The relative chronology of sound changes from Proto-Indo-European to Proto-Celtic

Deuffic, Maël

The relative chronology of sound changes from Proto-Indo-European to Proto-Celtic

Maël Deuffic

s2922975

MA thesis in Comparative Indo-European Linguistics

Supervisor: Prof.dr. Alexander Lubotsky
Second reader: Dr. Tijmen C. Pronk

Universiteit Leiden
July 2021

Table of contents

Abbreviations

Arm.	Armenian
Br.	Breton
Br.KLTG.	Breton Kerneveg (Cornouaille), Leoneg, Tregereg, Gwenedeg (Vannetais)
Brit.	British, Brythonic, Brittonic, P-Celtic
CC.	Continental Celtic
Celtib.	Celtiberian
Cis. Gaul.	Cisalpine Gaulish
Fr.	French
NHG.	New High German
Gaul.	Gaulish
Gal.Lat.	Gallo-Latin
Ga.	Goedelic, Goidelic, Gaelic, Q-Celtic
Gr.	Greek
It. Celt.	Italo-Celtic
IC.	Insular Celtic
Lat.	Latin
Lep.	Lepontic
Lith.	Lithuanian
MBr.	Middle Breton
MC.	Middle Cornish
MIr.	Middle Irish
MoBr.	Modern Breton
MoIr.	Modern Irish
MW.	Middle Welsh
MoW.	Modern Welsh
OBr.	Old Breton
OC.	Old Cornish
OE.	Old English
OHG.	Old High German
OIr.	Old Irish
ON.	Old Norse
Osc.	Oscan
OW.	Old Welsh
PBrit.	Proto-British, Proto-Brythonic
PC.	Proto-Celtic
PGa.	Proto-Goedelic, Proto-Gaelic, Primitive Irish
PIE.	Proto-Indo-European
Skt.	Sanskrit
Sp.	Spanish
Trans. Gaul.	Transalpine Gaulish

C	Consonant
D	Voiced stop [d, b, g, ǵ, g^{h}, g^{wh}]
D^{H}	Voiced aspirate stop [b^{h}, d^{h}, g^{h}, g^{wh}]
Đ	Voiced fricative [ð, β, ɣ, v, z]
G	Voiced velar stop [g, ǵ, g^{h}, g^{wh}]
Γ	Velar fricative [χ, χ^{h}, ɣ, γ^{h}]
H	Laryngeal

I	Semi-vowel [i̯, u̯]
L	Liquid [r, l]
K	Velar stop [k, ḱ, k^w, g, ǵ, g^h, g^{wh}]
Ḱ	Palatalized velar stop [ḱ, ǵ, $ǵ^h$]
K^W	Labialized velar stop [k^w, g^w, g^{wh}]
N	Nasal consonant [n, m]
T	Stop
T̥	Voiceless stop [t, p, k, ḱ, k^w]
Þ	Fricative [θ, f, χ, s, ð, β, v, ɣ, z]
R	Resonant [r, l, n, m, i̯, u̯]
V, V̄, V̆	Vowel, long vowel, short vowel

Introduction

The aim of this paper is to measure the difficulties and the debates about the relative chronologies from PIE to Proto-Celtic that have been established until now, and eventually to propose a new chronology. The reconstruction of Proto-Celtic is based mainly on Old Irish, but also Brittonic languages (Welsh, Breton, Cornish) and languages from the Continental group (Gaulish, Celtiberian, Lepontic). The first step of this work will be to make a list of the different phonetic changes that have been observed, each subsection being followed by a short summary of the relations which have been exposed, and in a second time, to evaluate, thanks to the material, to what extent all those changes can be ordered in a relative chronology. This thesis is a reaction mainly based on the works by McCone (1996), Isaac (2007), and Matasović (2009), who proposed more or less detailed or clear chronologies.

This chronology will be established thanks to two types of arguments.

1. Logical arguments providing only one relation of order between two developments. Three kinds of logical reasoning have been used:

1.1. The second element of rule 1 follows the same development of the first element of rule 2, in other words, there is transitivity between rule 1 and rule 2 (if $a > b$ and $b > c$, then $a > b > c$). We could symbolize this principle by the following principle:

Let *a*, *b* two different phonological sequences (for example $*eh_1$, $*\bar{e}$), which became *c*, the final sequence ($*\bar{\imath}$) .

If it is possible to establish one transitive order $a > b > c$, it is more economical and therefore preferable to two orders, namely $a > c$ and $b > c$ ($*eh_1 > \bar{\imath}$ and $*\bar{e} > *\bar{\imath}$), or $b > c$ and $*a > b > c$ ($*\bar{e} > *\bar{\imath}$ and $*eh_1 > *\bar{e} > *\bar{\imath}$).

The similar reasoning can be applied for $*eh_3 > *\bar{o} > *\bar{a}$, $*oH > *\bar{o} > *\bar{a}$, $*VH > *\bar{V}(H)$ > Dybo's law ($*\check{V}C\acute{V}$), *etc.*

1.2. The second element of rule 1 is different for the first element of rule 2, but the first element of rule 1 and the second element of rule 2 are similar. It is actually the contrary of the the reasoning exposed in 1.1..

Let $a > b$ and $c > a \not> b$, then $a > b$ is before $c > a$, otherwise we could simply say $c > a > b$, which is false.

- for example, $*\bar{e}$ became $*\bar{\imath}$ and $*e\underset{\circ}{\imath}$ became $*\bar{e}$ but did not become $*\bar{\imath}$, then $*\bar{e} > *\bar{\imath}$ is before $*e\underset{\circ}{\imath} > *\bar{e}$, otherwise we could say $*e\underset{\circ}{\imath} > *\bar{e} > *\bar{\imath}$, an order that the material refutes. It is the same for $*\underset{\circ}{\mu}n > bn$ before $*pn > *\underset{\circ}{\mu}n$, and $*g^w > *b$ before $*g^{wh} > *g^w$.

1.3. The first element of rule 1, although it belongs to the category of the first element of rule 2, does not become the second element of rule 2.

Let the developments $a > b$, and $c > d$, where $a \in c$.

- for example, $*C\underset{\circ}{L}T > *CLiT$ and $*\underset{\circ}{R} > *aR$, where $\underset{\circ}{L}$, a vocalic liquid, belongs to the category of the vocalic resonants $\underset{\circ}{R}$.

If $a > b$ before $c > d$, AND $b \notin c$, then $b \not> d$, then the order is correct.

- for example, **C$\underset{\circ}{L}$T* > **C$\underset{\frown}{L}$iT* before **$\underset{\circ}{R}$* > **a$\underset{\frown}{R}$*, AND $\underset{\frown}{L}$ does not belong to the category of vocalic resonants, then **CLiT* cannot become * *CaLT*.

If *a* > *b* before *c* > *d*, AND *c* ∈ *a*, then the order is incorrect because *d* cannot be equal to *b*.

- if **$\underset{\circ}{R}$* > **a$\underset{\frown}{R}$* is before **C$\underset{\circ}{L}$T* > **C$\underset{\frown}{L}$iT*, a vocalic liquid $\underset{\circ}{L}$ is a vocalic resonant $\underset{\circ}{R}$, then $\underset{\circ}{R}$ and **C$\underset{\circ}{L}$T* should become **aR*, ***CaLT*, which is incorrect because **C$\underset{\circ}{L}$T* became **CLiT*, not **CaLT*.

Other examples of such a reasoning can be found in **pe(R)k^{w}* > **k^{w}e(R)k^{w}*, **pL* > **bL*, **pN* > **$\underset{\circ}{\mu}$n* before **p* > *Ø*.

2. The second argument is based on the possibility of establishing a periodicity thanks to comparative arguments in which common developments must take place. For example, **m$\underset{\frown}{\mu}$* > **$\underset{\frown}{\mu}$* could be posited anywhere before the historical period, however, if this change happened in Italo-Celtic, it must predate all the specifically Celtic changes. In this chronology, we should distinguish three periods:

1. The Late Indo-European/Centum stage
2. The Italo-Celtic stage
3. The Proto-Celtic stage

The dialectalization stage is the *terminus post quem* of our study and it will not be analysed.

Synchronic arguments could also constitute a third type: as McCone (1996) does it in several places, each change could be inserted in a coherent synchronic system. For example, McCone considers that the change **g^{w}* > **b* created an unbalanced system (**t, *d, *d^{h} vs. k^{w}, Ø, *g^{wh}*) that brought the merger of **D* and **D^{h}* forward. This merger would have happened before **p* > *Ø* because with if there had been a series I. **t, *k, *k^{w}* in front **d, g, g^{w}*, where **g^{w}* was about to become **b*, the strictly parallel change **k^{w}* > *p* should have happened.[1] As it can be seen, such arguments need however much more assumptions. Yet, one must recognize that the absence of synchronic consideration will create some oddities in our chronology, such as the possibility of having laryngeals until the last stage of Proto-Celtic (3.6. **CHV* > **CV*) whereas all the other changes including laryngeals are to be posited during the Late Indo-European and the Italo-Celtic stage.

[1] McCone (1996), p. 43.

I. Proto-Celtic sound changes

1. Laryngeals

A whole thesis has been written recently on the development of laryngeals by Nicholas Zair (2012), a thesis which can be read in parallel with Schrijver's, on the development of laryngeals in Latin (1991). The matter is then quite large and only the most relevant and massive changes shall be mentioned here. Therefore, the specific development of **Hō-* in the lonely example of **h₂ōu-io-* > OW. *ui* 'egg', or the surprising reflex **a,* from **h₂o*, in OIr. *ar* 'ploughing' < **h₂orh₃-o-*, have been let apart.

1.1. **HV > *V*

1.1.1. **h₁/₂/₃ > *e / a / o*

As Zair says "there is no dispute that **h₁e-* gave **e-*, **h₂e-* gave **a-*, and **h₃e-* gave **o-* in Celtic",[2] we shall then just present few examples:

- **h₁ék̑uo-* > OIr. *ech* 'horse', OB. *eb*, Gaul. *Epos*, Celtib. *Ekua-laku* (Gr. *ἵππος*, Lat. *equus*).[3]
- **h₂eǵeti* > OIr. *agaid* 'drives, impels', MW, MBr, MC. *a* 'goes' (Gr. *ἄγει*, Lat. *agit*)
- **h₃ergeti* > OIr. *orcaid* 'kills', Gaul. imp. *orge* (Hit. *harkzi* 'dies')

  **h₃es-n-* > MIr. MW. MBr. *onn* 'ash-tree, Gaul. *Onnius*[4] (Gr. ὀξία 'beech', Lat. *ornus* 'manna ash')[5]

It goes without saying that this rule must predate or at least must coincide with **CHV > CV*, otherwise there would be simply no colouring-effect in Celtic: PIE **smh̥₂eli-* > *samh₂eli* > *samh₂ali* > **samali-* > OIr. *samail* 'similitude', MW. *hafal*, OBr. *hamal*, MoBr. *hañval*.[6]

1.1.2. **Ho > *o*

**h₁orbʰ-* > OIr. *orb* 'patrimony, heir'. Cf. Lat. *orbus* 'orphan', Gr. *ὀρφανός*.

**h₂oḱVri-* > OIr. *ochair* 'edge'.[7] The laryngeal **h₂* can be identified in **h₂eḱro-* > Gaul. *Axro-*, OIr. *ér* 'high, noble', Gr. *ἄκρος* 'high, extreme', Lat. *ācer* 'sharp'.[8]

For the words beginning with **h₃o-*, it cannot be decisive since it is often possible to reconstruct also **h₃e-*

1.1.3. *Hi, Hu > i, u*

**h₂i-n-dʰ-* > MW. *ennynnu* 'lightning'. Cf. Gr. *αἴθω* 'burn' where the laryngeal betrays itself by the colouring of the **e* (full grade **h₂eidʰ-*).[9]

---

[2] Zair (2012), p. 19.
[3] Matasović (2009), *s.v. *ekʷo-*.
[4] Delamarre (2003), *s.v. onno-*.
[5] Matasović (2009), *s.v. *osno-*. Two examples are given here since for **h₃erg-*, the type of the laryngeal is deduced from Celtic data and Hittite only proves the presence of the laryngeal.
[6] Matasović (2009), *s.v. *samali-*, **samalo-*. Deshayes (2003) *s.v. hañval*, for Old Breton.
[7] Zair (2012), p. 21.
[8] Matasović (2009), *s.v. *akro-*.
[9] Zair (2012), p. 26.

