Iranian, Balto-Slavic, Italo-Celtic, Greek and Albanian. It is conceivable that this is an innovation. The innovation could have been shared by at least some of these branches (regardless of whether one believes these stops became implosives or otherwise characterized by glottalization and voice). Because Bartholomae's Law must have taken place before the *mediae* had become voiced, it can then be dated to the period before this shared innovation.

It has repeatedly been stressed, e.g., by Miller (1977: 373), Rasmussen (1987) and Kümmel (2022: 247), that it is only to be expected that over time the effects of Bartholomae's Law are lost as a result of analogy (as can be observed in Iranian), so that if Bartholomae's Law is of PIE date, it is not surprising that few traces of it are found outside Indo-Iranian. This may be true, but the argument is a double-edged sword: if Iranian demonstrates the diachronic instability of Bartholomae's Law, it is unlikely to have been in existence for a very long time before it is attested in Vedic and Old Avestan. Also, the merger of  $*D$  and  $*D^h$  in Iranian obscured the original distribution of Bartholomae's Law, which no doubt accelerated the replacement of forms which had been affected by it (Miller 1977: 373). The lack of comparative evidence for Bartholomae's Law outside Indo-Iranian should therefore be taken seriously and the law should not be

projected back too far back in time. Positing an inner-Indo-Iranian (or perhaps dialectal PIE?) origin of Bartholomae's Law is therefore to be preferred, but this does have consequences for the reconstruction of the early Proto-Indo-Iranian stop system. In view of the discussion above, the assumption of a late, Indo-Iranian origin of Bartholomae's Law implies that the *mediae* were still (partly) voiceless in early Proto-Indo-Iranian, perhaps implosives (see footnote 11).

## 6 Relative Chronology

The preceding considerations lead to the following relative chronology:<sup>12</sup>

### Indo-Iranian

1. Progressive voicing in obstruent clusters (Bartholomae's Law):  $*-Dt-$ ,  $*-Ds-$  >  $*-Dd-$ ,  $*-Dz-$
2. PIE glottalic stops (traditional *mediae*) lose their glottalization before an obstruent, leading to a merger of all three series in this position:  $*T > *T /\_T, s$
3. PIE glottalic stops become voiced/implosive:  $*'T > *'D$

### Vedic

4. Voiceless stops become aspirated before a laryngeal:  $*T > *T^h /\_H$
5. PIE voiced stops (traditional *mediae aspiratae*) become aspirated/murmured/breathy voice:  $*D > *D^h$ ,  $*DD > *DD^h$ , except before  $*s$  (and perhaps  $*H$ ), where they merged with  $*T$
6. Grassmann's Law

It was suggested above that innovation 3, which led to the voiced reflex of PIE *mediae*, may have been shared with other branches in which these are voiced: Balto-Slavic, Italo-Celtic, Greek and Albanian, or a subset of these. In that case, innovations 1 (Bartholomae's Law) and 2 (merger of stops before an obstruent) were probably also shared with these branches. In view of Lachmann's Law in Latin and perhaps Winter's Law in Balto-Slavic (if Lith. *pėšćias*, OCS *pěšb* 'on foot' < *\*ped-s-*, see Pronk [this volume, Ch. 16]), innovation 2 would then have to be interpreted as a two-step process: 1) the glottalization was transferred to the vowel, causing the neutralization of stops before another obstruent;

12 If the early Proto-Indo-Iranian *mediae* were inherited as implosives, innovation 2 was a merger of implosive stops with voiceless explosive stops before an obstruent and innovation 3 is superfluous.

2) glottalization of the vowel was lost in Indo-Iranian, unlike in Italic where it lengthened the vowel. It cannot be ruled out, however, that innovations 1, 2 and 3 affected Indo-Iranian independently from the other branches of Indo-European.