1.1.4. Conclusion

1. **HV > *V*
2. **CHV > *CV*

1.2. **CHV > *CV*

As was shown above, the laryngeals had a colouring-effect on the vowel **e*. It is not sure if the effect occurred with the loss of laryngeals or before, what is sure at least is that even though it seems to be a very early change, other Celtic-specific developments took place before the total loss of laryngeals. Thus, we have:

- **ḱl̥Heto- > *kalHeto > *kaleto-* > OIr. *calad* 'hard', MW. MBr. *caled,* C. *cales*. The accute in Lith. *šálti* 'be cold, freeze' would prove the presence of a laryngeal,[10] which disappeared only after **R̥ > *aR*.[11]
- **snHi > *sanHi > *sani* > OIr. *sain*, OW. OBr. *han* (see 4.2. for the nasal)**.** See Lat. *seni*, Gr. *ἄνευ* It seems that there is no direct proof for the laryngeal, but it is the best explanation for the vocalic treatment of **n* in Celtic, Italic, and Greek.

*1. *h1/2/3 > *e/a/o, *R̥ > *aR,*
*2. *CHV > *CV*

1.3. **VH > *V̄(H)*

1.3.1. **eh1/2/3 > *ē / *ā / *ō*

Similarly to Latin and Greek, in Celtic, laryngeals coloured and lengthened the preceding **e*.

1.3.1.1. **eh1 > *ē(H)*

**seh1-lo > *sēlo- > *sīlo-* > OIr. *síl* 'seed', MW. MBr. *hil* 'offspring, race', Gaul. *Sila, Silus*. The same development took place in Lat. *sēmen* < **seh1-mn*.[12]

**h2ueh1nto- > *uēnto- > *uīnto- > *uinto-* > OIr. *fet*, MW. *gwynt*, MBr. *guent* (see 5.4. for further analysis).

Both changes clearly predate the change **ē > *ī* and the second one is also to be put before Dybo's law.

1.3.1.2. **eh2 > *ā(H)*

**bʰreh2tēr > *brātīr* > OIr. *bráthir* 'brother', MW. *brawt*, OBr. *brotr*, MBr. *breuzr*, OC. *broder*, Gaul. *Bratronos*. The colouring and lengthening effect of **h2* is also visible in Gr. Ion. *φρήτηρ-*, Gr. Att. *φράτηρ* 'member of a phratry', Lat. *frāter* 'brother'.[13]

[10] Joseph (1982), p. 40.
[11] Matasović (2009), p. 8.
[12] Zair (2012), p. 109.
[13] Zair (2012), p. 110.

The word for ‘swan’ can come from both a zero-grade **ǵʰḫ₂ns-* or an *e*-grade **ǵʰeh₂ns-*.[14] However, Lat. *ānser* and Gr. *χήν* present a *e*-grade (otherwise we would expect Lat. ***ănser*, Gr. ***χάν*), so we could suppose that the strong case prevailed in Celtic too. This would posit the development **eh₂ > ā* before **V̄RC > *V̆RC*: **ǵʰeh₂ns- > *gāns-i > *gănsi-* > PGa. **gāsi-* > OIr. *géis*.

*1.3.1.3. *eh₃ > *ō(H)*

Like the development **eh₁ > *ē*, this change is concealed by a further change of the long vowel, namely **ō > *ā*.

**deh₃-* > **dō-nu-* > **dānu-* > OIr. *dán* ‘gift’, MW. *dawn*. To be compared with Lat. *dōnum*, Gr. *δῶρον*.[15]

**gneh₃to-* > **gnōtós* > *gnātós* > OIr. *gnáth* ‘known’, MW. *gnawt*, OBr. *gnot* ‘usual’. To be compared with Gr. *γνωτός*, Lat. *nōtus*, Skt. *jñātá-*. For de Bernardo Stempel, a zero-grade could be reconstructed, the long vowel would then be explained by the development **CRHC > *CRāC*,[16] McCone reproduces the same explanation.[17] For Schrijver, the full grade is also possible.[18]

*1.3.2. *oH > *ō(H)*

The same development **ō > *ā* as in **eh₃ > *ō* occured here:

- **moh₁ros > *mōros > *māros* > OIr. *már*, W. *mawr*, Br. *meur*. OC. *maur*, Gaul. *-maros*, Lep. *Latu-marui*.[19] To be compared with Gr. *-μωρος* in *ἐγχεσί-μωρος* ‘great by his spear’, *ὑλακό-μωρος* ‘great by his barking’, *ἰό-μωρος* ‘great by his shout’.

*1.3.3. *IH > *Ī(H)*

Even though this change is not really questioned in general, the evidence for **iH > *ī* are not so clear. For **uH > *ū*, the development seems well assured.

**kruh₂-s* > **krūs* > OIr. *crú* ‘blood’, MW. *creu*, C. *crow*. To be compared with Skt. *kravíḥ* ‘raw meat’, Gr. *κρέας* (< **kreuh₂s*), Lat. *cruor* (< **kruh₂-ōs*).[20]

**uiHs-* > **uīs-* > MIr. *fí* ‘venom, poison’. To be compared with Lat. *uīrus* ‘, Gr. *ἰός* [ī]. Zair notices however that Skt. *viṣám* points rather to a short vowel. Matasović, for his part, reconstructs **ueis-os* > **uīsos* for Lat. *uīrus*.

1.3.4. Conclusion

It seems clear that those changes, as all changes including laryngeals, are in any case very early changes that still belonged at least to Late Proto-Indo-European.

*1. *VH > V̄(H)*

2. Dybo’s law **V̄CV́ > *V̆CV*: OIr. *úasal*, MW. *uchel*, Co. *huhel*, OBr. *uchel*, Gaul. *Uxello-dunum* < **o(u)psĕlos*, to be compared with the long vowel in Gr. *ὑψηλός*.

[14] Matasović (2009), *s.v. *gansi-*.
[15] Zair (2012), p. 110.
[16] de Bernardo Stempel (1987), p. 117.
[17] McCone (1996), p. 52.
[18] Schrijver (1995), p. 182.
[19] McCone (1996), pp. 59-60.
[20] Zair (2012), p. 115.

**ē* > **ī*: **h₂weh₁nto* > *wēnto* > *wīnto* > *winto-*
**V̄RC* > **V̆RC*: **h₂weh₁nto* > *wēnto* > *wīnto* > *winto*
ō* > **ā*: **deh₃-* > **dōno-* >dāno-*
**ei* > **ē*: **(H)reid-* > **rēd-o-* > Olr. *réidid* 'rides'
specifically Celtic changes

*1.4. *#HRC- > *#aRC- / *#RiC-*

The development of **#HRC* is quite disputed. For McCone, the sequence **h₁LC/m-* became **LiC/m-*, and **h₂/₃RC-* turned into **aRC-*.[21] However the second rule might be only valid for **h₂-*, as Schumacher notices, since there is no clear evidence for **h₃*.[22] The first case can be exemplified by:

- **h₁lm-o-* > **limo-* > MIr. *lem* 'elm-tree'. Cf. Lat. *ulmus,* OHG. *elm*.

However, there is also **h₁ndo-* > **ando-* > OIr. *and* 'in it' to be compared with Gr. *ἔνδον,* which coexist with OIr. *ind-*.

The second law, which according to Schrijver is Italo-Celtic,[23] a view that shall be followed here, is exemplified by:

- **h₂rtḱo-* > **arto-* > OIr. *art*, MW. *arth*, OBr. *Ard- Arth-*, Gaul. *Artio-*. See Hit. *hartagga-*, Gr. *ἄρκτος,* Lat. *ursus*. For Matasović, there must have been a stage **h₂rxþo-* which prevented a development **CLT* > **CLiT* and produced the normal develoment **R̥* > *aR* (see 4.2). However, there is little proof about such a special development, as Zair notices.[24]
- **h₂rǵ-nt-o* > OIr. *argat*, OW. OBr. *argant*, Gaul. *Arganto-*. Cf. Lat. *argentum*, Skt. *rajatá-*.
- **h₃ng^{wh}-* > **ang^{w}īn-* > OW. *eguin* 'nail' (see 2.6.1.). In Latin, the laryngeal has a colouring effect *unguis*.

A counterexample of **h₃RC-* > **aRC-* could be **h₃rǵ-* 'to stretch out'> **rig-* > OIr. *rig* 'fore-arm',but for de Bernardo Stempel, it could also come from **reǵ-* 'to stretch oneself' with a zero-grade.[25]

Zair remarks that there are only two reliable examples of **#h₁RC* > **RiC*, and eight examples of **#HRC* > **aRC* with only one root beginning with **h₁*. One could say McCone's theory works quite well, however, many of the second series of examples have a nasal, which are, of course, not concerned by the rule **CLT* > *CLiT*. This development could be just part of the rule **R̥* > **aR*.[26] In any case, if **#h₂/₃RC-* > **#aRC* is true, the change **h₂rtḱo-* > **arto-* would prove that it happened before **CLT* > **CLiT*.

1. **#h₂/₃RC* > **#aRC*

[21] McCone (1996), p. 52.
[22] Schumacher (2004), p. 126.
[23] Schrijver (2016), p. 495.
[24] Zair (2012), p. 36.
[25] de Bernardo Stempel (1999), p. 172, fn. 108.
[26] Zair (2012), p. 37.

2. specifically Celtic changes

*1.5. *#HC > *#C*

There is no initial laryngeal turning into a vowel in Celtic. The development of **h₂rtḱos* > OIr. *art* 'bear' appears to be a very early development concerning only **h₂* and **h₃*, and seems in any case quite different from the change we observe in Greek, Phrygian and Armenian. In the sequences **HRV*, **HT*, and **Hs*, the laryngeal always disappears. For **HiV*, the Greek evidence is not probant enough to draw a clear line.[27]

- **h₂ueh₁nt-* > MW. *gwynt*, MBr. *guent* (see 5.4.), Lat. *uentus*.
- **(H)iugo-* > MW. OC. *ieu* 'yoke' MBr. *yeu*. See Skt. *yugám*, Lat. *iugum*, Gr. *ζυγόν.*
- **h₁me* > OIr. *mé*, MBr. *me*, MC. *my*, OW. *mi*. See Gr. *ἐμέ*, Hit. *ammuk*, Lat. *me*.
- **h₁/₃dnt-* > **dant-* > OIr. *dét* 'tooth', MW. OBr. *dant*, OC. *dans*. See Gr. Att-Ion. *ὀδων* and Gr. Eol. *ἔδοντες*, Lat. *dens*.
- **h₁s-énti* > **sénti* > OIr. *it* 'they are', OW. *hint*, OBr. *int*. See Gr. *εἰσι*, Lat. *sunt*.

It is difficult to situate this loss since no other rule can interact with it. The change **CLT* > **CLiT* could also be expressed as **L̥T* > **LiT*, thus the change **h₁lm-* > **limo-* > MIr. *lem* 'elm-tree' (for McCone, the change also happens before **m*, see 1.4.) is of no use. All that can be said is that it probably occurred in Late Proto-Indo-European or in Italo-Celtic, since the Italic material shows similar reflexes of **#HC*.

1. #HC
2. specifically Celtic changes

*1.6. *CHC > *CaC, *CC*

Two reflexes appear for this sequence. The first one, **CaC*, is illustrated by:[28]

- **ph₂tēr* > **patīr* > **atīr* > OIr. *athir*, 'father' Gaul. dat. pl. *atrebo*
- **sh₁-tV-* > **satV-* > MW. MBr. *had* 'seed'
- **h₂enh₁-tleh₂* > **anatlā* > MIr. *anál* 'breath', MW. *anadyl*, MBr. *alazn*, MoBr. *anal*, *alan*.
- **h₂erh₃-tro-* > **aratro-* > MIr. *arathar* 'plough', MW. *aradyr*, MBr. *arazr*
- **uelH-tro-* > **uelatro-* > **ualatro-* > MW. *gwaladyr* 'lord, prince', OBr. *-gualatr*.
- **terh₁tro- 'auger'* > **teratro ->*taratro-* > OIr. *tarathar*, 'auger' W *taradr*

The last three cases imply that this change happened before Joseph's law (see 5.1.). Moreover, Schrijver situates this change during the Italo-Celtic period, as the following Latin development can prove it:

[27] Zair (2012), pp. 48-53.
[28] Zair (2012), pp. 57, 166-167.

Lat. *cerebrum* < **ḱerasrom* < **ḱerh₂srom*.[29] For Zair, such a development is trivial, [30]but Schrijver notices that it is present mostly in Tocharian, and is very rare in Germanic, Armenian and Albanian.[31]

The second kind of reflex is found in the quite famous example of 'daughter'

- **dʰuǵh₂tēr* > **dugtīr* > **duχtīr* > Gaul. *duxtir*. The presence of a laryngeal is proved by Skt. *duhitár-*, Gr. *θυγάτηρ*. The loss of the laryngeal happened before **T[labial/velar]t/s* > **χt/s*.

Nor Zair, nor Schrijver did really explain such a two-fold development. Matasović notices that **CHC* > **CC* does not happen in initial syllable,[32] but as Schrijver notices, it does not mean either that it should always happen in medial syllable (**dʰuǵh₂tēr* > **duχtīr vs. *terh₁tro-* > **teratro-*).[33]

Gaul. *duxtir* can be related to Osc. *FUTÍR* 'daughter' where the same loss seems to have occurred: **dʰuǵh₂tēr* > **fugt(ē)r* > **fukt(ē)r, *fuxt(ē)r*. For Schrijver, it could be seen as an Italo-Celtic development.[34]

1. **CHC* > **CaC*
2. **eRa* > **aRa, *pL* > **bL* (**pi-prh₃-se-* > *pi-prase* > PCelt. **pibrase-* 'will bestow, will give' > **fibrase-* > Olr. *ebraid*)[35], **pn* > *u̯n* (**dh₂p-neh₂* > **dapnā* > **dawnā* > OIr. *dúan*, **see…**)
3. other specifically Celtic changes

1. **CHC* > **CC*
2. **T[labial/velar]* > **χ / _t , s*

specifically Celtic changes

*1.7. *CRHC > CRāC, CRăC*

This rule, which was born very discreetly in the final paragraph of a mere footnote, in an article by Cowgill, has since provoked long discussions on its conditions of application and on the link which should be made or not with the Latin reflexes, in the frame of the Italo-Celtic hypothesis. Cowgill noticed that **ǵnh₁tós* gave Lat. *(g)nātus*, **strh₃tós* gave Lat. *strātus* and the same would appear in Celtic: **plh₁nós* > OIr. *lán*, W. *llawn*, Br. *leun*, Lat. *plēnus*.[36] The situation is however more complex since we find at least two reflexes for the structure **CRHC-*, **CRāC* and **CRăC*. The reflexes **CăRăC* and **CăRC* have been dismissed by Joseph (1982) and such a view is accepted by Schrijver,[37] then they will not be studied here.

[29] Schrijver (1991), p. 96.
[30] Zair (2012), p. 269.
[31] Schrijver (2016), p. 493.
[32] Matasović (2009), p. 6.
[33] Schrijver, *ibid*.
[34] Schrijver (1991), pp. 331-333.
[35] Matasović (2009), p. 9.
[36] Cowgill (1970), fn. 30.
[37] Schrijver (1995), p. 168.

Joseph, following Kuryłowicz's theory on the morphological zero-grade, assumed that **CRăC-* analogically replaced **CRāC* in order to maintain the morphological opposition between zero-grade and full-grade. This *ă*-grade is called by Joseph a "super zero grade" since it recreates the phonological opposition between the two grades which had been ill-treated by the development of **CRHC-* to **CRāC,* where a long-vowel **ā* (zero-grade) could hardly be distinguished from the other long vowels representing a full grade (**e/oH > *V̄H*).[38]

De Bernardo Stempel prefered to explain the alternation **CRāC / *CRăC* with phonetic arguments, saying that the structure **CRHCV* became **CRāCV* whereas **CRHCC* developed into **CRăCC*. The exceptions showing a short vowel were explained by Joseph's theory of morphological zero-grade.[39]

For Schrijver,[40] this rule has to be specified by another phonetic rule, without resorting to the morphological zero-grade argument. He explains the structure **CRăC* by saying that only the structure **CRHTC* ends up in **CRăTC,* with an intermediary development **CRH^{ə}T*, as is exemplified by:

- Lat. *glăber* 'smooth' < **$g^{h}l̥d^{h}$-ro-*
- OIr. *flaith* 'rule' < **$wl̥h_2$-ti-* (where *-i- is a consonant)

Isaac adds that **CRHt > *CRăt* must be linked with the development PIE. **CIHt* > PC. **CĬt* (**$b^{h}uh_2$-táh$_2$-* > OIr. *both,* W. *bod* 'hut, dwelling', **$b^{h}uh_2$-tí-* > OIr. *buith,* MBr. *bout* 'being'), resorting to a series of specific phonetical environments, instead of Dybo's rule.[41] Schrijver notices that the number of micro-conditions posited by Isaac did not prevent Zair to find several counterexamples.[42]

Concerning the relative chronology, Matasović situates this rule before Dybo's rule **VHCV́ > V̄CV́ > V̆CV,* on the basis of **sprHgtó > sprāgtó > sprăgtó* > PC. *sfrăxto-* > W. *ffraeth,* Br. *fraezh* 'intelligible', which would otherwise make **sprāχto-* > W. ***frawth,* Br. ***freuzh, *strh$_3$-tó- > *strātó- > străto-* > OIr. *srath* 'grass, sward, valley', OW. *Strat* 'valley', MBr. *strad* 'bottom'. It must also be noted that depending on the acceptance of the Italo-Celtic hypothesis, this rule can be put before or after the common Celtic and Italic changes.

Concerning its relation with **CHC > *CăC,* we can either suppose that both sequences developed, possibly at the same time, in different ways because of their intrinsic properties, or we can assume that **CRHC > *CRāC* must have happened before **(C)CHC > *CăC* where **C* could be a resonant.

1. **CRHC > *CRāC, *VH > V̄*
2. *V̄CV́ > V̆CV, *CHC > *CăC*
3. **CLT > CLiT*

[38] Joseph (1982), p. 56.
[39] de Bernardo Stempel (1987), pp. 40-43.
[40] Schrijver (1991), pp. 417-418.
[41] Isaac (2007), pp. 21-59.
[42] Schrijver (2016), p. 491.

4. other specifically Celtic changes: *g^w > *b, *pL > *bL, *eRa > *aRa, *ō(C)# > ū(C)#, *u̯n > *bn

*1.8. *V̄CV́ > *V̆CV́ (Dybo's law) and *CHIC > *CĪC, CĬC*

Dybo proposed in 1961 that long vowels, most of the time coming from a vowel followed by a laryngeal, were shortened when they were followed by a stressed syllable.[43]

Here are some examples taken from an article by Kortlandt:[44]

- OIr. *beo* 'alive', W. *byw*, Co. *byw*, *bew*, Br. *beo* < ***g^wĭuos*** vs. Skt. *jīváḥ*, Lith. *gývas*, Latv. *dzîvs*, SCr. *žîv* < ***g^wīuós*.**
- Lat. *vĭr* 'man', Ir. *fer*, W. *gŵr* (pl. *gwŷr*), OCo. *gur*, Br. *gour* < ***uĭros*** vs. Skt. *vīráh* < ***uīrós***.
- Lat. *sŭcula* 'pig', W. *hwcc*, Co. *hoch*, Br. *hoc'h* < ***sŭcolā*** vs. Skt. *sūkaráh* < ***sūkolós***.
- OIr. *om*, W. *of* < ***ŏmos*** vs. Gr. *ὠμός*, Skt. *āmáh* < ***HoHmo-*.**

The real problem of this rule is to know if it is an Italo-Celtic change, *i.e.*, a change happening in a common language, or an areal western change which concerned already quite distinguished languages as were Proto-Germanic, Proto-Celtic, and Proto-Italic. In Dybo's formulation, in Italic and Celtic, the shortening before any consonant, but in Germanic, it only happens before a resonant, so there would be no reason to link both changes. However for Schrijver, this shortening, which he defines as Italo-Celtic,[45] takes place exactly in the same environment as in Germanic (*V̄RV́ > V̆RV but in *V̄TV́ there is no change),[46] it is then necessary for the sake of the Italo-Celtic hypothesis to show that Dybo's rule in Proto-Germanic and in Italo-Celtic are different, which explains why he presents the rule *CHIC > *CĪC in Germanic, and *CHIC > *CĬC in Italo-Celtic. An example of those rules can be found in the words MIr. *sith-* 'long', MW. *hyd* 'length', MBr. *het*, MC. *hes*, from *sĭto- < *sh_1i-tó* or *seh_1i-tó-* (root *seh_1- > Lat. *sērus* 'late'). On the other hand, in Germanic we find OE. *sīd*, OHG. *sīto* < *sh_1i-tó-* where *ī remains long because Dybo's law only apply when the long vowel is followed by a resonant.[47] On the contrary for Zair, in Celtic *CHIC becomes *CĪC, any shortening being the result of Dybo's law, whether the consonant is a resonant or not (*sh_1i-tó- > *sītó- > *sĭtó-). He provides three "good" examples of *CHIC > *CĪC:[48]