### References

- Anderson, Stephen R. 1970. On Grassmann's Law in Sanskrit. *Linguistic Inquiry* 1, 387–396.
- Bartholomae, Christian. 1882. *Arische Studien*. Halle: Max Niemeyer.
- Beekes, Robert S.P. 1988. *A Grammar of Gatha-Avestan*. Leiden: Brill.
- Beekes, Robert S.P. 2010. *Etymological Dictionary of Greek*. Leiden: Brill.
- Bennett, William H. 1966. The Germanic evidence for Bartholomae's Law. *Language* 42/4, 733–737.
- Borowsky, Toni and Ralf-Armin Mester. 1983. Aspiration to roots: Remarks on the Sanskrit diaspirates. In: Amy Chukerman, Mitchell Marks, and John F. Richardson (eds.), *Papers from the Nineteenth Regional Meeting of the Chicago Linguistic Society*, 52–63. Chicago: The Society.
- Burrow, Thomas. 1973. *The Sanskrit Language*. London: Faber and Faber.
- Calabrese, Andrea and Samuel Jay Keyser. 2006. On the peripatetic behavior of aspiration in Sanskrit roots. In: Eric Bakovic, Junko Ito, and John McCarthy (eds.), *Wondering at the Natural Fecundity of Things: Essays in Honor of Alan Prince*, 71–94. Santa Cruz, CA: Linguistics Research Centre.
- Cantera, Alberto. 2017. The phonology of Iranian. In: Jared S. Klein, Brian D. Joseph, and Matthias Fritz (eds.), *Handbook of Comparative Indo-European Linguistics*, vol. 1, 481–503. Berlin: Mouton de Gruyter.
- Cardona, George. 1991. On the dialect status of Vedic forms of the types *dakṣ-/dhakṣ-*. In: B. Lakshmi Bai and B. Ramakrishna Reddy (eds.), *Studies in Dravidian and General Linguistics: A Festschrift for Bh. Krishnamurti*, 263–273. Hyderabad: Centre of Advanced Study in Linguistics.
- De Decker, Filip. 2015. What is the Greek counterpart of (Proto-)Indo-Iranian  $(*)t^h$ ? *International Journal of Diachronic Linguistics and Linguistic Reconstruction* 12, 89–164.
- de Vaan, Michiel. 1999. The PIE root structure  $*Te(R)D^h-$ . *Historische Sprachforschung* 112/1, 1–25.
- de Vaan, Michiel. 2009. *Etymological Dictionary of Latin and the Other Italic Languages*. Leiden: Brill.
- Ejerhed, Eva I. 1981. The analysis of aspiration in Sanskrit phonology. *Nordic Journal of Linguistics* 4/2, 139–159.