- MIr. *sín* 'the ring or collar worn by Morann Mac Máin', OW. *hin* 'limite, extremité'[49] gl. *limite leuo* 'on the left side' < *sīnV- < *sh_1i-nV-. To be compared with Hit. *išḫāi* 'binds' < *sh_2ei-.
- MIr. *sínid* 'stretches' < *sīnV- < *sh_1i-nV-. Same root as MIr. *síth-*.
- OIr. *súil* 'eye (of the sky) = sun' < *sūli- < *sh_2u-l-i-. To be compared with MW. *heul* 'sun', MB. *heol* and Skt. *sū́rya-*, Gr. *ἠέλιος*, Lat. *sōl*. Here we have the possibility of derivating *súil* from a weak case of the amphikinetic word *seh_2wōl / *sh_2ulós*, or, as

[43] Dybo (1961).
[44] Kortlandt (1981), pp. 27-28.
[45] Schrijver (2016), p. 491.
[46] Schrijver (1991), p. 343.
[47] *ibid.*, p. 527.
[48] Zair (2012), pp. 119-120, 128.
[49] Loth (1884) *s.v. cléd* and *hin*.

Matasović notices, from a a form *$sh_2wōl$- which would give also OIr. *súil*, but which might be more surprising morphologically.[50]

Schrijver answers to Zair on the possibility of having **CHIC* > **CǏC*, giving examples of the form **CHIT* (*b^hu-*tó*- > OIr. *-both* 'one was') but on the form **CHIR*, he does not evoke OIr. *sín*, *sínid*, and *súil*, but other examples considered as less reliable by Zair himself.[51] On the other hand, Zair explains that *sh_1i-*nV*-, with possibly an accent on the suffix, did not undergo Dybo's law because such kind of adjectives ending in *-*no*-, *-*lo*-, *-*ro*- were likely to be susbstantivized and then to undergo a retraction of the stress.[52] For Schrijver, the suffix *-*ro*- is not necessarily stressed (Skt. *vípra*- 'trembling', then **puH-ro*- > **pūro*- > MIr. *úr* is not a counterexample of Dybo's law since one cannot establish **puH-ró*-. He recognizes however that some cases are still quite difficult: *d^huH-*mó*- > Lat. *fūmus* (instead of **fŭmus*. See Skt. *dhumá*-), Lat. *dūrus* (not **dŭrus*. See Skt. *dūrá*-), ON. *stúrr* (Skt. *sthūrá*-).

On his final evaluation of Schrijver's, Isaac's, and his theory, Zair considers that no satisfying answer has been given yet,[53] Schrijver himself acknowledges the flaws of his theory but defends its "simplicity and completeness". Therefore, for our purpose, we will keep Dybo's rule with its initial formulation, albeit with extreme care, and we will omit the development of **CHIC*. Dybo's law must have happened before *$\bar{e} > \bar{\imath}$*:

- W. *uchel*, Co. *huhel*, Br. *uc'hel* < **ouχsĕlo*- < **oupsĕlos* < **oup-sē-ló*- *vs*. Gr. *ὑψηλός*.
- OIr. *del* < *$d^hĕlos$ < *$d^hēlós$. *vs.* Latv. *dệls* (gen. *dệla*) < *$d^hēlós$

Of course, this law applies after laryngeals became long vowels in the concerned combinations.

- **HoH-mó*- > **ōmó*- > *ŏmo*- > OIr. *om*
- **uiH-ró*- > **uīró*- > *uĭró*- > OIr. *fer*

*1. *CRHC > *CRāC, *oH > *ō, *IH > ĪH*
*2. *V̄CV́ > *V̆CV*
*3. *$\bar{e} > \bar{\imath}$, *$\bar{o} > \bar{a}$*

2. Stops

*2.1. *TK > *KT*

This change is probably one of the first development that appeared in Celtic since it can be found in many other Indo-European languages. The PIE reconstruction is based on the reflexes of Hittite and Tocharian and concerns only a limited set of words. According to Schindler, since the cluster **TK* is only present int those two languages, the metathesis must have happened after their split from Proto-Indo-European.[54]

- *$d^heg^hōm$ > Hit. *tēkan*, Toch. A *tkam* 'earth', OIr. *dú*
- *d^hg^hom-*yo*-> Lat. *homō*, Goth. *guma*, Gaul. *-xtoni(o)n*, OIr. *duíne* 'man', MW. *dyn*, OBr. *don*, *den*

[50] Matasović (2009), *s.v.* **sāwol*- / **sūli*-.
[51] Schrijver (2016), p. 491.
[52] Zair (2012), p. 113.
[53] *ibid.*, p. 147.
[54] Schindler (1977), p. 34.

- *$d^hǵ^h(y)es(i)$ > Gr. *χθές* ‘yesterday’, Lat. *heri*, OHG. *gesterēn*, OIr. *in-dé*, MW. *doe*, MBr. *dech*
- *$h_2rtḱo$- > Hit. *hartagga-*, Gr. *ἄρκτος*, Lat. *ursus*, Gaul. *Artio*, OIr. *art*, MW. *arth*, OBr. *Ard-*, *Arth-*

On the basis of Latin reflex *-s-*, it has been supposed that Italo-Celtic had known an intermediary form **kþ* / **gð*, maybe pronounced in Proto-Celtic as [t͡s] and [d͡z].[55] However, Isaac contested this common development, saying that the metathesis is only visible in Celtic and in Greek, not in Italic. Moreover, Italic shows two different reflexes (-)*s-* and *h-* (**$d^hg^{wh}i$-ti-* > Lat. *sitis* ‘thirst’, **tḱi-tu-* > Lat. *situs* ‘placed’, **$h_2rtḱo$-* > Lat. *ursus*, and **$d^hg^hōm$* > Lat. *homō* ‘human’, *humus* ‘earth’, **$d^hǵ^h(y)es(i)$* > *heri*), the latter being explained by Meiser with another metathesis **g^hd-* > **d^hg^h*, where **g^h* stands for the zero-grade of the pronoun **g^he/o-* ‘at that day’.[56] Concerning Lat. *heri*, Isaac notices that Meiser’s explanation does not solve the problem since we would have to posit **$ǵ^hd^{(h)}$* > **$d^hǵ^h$* (metathesis specific to ‘yesterday’) > **g^hd^h* (second general metathesis). He proposes that **g^hd^h* was merely simplified in **g^h*, then Lat. *-h-*, whereas the cluster **TK* underwent a spirantization **ÞΓ* and a simplification in **s*:[57]

- **$ǵ^hdies$* > **$ǵ^hd^hes$* > **g^hes* > **χeri* > *heri*
- **$d^hg^{wh}iti$-* > **$ðɣ^{wh}iti$-* > **$z^{ɣh}iti$* > *sitis*.

In that case, only Celtic and Greek would have undergone the metathesis **TK* > **KT*. Without supposing a historical relation between Celtic and Greek, Isaac clearly rejects the possibility of an Italo-Celtic stage and prefers to consider the potential similarities between those branches as mere cases of geographical contact having occurred during the long period between the westward migration and the first attested texts.[58]

One could say however that Celtic and Italic show a surprising number of similarities considering their phonetic and morphologic evolution and that the mere development of the cluster **TK* and the difficulties presented by Italic reflexes is not such an important objection to the Italo-Celtic hypothesis but rather a problem specific to Italic. In our chronology, we will consider that the change **TK* > **KT* happened then at the latest during the Italo-Celtic period, although one should recognize that the Italic material is truly bewildering.

*1. *TK* > **KT*

2. specifically Italo-Celtic and Celtic changes

*2.2. *$T^{[dental]}T^{[dental]}$ > *t^st*

Matasović posits the rule **$T^{[dental]}T^{[dental]}$* > **ss*, but there must have been an intermediary stage **t^st* because of the Gaulish reflex and of its relation with the early Celtic change **CLT* > **CLiT*. Indeed, Gaulish shows the spelling *-ðð-* in *neððamon* (OIr. *nessam*, MW. *nessaf* ‘nearest’). For McCone, this *-ðð-* is a remainder of the intermediary stage **t^st* and was pronounced as an affricate [t͡s]. Because of OIr. *fo:cress* ‘was thrown/put’ < **krisso-* <

[55] McCone (1996), p. 48.
[56] Meiser (1998), pp. 96-97.
[57] Isaac (2007), p. 80.
[58] *ibid.*, p. 94.

krts(t)o-*, this change must have happened after **CLT > *CLiT*,[59] otherwise we would expect **krsso > *kars(s)o > OIr. **carr*, following the exact same development as OIr. *carr* 'wagon' < **karso* < **krso-* 'run' (Lat. *currō* 'I run', OE. *hors* 'horse').[60] Matasović labelled this change as a dialectal Indo-European change because it is also found in Italic and Germanic (wid-to-* > Lat. *vīsum*, **mith₂-to-* > Lat. *missum*).[61] Then it seems possible to assume a dialectal development $*T^{[dental]}T^{[dental]} > *t^st$ and an Insular Celtic development $*t^s(t) > *ss$, between which **CLT > *CLiT* took place.[62]

This development must also have happened before $*T^{[labial/velar]}t/s > *\chi t/s$, otherwise we would expect **krid-to > *kriχto-* > OIr. ***cricht* (to compare with **prp-tu- > *riχtu-* > OIr. *richt*).[63]

1. $*T^{[dental]}T^{[dental]} > *t^st$
2. **CLT > *CLiT* and specifically Celtic changes: $*g^w > *b$, **pL > *bL*, **eRa > *aRa*, **ō(C)# > ū(C)#*, $*\underset{\circ}{u}n > *bn$
3. $*T^{[labial/velar]}t/s > *\chi t/s$
4. $*t^st$ > IC. **ss*

2.3. **Ḱ > *K*

This change is shared with all Centum languages and does not interact with any other Celtic phonetic rule. It must be early, *i.e.*, before the Italo-Celtic period. On a methodological point of view, it would also be unnecessary to suppose a late retention of the phonetic opposition between palatalized, plain, and labialized velar stops, since the longer it is put among the features that could have an influence on other sounds, the longer it is surprising to see that such a distinction has absolutely no influence.

- **dḱm-* > **dekam* > OIr. *deich* 'ten', MW. *deg*, OBr. C. *dec*, Gaul. *decan-*, *decometos* 'tenth', Celtib. *tekametam*, *vs.* Skt. *dáśa,* OCS. *desętь-*.
- **ǵrHno-* > OIr. *grán* 'grain', MW. *grawn*, MBr. *greun*, *vs.* Lith. *žìrnis* 'pea'
- $*ǵ^hleuH-$ > MW. *glo* 'coal', MBr. *glou*, *glaou*, *vs.* Skt. *jvālá-* 'flame, coal'.

1. **Ḱ > *K*
2. specifically Italo-Celtic changes
3. specifically Celtic changes

2.4. **RDC- > *RaDC*

This change is sometimes called as Schrijver's rule and is seen as Italo-Celtic. The reason of the introduction of a vowel **a* before a voiced stop is not clearly stated but if we subscribe to the glottalic theory, a form $*R^ʔDC$ could be easily equated with **CʔC > *CaC* and **#ʔRC > *#aRC* (where **ʔ* would be a laryngeal). We have for example:

[59] McCone, *ibid*.
[60] Matasović (2009), *s.v. *karro-*.
[61] *ibid.*, p. 6.
[62] McCone (1996), p. 48.
[63] Matasović (2009), p. 6, and *ibid. s.v. *frixtu-* for OIr. *richt*.

- **mǵh₂* > **mg-lo-* > **maglo-* > OIr. *mál* ‘prince’, MW. *mael*, MBret. *-mael*. To be compared with Lat. *magnus* < **mg-no-*.[64] It seems possible to posit this change before **CHC* > **CC*; for Delamarre, Gaul. *Magalos* would be a later development, from PC. **maglo-*, where *a* was inserted as a epenthetic vowel between *g* and *l*. Other examples would be required to prove this rule, however, this seems to be the best solution since a Proto-Celtic development **magalos* could hardly give the Insular Celtic forms. The development of **maglo-* can be compared with **h₂eg^{h}lo-* > *aglo-* > OIr. *álad* ‘wound, affliction’, MW. *aeled* ‘pain, distress’, see Skt. *aghrā-* ‘evil, distress’.[65]
- **b^{h}rǵ-smn-* > *brag-smn* > W. *bram* ‘to fart’, Br. Co. *bramm*. **b^{h}rǵ-ie-* > OIr. *braigid*. See Lat. *frangere* ‘break’, OHG. *brehhan*.[66] Matasović proposes to relate it to **b^{h}rHg-* (Lat. *fragrāre* ‘smell’, OHG. *bracko* ‘tracking dog’): **b^{h}rāg-ié* > **b^{h}răgié-* (Dybo’s law). One must recognize that the semantic relation is probably more appealing. He also notices that this word cannot be taken as a good example of Dybo’s law since no reflex of this root is found in Vedic or Greek.[67]

For Matasović and Zair, the rule is yet still doubtful.[68] We can following counter-example:

- **h₂mlǵ-to-* > **mligto-* > **mliχto-* > OIr. *mlicht* ‘milk’. See Gr. *ἀμέλγω* ‘to milk’, Lat. *mulgeō*.
- **h₃rǵ-to-* > **rigto-* > **riχto-* > OIr. *-recht* ‘extend, stretch’. A paradigm levelling is possible, though: **h₃rǵ-eti* > **rig-eti* >> **rig-to-*.

If we accept this rule, it must be posited in the following order:

1. **RDC* > **RaDC*
2. **CLT* > **CLiT*: otherwise, PC. ***brig-*
3. **R̥* > **aR*: otherwise, PC. ***barg-*

2.5. **g^{w}* > **b*

The main point of this rule is its relation with **g^{wh}*. Indeed, if we suppose that *g^{w}* became *b* after **g^{wh}* became *g^{w}*, then every **g^{wh}* should have a reflex *b* too, which is not the case. Another possibility is that **g^{wh}* lost its labial element before **g^{w}* > *b*, or that **g^{wh}* did not change when **g^{w}* developed into **b*, and eventually became **g^{w}* or **g^{h}*:

- 1. **g^{wh}* > *g$^{(h)}$* 2. *g^{w}* > *b*
- 1. **g^{w}* > *b* 2. **g^{wh}* > *g^{w} / g^{h}*

One could be surprised that **g^{w}* became **b* whereas **g^{wh}* did not developed into **b^{h}* at the same time. However, the evolution of **k^{w}* into OIr. *c* seems to prove that the simplification of **g^{w}* did not affect all the range of labialized velar stops.

Examples can be found in:

[64] Schrijver (1991), pp. 415-416, and (2016), p. 494.
[65] Matasović (2009), *s.v. *aglo-*.
[66] Schrijver (1991), p. 478.
[67] Matasović (2012), p. 135.
[68] Matasović (2009), p. 11, Zair (2012), p. 65.

- *$g^{w}enh_2$ > *$benā$ > OIr. *bé* ‘woman’, *ben*, OW. *ben*, MBr. *(h)e-ben* ‘the other one’, lit. ‘her female fellow’[69], Gaul. gen. pl. *bnanom*. See Skt. *jáni*, *gnā́*, Gr. *γυνή*, OE. *cwen*.[70]
- *$g^{w}iH$-*uó*- > *bĭuó*- > OIr. *béo* ‘alive’, MW. *byw*, MBr. *beu*, Gaul. *Biuonia*.[71] See 1.8. for Dybo’s law.

1. *g^{w} > *b
2. *D^{h} > D (where *g^{wh} > *g^{w})

2.6. $*D^{h} > D$

Considering the global phonetic system, this change is extremely important since it made all the aspirated voiced stops (or voiced stops according to the glottalic disappear) disappear, but as well as the disappearance of the palatalized velar stops, it seems that this range had absolutely no influence on the preceding or the following change. Only comparative evidence with the other Indo-European languages forces us to reconstruct those ranges for Celtic, or as McCone would say: “Since it does not affect the number of phonemes posited, the issue of the traditional stop system versus glottalic alternatives, which are highly inefficient where Celtic is concerned, is essentially one of notation only.”[72] In this section, we shall study the particular case of *g^{wh} , which seems to be the only aspirated stop that did not behave exactly like its non-aspirated counterpart, the phoneme *g^{wh}, as it has been exposed in 2.5.. The question will be whether *g^{wh} maintained its aspirated or its labial element. In a second part, we shall see the different interpretations of this important change in the stop system, and finally a possible treatment of the aspirated stops in Italo-Celtic.

2.6.1. $*g^{wh} > *g^{h} / *g^{w}$

According to Pedersen and Thurneysen, Proto-Celtic underwent the change *g^{wh} > *g^{h} > *g, however, according to Morris-Johnson, Binchy, Sims-Williams and Cowgill, the view cannot be correct and must be replaced by *g^{wh} > g^{w}. The argument for the former development was based on OIr. *guirid*, W. *gori*, Br. *gor* ‘warm’ < *g^{wh}*or-eie*- (Gr. *θερμός*, Lat. *for-ceps*). However, we see that Welsh and Breton *g*- can also come from PIE. **w*- > *PBrit.* **gw*- > *W. g*-, like in PIE. **wolk*- > **gwolchi* > W. *golchi* ‘wash’, Br. *gwalc’hiñ* ‘id.’. Then it is possible simply to posit that in Proto-Celtic we have *g^{wh} > *g^{w}, followed by the Proto-Brittonic development *$g^{w}o$- > **wo*- > **gwo*- > W. *go*-, Br. *go*-, and PIE. **wo*- > PC. **wo*-, followed by PBrit. **gwo*- > W. *go*-. In other words, PIE. *g^{wh}- > PC. *g^{w}- > PBrit. **w*- and PIE **w* would have simply merged during the Proto-Britonnic period, whereas PIE. $g^{wh}o$- > *$g^{w}o$- would have become *go*- in Old Irish, and PIE. **wo* would have developed into OIr. *fo*- (**wolk*- > OIr. *folcaid*).[73] It is phonetically much more straightforward to suppose a spirantisation of *g^{w} > **w*, then an addition of a velar stop before a labio-velar semi-vowel (see for example Lat. *uespa* > Fr. *guêpe*), and finally the disappearance of **w* before **o* (as can be seen in the difference of

[69] Breton opposes the masculine expression *an eil hag e-gile* ‘one another’, lit. ‘the male one and his male fellow’ (OBr. *kiled* ‘fellow’) to the feminine *an eil hag he-ben* ‘the female one and her female fellow’.
[70] Matasović (2009), *s.v. *benā*.
[71] *ibid.*, *s.v. *biwo*-.
[72] McCone (1996), p. 37.
[73] McCone (1996), p. 38.

treatment in Welsh *golchi,* Br.G. *golc'hein* and Br.KT. *gwelc'hi,* Br.L. *gwalc'hi*)[74], than a mysterious change from **g* to **w*.

Other examples of **g^{wh}* > **g^{w}* can be found in MW. *gwedi* 'prayer', OIr. *guide* 'id.' Gaul. *uediiumi* < **g^{wh}ed^{h}-*, MW. *guanu* 'wound', MBr. *goanaff* 'id.', OIr. *gonaid* 'wounds, slays' < **g^{wh}en-* 'smite, slay'.

Pedersen had proposed to equate W. *gwaew* 'spear', OC. *hoch-wuyu* 'swine spear', MBr. *goaff* 'spear', Gaul.Lat. *gaesum* 'id.' and *OIr. gae* 'id.', with OIr. *g-* and Brit. *gw-* both from PIE. **g^{h}-* (Gr. *χαῖος* 'shepherd's staff', ON. *geirr*).[75] However, Schrijver prefers to derive W. *gwaew* from PC. **uφo-gaisu- > *Woɣoew > *gwoɣoew,* to be compared with MIr. *foga* 'small spear', showing then that there is no reason to suppose **g^{h}* > **g^{w}* in Brittonic.[76] Finally, this correspondence might be of no use to describe the normal evolution of PIE. **g^{h}*, since according to Delamarre, this Celtic word was a loanword from Germanic **g^{h}oisos,* because of the vocalism **-ai-* instead of **-oi-*.[77]

In internal position, it is also more convincing to reconstruct W. *-f-, -w-* < **g^{wh}* than < **g^{h}*, for phonetical and comparative reasons. Indeed, if we relate Lat. *unguis*, Gr. *ὄνυξ, ὄνυχος,* OIr. *ingen,* and OW. *eguin,* we can only reconstruct **h$_3$n(o)g^{wh}-*, since a form **h$_3$nóg^{h}-w-s, *h$_3$n(o)g^{h}-ew-s* would probably produce the Greek forms ***ὀνοχυς, ὀν(o)χευς*.[78] The development is then: **h$_3$ng^{wh}-* > PC. *ang^{w}īn* > PBrit. *anwīn* > *angwīn*.