- Hackstein, Olav. 2002. Uridg. \*CH.CC > \*C.CC. *Historische Sprachforschung* 115, 1–22.
- Hoffmann, Karl. 1975. *Aufsätze zur Indoiranistik. Band 1*. Wiesbaden: Reichert.
- Hoffmann, Karl and Bernhard Forssman. 2004<sup>2</sup>. *Avestische Laut- und Flexionslehre*. Innsbruck: Institut für Sprachwissenschaft.
- Jakobson, Roman. 1958. Typological studies and their contribution to historical comparative linguistics. In: Eva Sivertsen (ed.), *Proceedings of the Eighth International Congress of Linguists, Oslo 1958*, 17–35. Oslo: Oslo University Press.
- Janda, Richard D. and Brian Joseph. 1989. In further defense of a non-phonological account of Sanskrit root-initial aspiration alternations. In: Joyce Powers (ed.), *ESCOL '88. Proceedings of the Fifth Eastern States Conference on Linguistics*, 246–260. Columbus, OH: Ohio State University.
- Janda, Richard D. and Brian Joseph. 2002. Sanskrit as she has been misanalyzed prosodically. *Yearbook of South Asian Languages and Linguistics* 5, 59–90.
- Kaye, Jonathan and Lowenstamm, Jean. 1985. A non-linear treatment of Grassmann's law. In: Stephen Berman, Jae-Woong Cohe, and Joyce McDonough (eds.), *Proceedings of North East Linguistic Society* 15, 220–233. Amherst, MA: GLSA.
- Kiparsky, Paul. 1965. *Phonological Change*. Massachusetts Institute of Technology PhD thesis.
- Kloekhorst, Alwin and Tijmen Pronk 2019. Introduction: reconstructing Proto-Indo-Anatolian and Proto-Indo-Uralic. In: Alwin Kloekhorst and Tijmen Pronk (eds.), *The Precursors of Proto-Indo-European: The Indo-Anatolian and Indo-Uralic Hypotheses*, 1–14. Leiden–Boston: Brill.
- Kobayashi, Masato. 2004. *Historical Phonology of Old Indo-Aryan Consonants*. Fuchu, Tokyo: Research Institute for Languages and Cultures of Asia and Africa, Tokyo University of Foreign Studies.
- Kortlandt, Frederik. 1978. Proto-Indo-European obstruents. *Indogermanische Forschungen* 83, 107–118.
- Kortlandt, Frederik. 1981. Glottalic consonants in Sindhi and Proto-Indo-European. *Indo-Iranian Journal* 23/1, 15–19.
- Kortlandt, Frederik. 2003. An Indo-European substratum in Slavic? In: Alfred Bammesberger and Theo Vennemann (eds.), *Languages in Prehistoric Europe*. Heidelberg: Winter, 253–260.
- Kümmel, Martin Joachim. 2022. Indo-Iranian. In: Thomas Olander (ed.), *The Indo-European Language Family. A Phylogenetic Perspective*, 246–268. Cambridge: Cambridge University Press.
- Kuryłowicz Jerzy. 1935. *Études indoeuropéennes*. Kraków: Skład główny w księgarni Gebethnera i Wolffa.
- Leumann, Manu 1928. *Lateinische Grammatik. Laut- und Formenlehre, Syntax und Stilistik, in fünfter Auflage völlig neu bearbeitet*. Munich: Beck.

- Lloret, Maria-Rosa. 1995. The representation of glottals in Oromo. *Phonology* 12, 257–280.
- Lombardi, Linda. 1994. *Laryngeal Features and Laryngeal Neutralization*. New York: Garland.
- Lubotsky, Alexander M. 1981. Gr. *pégnumi* : Skt. *pajrá-* and loss of laryngeals before mediae in Indo-Iranian. *Münchener Studien zur Sprachwissenschaft* 40, 133–138.
- Lubotsky Alexander M. 2004. Avestan *siiazd-*, Sanskrit *sedh-*, Latin *cedere*. In: Adam Hyllested et al. (eds.), *Per Aspera ad Asteriscos: Studia Indogermanica in Honorem Jens Elmegård Rasmussen Sexagenarii Idibus Martiis Anno MMIV*, 322–332. Innsbruck: Innsbrucker Beiträge zur Sprachwissenschaft.
- Lubotsky, Alexander M. 2018. The phonology of Proto-Indo-Iranian. In: Jared S. Klein, Brian D. Joseph, and Matthias Fritz (eds.), *Handbook of Comparative Indo-European Linguistics*, vol. 3, 1875–1888. Berlin: Mouton de Gruyter.
- Martinet, André. 1955. *Economie des changements phonétiques: traité de phonologie diachronique*. Berne: Francke.
- Mayrhofer, Manfred. 1986. *Indogermanische Grammatik. Band 1. 2. Halbband: Lautlehre [Segmentale Phonologie des Indogermanischen]*. Heidelberg: Carl Winter.
- Meier-Brügger, Michael. 2003. *Indo-European Linguistics*. Berlin–New York: De Gruyter.
- Melchert, H. Craig fthc. The position of Anatolian. In: Michael Weiss and Andrew Garrett (eds.), *Handbook of Indo-European Studies*. Oxford: Oxford University Press.
- Mey, Jakob L. 1972. Was Bartholomae really a Grassmann? *Nordic Journal of Linguistics* 26, 81–89.
- Meyer, Wilhelm. 1887. Kleine Beiträge zur lateinischen Grammatik. *Zeitschrift für vergleichende Sprachwissenschaft* 28, 162–176.
- Miller, D. Gary. 1977. Bartholomae's Law and an IE root constraint. In: Paul J. Hopper (ed.), *Studies in Descriptive and Historical Linguistics: Festschrift for Winfred P. Lehmann*, 365–392. Amsterdam: Benjamins.
- Olander, Thomas (ed.). 2022. *The Indo-European Language Family: A Phylogenetic Perspective*. Cambridge: Cambridge University Press.
- Phelps, Elaine. 1975. Sanskrit diaspirates. *Linguistic Inquiry* 6, 447–464.
- Puhvel, Jaan. 1972. 'Bartholomae's Law' in Hittite. *Zeitschrift für vergleichende Sprachforschung* 86, 111–115.
- Rasmussen, Jens Elmegård. 1987. On the status of the aspirated tenuous and the Indo-European phonation series. *Acta Linguistica Hafniensia* 20/1–2, 81–109.
- Rasmussen, Jens Elmegård. 1989. Die Tenuis Aspiratae, Dreiteilung oder Vierteilung des indogermanischen Plosivsystems und die Konsequenzen dieser Frage für die Chronologie einer Glottalreihe. In: Theo Vennemann (ed.), *The New Sounds of Indo-European. Essays in Phonological Reconstruction*, 153–176. Berlin–New York: De Gruyter.