Such a reconstruction allows to preserve the correspondences for:

- **dng^{wh}-:* OLat. *dingua* 'tongue', OIr. *tengae* 'id.', MW. *tauawt* 'id', MoW. *tafod* 'id', OBr. *tauot* 'id', MoBr. *tañva* 'taste'.
- **d^{h}eg^{wh}-*: Skt. *dah-* 'burn', OIr. *daig* 'flame', MW. *deifio* 'burn', OBr. *deuuet-*.
- **sneig^{wh}-*: Lat. *nix, nivis*, OIr. *snig-* 'pours, drips', MW. *nyf* 'snow'.[79] For this word in Welsh, one could also suppose a late borrowing from Lat. *nivem*, since it is quite surprising to find no trace of such a word in Cornish and Breton. The Common Celtic word for 'snow' seems to be rather **argyo-* < PIE. **h$_2$erǵ*: OC. *irch*, Br. *erc'h*, MW. *eiry*.[80]

The labial element is also necessary to explain the change **K^{W}a* > **K^{W}o* in Proto-Gaelic. If **k^{w}r-io-s* > **k^{w}ar-io-s* > OIr. *coire* 'cauldron', then we can reconstruct **g^{wh}r-* > **g^{w}ar-* > **g^{w}or-* > OIr. *goire* 'filial duty', as well as **g^{wh}n-* > **g^{w}an-* > **g^{w}on-* > OIr. *gonaid*, to be compared with Hit. 3sg. *kuenzi*, 3pl. *kun-anzi*, where a regular alternation between *e*-grade and zero-grade appears, the latter having been generalized in Celtic, which remains much more understandable than a hypothetic *o*-grade.[81] Since in Brittonic, **k^{w}r-ios* is reflected by MW. *peir*, Br. *per*, with no rounding of **a*, it is possible to posit the following chronology:

*1. *k^{w}r, g$^{w(h)}$r > *k^{w}ar, g$^{w(h)}$ar*

[74] ALBB, *s.v.* 'laver'.
[75] Pedersen (1909), p. 96.
[76] Schrijver (1995), p. 131.
[77] Delamarre (2001), *s.v. gaiso-*.
[78] Cowgill (1980), p. 74.
[79] McCone (1996), pp. 39-40.
[80] Matasović (2009), *s.v. *argyo-*.
[81] McCone (1996), p. 41.

2. *k^w, $g^{w(h)}$ > PBrit. *p, b* (separation of Proto-Irish and Proto-Brittonic. The labial element is still present in Proto-Irish.)

3. *$k^w a$, $g^w a$ > *$k^w o$, $g^w o$ > OIr. *co-, go-*.

This last change, as a Proto-Irish change, is then beyond our scope, but it shows the validity of the change *g^{wh} > *g^w.

2.6.2. Interpretations of the loss of aspirated stops

The loss of aspirated stops has long been a non-subject in the Celtic studies, as Schrijver points out: "How and why the merger of the two PIE series took place is unclear; the development is generally taken for granted."[82] For McCone, the development of *g^w to *b* and *g^{wh} to *g^w can structurally explain this silent revolution.[83]

We shall begin from the PIE stage, where we present the two theories about Indo-European stops, although McCone in his demonstration only considers the traditional theory.

Traditional				
p	t	ḱ	k	k^w
b	d	ǵ	g	g^w
b^h	d^h	$ǵ^h$	g^h	g^{wh}

Glottalic theory				
p:/p	t:/t	ḱ:/ḱ	k:/k	k^w:/k^w
p'/'b	t'/'d	ḱ'/'ǵ	k'/'g	k^w'/'g^w
p/b	t/d	ḱ/ǵ	k/g	k^w/g^w

The second stage is quite accessory since it tackles the question of palatalized velars. As it had no influence in Celtic developments, the most economical solution is to get rid of those elements as soon as possible, but theoretically, there is absolutely no means of situating it in the Proto-Celtic relative chronology. Here is then the Centum stage:

Traditional			
p	t	k	k^w
[b]	d	g	g^w
b^h	d^h	g^h	g^{wh}

Glottalic theory				
p:	t:	k:		k^w:
[p'/'b]	t'/'d	ḱ'/'ǵ	k'/'g	k^w'/'g^w
b	d	g		g^w

Cowgill pointed that *b* was quite rare, which probably allowed *g^w to take its place.[84] Such interpretation can be based on the scarcity of ejective *p'* in the languages that do have this series. However, if this phoneme is to be seen as an implosive *'b*, it is on the contrary very rare to see such a gap.[85] We could suppose then that *k^w' became a plain voiced *b* (and not *p'*, since this phoneme probably did not exist and is typologically quite rare). In that case,

[82] Schrijver (2016), p. 496.
[83] McCone (1996), pp. 42-43.
[84] Cowgill (1980), pp. 65-66.
[85] Maddieson (1984), p. 112.

however, there seem to be no structural reason for the change *k^{w}' > *b*, contrarily to McCone's explanation. If we consider that the second range was however implosive, as the Italic material seems to point out in Lachmann's law, it can be simply said that *'g^{w} became *'*b* precisely because of the typologically unbearable labial gap in the implosive series. The following table shows the Early Celtic stage.

Traditional			
p	t	k	k^{w}
b	d	g	
b^{h}	d^{h}	g^{h}	g^{wh}

Ejective			
p	t	k	k^{w}
	t'	k'	
b	d	g	g^{w}

Implosive			
p	t	k	k^{w}
'b	'd	'g	
b	d	g	g^{w}

The change *g^{w} > *b highly disrupted the general system of velar stops since *g^{wh} had lost its non-aspirated counterpart, whereas the opposition [±aspirated] was still valid in the plain velar stops series. This allowed *g^{wh} to become simply *g^{w}, creating this time a disequilibrium in the aspirated stops, soon resolved by their loss.[86] The same explanation seems valid for the implosives. Concerning the ejective interpretation, the loss of another ejective (*k^{w}') would have highly jeopardized the opposition [±pulmonic], the feature [-pulmonic] becoming rarer. In a later stage, one of the series merged with the other:

Traditional			
p	t	k	k^{w}
b	d	g	g^{w}
b^{h}	d^{h}	g^{h}	

Traditional			
p	t	k	k^{w}
b	d	g	g^{w}

Ejective / Implosive			
p	t	k	k^{w}
b	d	g	g^{w}

It seems then that both interpretations of the glottalic theory are compatible with the Celtic development of stops, the ejective model being particularly convincing because of *k^{w}' > *b and the dramatically unbalanced system it created.

[86] McCone (1996), p. 43.

2.6.3. The series of aspirated stops: a link with the Italic branch?

For Schrijver, in an article defending the Italo-Celtic hypothesis, the evolution of Celtic aspirated stops must be related to the fricativization observed in Italic. In Italic, the aspirated voiced stops, in anlaut, turned into fricatives, namely [x/h] and [f] in all Italic languages:[87]

- **b^h* > *f*: **b^{h}er-oH* > Lat. *ferō*
- **d^h* > *f*: **d^{h}eh$_1$-* > Lat. *fē-mina, fē-cundus, fē-tus*
- **g^h* > *h*: **g^{h}ostis* > Lat. *hostis*
- **g^{wh}* > *f*: **g^{wh}er-* > Lat. *for-ceps*

Before a liquid, initial **g^h* remained a velar stop *g-*: **g^{h}lh$_2$d^{h}ro-* > Lat. *glaber* (ON. *gladr*). It is possible that this development was specifically Falisco-Latin and not Sabellic.

In Inlaut, we find Lat. *b, d, v, h*, Sab. *β, β, β, h* (where [β] is written {F}), Lat. *b, d, g^w, g* after a nasal, and Lat. *b, b, v, h* after *u, l, r*.

- **-b^h-* > *-b-*: **neb^{h}eleh$_2$* > Lat. *nebula*
- **-d^h-* > *-d-*: **med^{h}ios* > Lat. *medius* (but **uerd^{h}om* > Lat. *verbum*)
- **-g^{wh}-* > *-v-*: **snig^{wh}-es* > Lat. *nivis* (but **sning^{wh}-* > Lat. *ninguit*)
- **-g^h-* > *-h-*: **ueǵ^h-e/o-* > Lat. *vehō* (but **h$_3$miǵ^h-* > Lat. *mingo*, and **d^{h}iǵ^h-lo-* > **figlo* > Lat. *figulus*)

According to Ascoli, **b^h*, **d^h*, **g^{wh}*, **g^h* became **f, *þ, *χ^w, *χ,* and later all the intervocalic fricatives (including **s*) in Inlaut became voiced fricatives **β, *δ, *ɣ^w, *ɣ, *z* (later, **z* underwent rhotacism in Latin). This hypothesis would be proved by the development of **uasd^{h}o-* > **uasþo* > *vastus* (instead of **uasd^{h}o-* > **uazðo-* > ***vādum*). For Hartmann, this evolution can be reversed: firstly, voiced fricatives, then voiceless fricatives in Anlaut, as can be seen in **g^{h}lh$_2$d^{h}ro-* > **glaðro-* > **glaβro* > Lat. *glaber* (instead of **glaþro* > **glatro-* > ***later*). Schrijver prefers to retain Hartmann's explanation [+voiced] > [-voiced] and points as an exceptional rule the case of **-sd^h-* > **-sþ-* > *Lat. -st-*, a rule which could be formalized as such: *D^h / s_* > Lat. *sT*.[88]

In a first stage, **D^h* would have turned into **Đ* word-initially and after a vowel, **r*, or **l* (**d^{h}eh$_1$-* > **ðē-*, **med^{h}ios* > **meðios*). Then Proto-Celtic and Proto-Italic would have split, and Proto-Celtic **D* underwent lenition **Đ*, creating then a confusion between originally voiced stops and aspirated voiced stops, resolved with a complementary distribution: on one hand voiced fricative after vowel (and after a word boundary with a vocalic auslaut), and in final position, on the other hand voiced stop after a consonant and word-initially.[89]

Even though this demonstration works, it is possible to rise two remarks:

- The Celtic material does not prove (nor disprove) anything of that . The main point of this article is to explain how Italic fricativization can be integrated in the Italo-Celtic

[87] Meiser (1998), pp. 101-103.
[88] Schrijver (2016), p. 496. The rule is not clearly exposed in Schrijver's article and seems to be deduced from Meiser (1998), p. 118. However Meiser does not create a new rule and simply says: "Diese Entwicklung *-zd^h-* > *-st^h-* > *-st-* ist eines der stärksten Argumente dafür, daß die uridg. Mediae Aspiratae im Italischen zunächst als stimmlose Spiranten fortgesetzt wurden".
[89] *ibid.*, p. 497.

hypothesis. If one does not try to prove this hypothesis but is just interested in Celtic changes, the development exposed is of no use.

- The rule *D^h / s_ > *sT* supposes that *D^h did not turn into a fricative after a consonant, which goes against Ascoli's and Hartmann's views for whom the fricativization happened everywhere. We could also say of course that since both views have counterexamples, the law *sD^h > *sT* is actually necessary. A consequence is also that **sD* became **zD* only after the Italo-Celtic period, in Italic languages.

*2.7. *pe(R)k^w > *k^we(R)k^w*

The total regressive assimilation of **p* before *k^w has been seen as an Italo-Celtic innovation, happening of course before the loss of **p* in Celtic. This rule provoked much debate, some arguing that this change could be seen as trivial, debunking then this change as Italo-Celtic, some also pointing the scarcity of evidence. The following section will then analyse the relevance of such a change and its integration in the Italo-Celtic period.

Watkins presents several arguments against an interpretation of this change as an Italo-Celtic one, the first being that in Italic this change does not eliminate the opposition between **p* and *k^w, whereas it does in Celtic. For Matasović, this kind of evolution is quite "trivial"[90], as it can be compared with **penk^{w}e* > Go. *fimf*. But Watkins says that in Celtic, it is possible that such a development was caused by the weakening of **p* > *φ, giving way to an assimilation to *k^w motivated by the dephonologization of **p*.[91]

The situation would be then as follows:

	before the dissimilation	after the dissimilation
Italic	*t, k, k^w, p*	*t, k, k^w, p*
Celtic	*t, k, k^w, p*	*t, k, k^w, Ø* (Goidelic) *t, k, p, Ø* (Brittonic

In Italic, there is still a "square opposition" whereas in Celtic there is a "triangle opposition". In other words, the phonologic consequences are quite different in each case. Then for Watkins, the assimilation of **p* to *k^w must coincide or follow the weakening of **p* to *φ > Ø*. If we consider though, like Hoenigswald, that this change must have happened (much) before **p* > Ø*, the argument is not valid anymore.[92]

Only three examples prove this rule:[93]

[90] Matasović (2009), p.12.
[91] Watkins (1966), p. 34.
[92] Hoenigswald (1973), p. 325.
[93] Watkins (1966), p. 33.

- Lat. *quīnque*, Osc. *púmp-* ‘fifth day’, U *puntes*, OIr. *cóic*, OW.*pimp*, OBr. *pemp*, Gaul. *pempe-*. To compare with Skt. *páñca*, Gr. *pénte*, Go. *fimf*, Lith. *penkì*, OCS *pętь*, Alb. *pesë*.

  One of the main arguments of Watkins to debunk the unity of this change is to say that **p* before **k*^{w} did not evolve everywhere into **k*^{w}, but was simply lost, namely inOIr. *deac, deëc* ‘ten’, which cannot be related to PIE **dekḱmt* for the latter regularly gives *deich*, but to **duei-penk*^{w}*-om* ‘two-fives’. If multiplications are quite common in Celtic (Br. *triwec’h* ‘three-sixes’, W. *deunaw* ‘two-nines’), as Watkins says, it is however quite surprising to see it in such an important number as ‘10’, the Celtic system being based, from eleven to nineteen, on the number 10 (*trí mís deacc* ‘three months and ten’). For Cowgill, **duei-* is not the form we find in composition, **k*^{w} should have been palatalized, and finally, as a “pivotal number” (contrarily to ‘eighteen’), it seems unlikely to create such a form. His explanation however is still problematic, since he derives *deac, deëc* from gen. sg. **dekan-os* with an unexplainable metathesis **deankos*.[94] Schrijver adds that forms such as **dwi-penk*^{w}*-om* and **dwei-penk*^{w}*-ou* assume an inflection, which is never attested in the other Indo-European languages. A simple **dw(e)i-penk*^{w}*e* would have yielded a final palatalized velar stop. For him, the explanation of Hertz **dekḱm-k*^{w}*e* is plausible: **dekḱm-k*^{w}*e* > PCelt. **dekank* > **dechāg* > **deēg* > OIr. *dëec*.[95] However he fails to find a perfect phonetic correspondence, for he gives *for·roíchan* ‘thou hast taught’ < **·roechan* < **·rochechan*, with dissimilation of **ch...ch* > **...ch*, but not **k...k* > **...k*. Thus, it is still quite unclear if the Old Irish form is problematic or not for the assimilation of **p* before **k*^{w}. Considering the semantic justification of the enclitic **k*^{w}*e*, we should notice that actually *deac* is in Old Irish the word used in composition from ‘11’ to ‘19’, whereas the number ‘10’ is expressed by *deich*,[96] it would not be surprising then to use **-k*^{w}*e*, meaning ‘and’, as can be seen in several similar examples. Further research should however be led as whether such a composition in this ten is likely (Lat. *unus et viginti*, but *undecim*, NHG. *ein<u>und</u>zwanzig* but *elf*, Br. *un-<u>ha</u>-tregont* but *unnek* < **un-dek*. Spanish knows this composition, but only from ‘16’ *diec<u>i</u>séis*).

- Lat. *quercus* ‘oak’, OIr. *ceirt* ‘apple-tree, letter Q in Ogam', MW.*perth* ‘bush, hedge, thicket’. To compare with OE *furh* ‘fir-tree’, OIc. *fjǫrr* ‘tree, man’.

  In addition to the list given above, the Greek word *ἑρκύνιοι* (*δρυμοί*), Latinized as *Hercynia* (*silva*), designating the oak forests of Northern Gaul, has been seen as another Celtic cognate. For Meillet, it shows that in PCelt. **perk*^{w}*un-* developed into **perkun-* (**k*^{w}*u* > **ku*) before the assimilation of **p* > **k*^{w}. Therefore **perkun-* could regularly develop into **φerkun-*, then **erkun-*. We could suppose then that the Greek interpretation of this supposedly autochthonous Celtic word with an initial aspiration is a trace of Celtic **φ*. If this is correct, **pe(R)k*^{w} > **k*^{w}*e(R)k*^{w} cannot be an Italo-Celtic development since in this particular word, it would have only applied in Italic, whereas

[94] Cowgill (1970), p. 145.
[95] Schrijver (1993), p. 183-184.
[96] Vendryes (1908), pp. 131-132.

in Celtic, a change from *$k^w u$ to *ku would have prevented the assimilation. Cowgill considers this argument but seems to refuse to state clearly that it is a major obstacle to the Italo-Celtic hypothesis, simply saying that "the differing outcomes of *$perk^w u$- 'oak' in Latin and Celtic indicate that when the assimilation occurred Italic and Celtic were already differentiated by a change of *$k^w u$ to *ku* in Celtic".[97]

A regular example could be the name of a Celtiberian people, *Querquernī* (Pliny 3.3), *κουακερνοί* (Ptol. 2.6.47). According to Prósper Pérez, the Latin form might have been influenced by Lat. *quercus* (*Querquernī* instead of **Quequernī*), which is quite dubious because it would mean that a semantically rather strange etymological link was made by Pliny. If the Latin form is true, it can be compared with the name of a Venetic people *Quarquenī* (Pliny 3.130) and *NYMPHIS PERCERNIBVS* (Vaucluse, Narbonensis, CIL XII, 1329). However, this last example would prove that the assimilation did not take place in this Gaulish dialect, which blurs even more the picture if an Italo-Celtic unity is to be assumed. In order to explain the two developments *$pe(R)k^w$ > *$k^w e(R)k^w$ and *$perk^w u$ > *$Øerku$, Prósper Pérez proposes that the first one could take place thanks to the presence of a suffix *-*erno*- in Celtic *$k^w erk^w$-*erno*-, whereas the second one was provoked by a *-*u*- suffix, which we also find in Lat. *quercus, quercūs*. Nonetheless, it must be proved that a Celtic root *$k^w erk^w$- was lively enough to undergo such kinds of derivation. This hypothesis seems to be supported by other Celtic cognates: OIr. *ceirt*, MW. *perth* < *$k^w erx$-*t*- < *$k^w erk^w$-*t*-.[98] Matasović points however that *ceirt*, being only found in glossaries and naming the Ogam letter Q, is not a very strong etymology.[99] If MW. *perth* is correct, it should be put before *$T^{[labial/velar]}t/s$ > *$\chi t/s$.

One could finally notice that *$perk^w us$ is only present in Celtic, Italic, and Germanic, but nobody seems to have contemplated the possibility of language contact or at least of an innovation of western Indo-European languages, which may have consequences on the result of this word.

- Lat. *coquō* 'to cook', *popīna* 'eating-house'[100], MW.*pobi* 'to cook', MBr. *pibi*, *poba*. To compare with Skt. *pácate*, Gr. *péssō*, OCS *pešti*, *pečetь*, Lith. *kepù*, *kèpti*

  This case seems to be the only one that confirms without difficulty the rule of assimilation. In Latin, we can reconstruct *$pek^w ō$ > *$k^w ek^w ō$ > *quoquō* (Pl. Men. 241) > *coquō*. The change from [k^{w}e] to [ko] is also regular. See *$k^w elō$ > *$k^w olō$ > *colō* 'to live in, to take care of' (Skt. *cárati*, Gr. *pélomai*).[101]

Two other examples were presented but dismissed later:

- The example *cunctus* 'whole', compared with hit. *pa-an-ku-uš,*[102] is irrelevant because of Hit. gen.sg. *pankauaš,* which shows that Hit. -*k*- cannot come from PIE. *k^w.

[97] Cowgill (1970) p. 113.
[98] Prósper Pérez (2013), p. 11.
[99] Matasović (2009), *s.v. *$k^w erxt$-.
[100] Probably a Sabellic form, equivalent to Lat. *coquīna* 'art of cookery' (Apul.). Cf. Steinbauer (1989); De Vaan (2008), *s.v.*
[101] Meiser (1998), § 65, 5.
[102] Silvestri (1970).

Moreover, this Hittite word is to be linked with Skt. *bahú-*, from **$d^hb^hng^h$-eu-*,[103] not **ponk^w-u-* which Latin might reflect.[104]

- **prok^w-* > Lat. *prope* 'near, close', superlative *proximus*. Such a pair, according to Ernout and Meillet, must go back to **prok^w-*, but the assimilation did not take place (**Lat. *quaroque* ?) because the sequence **k^{w}r* was simply impossible,[105] whereas in Celtic, it was, as Thurneysen proved it in Old Irish: **k^{w}rmi-* > OIr. *cruim* 'worm', OW. *prem*, MBr. *preff* (Skt. *kṛ́mi-*, Lith. *kirmìs*).[106] Watkins concludes that the assimilation is distinct in Celtic and Italic since in on language, **k^{w}r* was possible, and not in the other.[107]

  It was finally proven by Dunkel that **prok^{w}e* was not the correct reconstruction, but that a reduplicated form **própro* had to be considered as its real etymology. It developed into **propre* (**ŏ# > ĕ#*, like in *sequere*, to be compared with Gr. *epeo*.) and then into *prope* (**agrestris > agrestis*, **procrerus > procerus*). The superlative *proximus* is explained by an analogy with *maximus*, which avoided a unique and more hardly recognized ***propsimus* (the *-psimus* superlative does not exist in Latin).[108]

To conclude, Watkin's main objections (Lat. *prope*, OIr. *deac*) do not seem so decisive. The words for 'cook' and 'five' are quite sure, but it must be admitted that the word for 'oak' is still quite problematic. However, as Cowgill says, "the paucity of examples is not a good reason to doubt that this is a real sound law".[109] If we stick to Watkins's position the relative chronology should probably be as such:

1. pL > bL, pn > bn
2. p > f
3. pe(C)k^w > k^{w}e(C)k^w

However, we shall retain the following chronology:
1. **pL > *bL, *pn > *bn, *pe(R)k^w > *k^{w}e(R)k^w*
*2. *p > Ø, *T$^{[labial/velar]}$t/s > *χt/s*

*2.8. *T$^{[labial/velar]}$t/s > *χt/s*

A labial or a velar stop becomes a velar fricative **χ* before a **t* or an **s*. This **χ* is clearly visible in Old Irish and in Gaulish, but in British, it became **į* before **t*.[110] By the way, Zink notices that the early palatalisation which led to Fr. *fait* 'done' (< **faγto* < Lat. *factum*) could have the same Celtic origin.[111]

[103] Kloekhorst (2008), *s.v. panku-*.
[104] Sihler (1995), p. 145-146.
[105] Ernout, Meillet (1932), *s.v. propter*.
[106] Thurneysen (1946), p. 137.
[107] Watkins (1966), p. 34.
[108] Dunkel (1980), pp. 101-102.
[109] Cowgill (1970), p. 113.
[110] Jackson (1953), pp. 407-411.
[111] Zink (1986), p. 107.