- Sag, Ivan. 1974. The Grassmann's Law ordering pseudoparadox. *Linguistic Inquiry* 5, 591–606.
- Sag, Ivan. 1976. Pseudosolutions to the pseudoparadox: Sanskrit diaspirates revisited. *Linguistic Inquiry* 7, 609–622.
- Scharfe, Hartmut. 1996. Bartholomae's Law revisited or how the Ṛgveda is dialectally divided. *Studien zu Indologie und Iranistik* 20, 351–377.
- Schindler, Jochem. 1976. Diachronic and Synchronic Remarks on Bartholomae's and Grassmann's Laws. *Linguistic Inquiry* 7, 622–637.
- Struijke Caro. 2002. *Existential Faithfulness: A Study of Reduplicative Tetu Feature Movement and Dissimilation*. New York: Routledge.
- Szemerényi Oswald. 1990<sup>4</sup>. *Einführung in die vergleichende Sprachwissenschaft*. Darmstadt: Wissenschaftliche Buchgesellschaft.
- Tremblay, Xavier 2005 Bildeten die iranischen Sprachen ursprünglich eine genetische Familie oder einen Sprachbund innerhalb des indo-iranischen Zweiges? Beiträge zur vergleichenden Grammatik der iranischen Sprachen v. In: Gerhard Meiser and Olav Hackstein (eds.), *Sprachkontakt und Sprachwandel. Akten der XI. Fachtagung der indogermanischen Gesellschaft 17.–23. September 2000, Halle an der Saale*. Wiesbaden, Reichert, 673–688.
- Vennemann, Theo. 1978. Grassmann's law, Bartholomae's law, and linguistic methodology. In: Irmengard Rauch and Gerald F. Carr (eds.), *Linguistic Method: Essays in Honor of Herbert Penzl*. Berlin, Boston: De Gruyter Mouton, 557–584.
- Wackernagel, Jacob and Albert Debrunner. 1954. *Altindische Grammatik*. Band 11.2. *Die Nominalsuffixe*. Göttingen: Vandenhoeck & Ruprecht.
- Wodtko, Dagmar, Britta Irslinger, and Caroline Schneider (eds.). 2008. *Nomina im Indogermanischen Lexikon*. Heidelberg: Winter.
- Yates, Anthony D. 2019. The phonology, phonetics, and diachrony of Sturtevant's Law. *Indo-European Linguistics* 7/1, 241–307.
- Zwicky, Arnold M. 1965. *Topics in Sanskrit phonology*. Massachusetts Institute of Technology PhD thesis.