The formulation presented by Matasović is too general and vague: "*C_1C_2 > *xC_2 (where C_2 stands for any stop and *s)":[112]

- *C_1 stands for a stop, not for any consonant like a resonant: *$h_2$ner-to- > OIr. *nert* 'strength', *wēnto > MW. *gwynt*. Moreover, it never stands for a dental, but for a labial stop (*p, *b^h) and velars stops (*ḱ, *k^w, *ǵ, *g^w, *g^{wh}), as it will be exposed below. Any dental would indeed become *T^sT in front of another dental, and before another stop it can be assimilated (OIr. *ad-* 'to': *ad-daim, -aicci, edbart*); before an *s, it seems to be assimilated, like in the Old Irish sigmatic future *ísaid* 'he will eat' < *h_1i-h_1d-se-.
- *C_2 always seems to be *t or *s, which might also be a statistical bias since many suffixes begin with those consonants (*-to-, *-ti-, *-tu-*, desiderative *-se-, nom. sg. *-s), contrarily to labials and velars.

Isaac creates two different rules *$K > Γ/\_T^{[dental]}$, *s* and *$φ > x/\_t,sV$ because of change which would have taken place between them, the development of schwa between two initial stops *ø > *ə / #T_T*, a rule which would explain *kpro- > *gbro > *gəbro- > OIr. *gabor* 'goat' (see 2.9.), and *ptr- > *pətər > *φətər > *ətər > OW. *atar* 'bird'. See Hit. *pattar* 'wing', Skt. *pátra-*, Gr. *πτέρον*, Lat. *penna*. . As a consequence, it must be put before *$φ > x/\_t,sV$, otherwise the development would be *ptr- > **xtr*, and before *$φ > Ø$ (*φtr- > *tr- > OW. **târ*). It happened after *$K > Γ/\_T^{[dental]}$ because of *gdes > *γdes > OIr. *in-dé* 'yesterday', W. *doe*, MBr. *dech*, which would have become otherwise *gədes*. It seems nevertheless quite unsafe to base this chronology on the still quite uncertain cluster *TK* and on the development of the *Wanderwort *kpro-* 'goat'. The development of a vowel in *ptr-* could also come from a full-grade, or with an analogy with *fet-no- < *pet-* 'fly' (OIr. *én* 'bird', MW. *edn*, MBr. *ezn*).[113]

For all those reasons, the most secure formulation seems to be *$T^{[labial/velar]} > *χ$ / _t,s. A broader formulation could suppose that due to the lack of example, one cannot completely dismiss the possibility that any stop becomes *χ before any other stop or an *s (including a dental before an *s, or a stop before a non-dental stop).

Here are the examples that we can adduce:

- *septm > *seχtam > OIr. *secht* 'seven', MW. OBr. *seith*, OC. *syth*, Gaul. *sextan-*. See Skt. *saptá*, Gr. *ἑπτά,* Lat. *septem*.[114]
- *prp-tu > *priptu- > *riχtu- > OIr. *richt* 'appearance', MW. *rith*, OBr. *(ar)rith*. See Gr. *πρέπω* 'appear'.[115] This change happened after *CLT > CLiT* and before *$p > Ø$.
- *tep-s-mo- > *teχsmo- > *teχmo- > *tēmo- > W. *twym* (see 2.11.2.)
- *uob^hs- > *uoχs- > W. *gwychi* 'wasp', OBr. *guohi* gl. *fucos* 'hornet'. See Lat. *uespa* 'wasp', OE. *wœsp*.[116]
- *deḱs- > *deχs- > OIr. *dess* 'right', MW. *dehau*, OBr. *dehou*, Gaul. *Dex(s)iua*.[117]
- *pok^w-to- > *k^wok^w-to > *$k^woχto$- > W. *poeth* 'hot', MBr. *poaz* 'cooked', Co. *poth* (see also 2.7.).[118]

[112] Matasović (2009), p. 9.
[113] *ibid., s.v. *fatar.*
[114] *ibid., s.v. *sextam.*
[115] *ibid., s.v. *frixtu-.*
[116] *ibid., s.v. *woxs-V-.*
[117] *ibid., s.v. *dexs(i)wo-.*
[118] *ibid., s.v. *k^wok^w-o-.*

- *h_2ēǵ-s-t > *h_2aχst > *aχt > OIr. ‘drove’, W. *aeth* ‘went’. See Skt. *ájati* ‘drive’, Gr. *ἄγω*, Lat. *agō*.[119]
- *mrg^w-to- > *mrig^{w}to- > *mriχto- > OIr. *mrecht* ‘variegated, diversified’, *OW. brith*, MBr. *briz*. See Lith. *márgas* ‘variegated’, OIc. *myrkr* ‘dark’. This etymology is not certain.[120]
- *snig^{wh}-t- > *sniχt- > OIr. *snechtae* ‘snow’. See Lat. nom. sg. *nix, gen. sg. nivis, ninguit* ‘it snows’, Gr. *νείφει*.[121]

In Celtiberian, this *χ seems to have been lost: *retu-keno* (Gaul. *Rextu-geno*) < *reǵ-tu-, *usama* ‘high’ (Gaul. *Uxama*) < *oup-samo-, *tuateros* ‘daughter’ (Gaul. *duxtir*) < *dugtīr.

1. *CLT > *CLiT
2. *T[labial/velar]t/s > *χt/s
3. *p > Ø

2.9. *-pL- > *-bL-

This development took place of course before *p > Ø. Isaac establishes the rule “*p > *b /{C,V}_R” where *R* stands for “any sonant”,[122] but later he writes “*Internal PIE* *p *become* *b *before a non-syllabic liquid*”, giving the example *kpro- > *gbro- > *gabro- > OIr. *gabor*, OBr.W. *gabr*[123] (Gr. *κάπρος*, Lat. *caper*, ON. *hafr)*. It is clear indeed that only liquids are concerned by this change since *pN became *u̯n (see 2.10.) after a back vowel.

- *pi-prh$_3$-se- > *pibrase- > *fibrase- > Olr. *ebraid* ‘will bestow, will give’.[124]
  before p > f
- *duei-plo- > *duēblo- > OIr. *díabul* ‘double’. See Lat. *duplus*.[125]
- *pi-plh$_2$-se-ti > *piplaseti > *piblaseti > OIr. *eblaid* ‘will drive’. See Lat. *pellō* ‘push, move’.

Such a change took only place in internal position, as the development of OIr. *richt* ‘form, appearance’ proves it: *prp-tu > *priptu- > *riχtu- instead of **briχtu- (see 2.8.).

1. *-pL- > *-bL-
2. *p > Ø

2.10. *pn > *u̯n

The formulation of the rule varies between Matasović and McCone. For the former, the rule is “*pN > *wN (where N is any nasal), presumably only after back vowels”,[126] however no example of *pm > *u̯m can be found (at least by me) in his dictionary but only of *pn > *u̯n. McCone, on his part, writes “*p > w* between a back vowel and *n*”.[127] This is the

[119] *ibid., s.v. *ag-o*. Isaac (2007), p. 66.
[120] *ibid., s.v. *mrixto-*.
[121] *ibid., s.v. *snig^w-(y)o-*.
[122] Isaac (2007), pp. 62,
[123] *ibid.*, pp. 64, 68.
[124] Matasović (2009), p. 9.
[125] *ibid.*
[126] *ibid.*
[127] McCone (1996), p. 45.

formulation we decided to keep, even though it would not be phonetically absurd that **n* and **m* would produce the same voicing. This could be explained by the fact that there seem to be no occurence of PC. **-pm-*.

For Matasović, this only happens after a back vowel. Like the preceding development, it occured before **p > Ø*. Here are the examples:

- **supno-* > PCelt. **suu̯no-* > **sou̯no-* 'sleep' (OIr. *súan*, W *hun*). See Skt. *svápna-*, Gr. *ὕπνος*, Lat. *somnus*, OE. *sefn*, Lith. *sãpnas*.[128] This change occured before **uu̯ > *ou̯*.
- **kHp-no* > **kapno* > **kawno* > OIr. *cúan* ‘port, haven’, see Lat. *capiō*. For de Bernardo Stempel, because of the monophthongisation of **aw > *ō,* it is implausible to have a stage **-bn-*.[129] Moreover, the sequence **-bn-* is more likely to develop into OIr. *-m(u)n-* (**g^{w}neh$_2$-* > **bnā* > OIr. nom. pl. *mná* ‘women’, **obnu-* > OIr. *omun* ‘fear’). This development happened after **CHC > CaC,* since a back vowel is required before **pn* to make it evolve into **u̯n*.
- **dh$_2$p-neh$_2$ > *dapnā > *dawnā* > PGa. **dōnā* > OIr. *dúan* ‘poem’. See Lat. *daps* ‘sacrifice’, ON. *tafn* ‘sacrificial animal’.[130]

This change must also be placed after **u̯n > *bn*, otherwise we would expect **supno-* > **suu̯no* > **subno-* > OIr. ***somun*, MW. ***hwfn* (like PC. **dubno-* > OIr. *domun*, MW. *dwfn*). See 6.4.

See 4.2. for **R̥* > *aR* before **pn* > **u̯n*.

1. **CHC > *CaC, *R̥ > aR, *u̯n > *bn*[131]
2. **pn > *u̯n*
3. **p > Ø, *uu̯ > *ou̯*

2.11. **p > (φ) > Ø*

2.11.1. *A late retention of *p?*

It is very clear that **p* disappeared in Celtic languages (**ph$_2$tēr* > OIr. *athir*, **pi-ph$_3$-* > *OIr*. *ibid*, MW. *yuet*, *M*Br. *euaff*) and that this phoneme did not reappear in Brittonic before the simplification of **k^w* to *-p-* (**penk^{w}e* > **k^{w}enk^{w}e* > W. *pymp*, Br. *pemp*), and in Gaelic before the introduction of Latin *-p-* (Lat. *praedicat* > OIr. *pridchid*, Lat. *peccātum* > OIr. *peccath*). This loss, albeit not so usual, is also found in Arabic (/t/ and /d/, /k/ and /g/, but only /b/) and in other Afro-Asiatic and Nilo-Saharan languages. Maddieson notices on this subject that those gaps can also be “local aberrations” rather than typological models.[132] The Celtic example is then crucial in order to determine how such a phoneme can disappear and, if some intermediary sound is left before its complete loss, what exact value we should give to it and in which chronology it should be inserted.

According to Eska, <𐌅> in the Lepontic word of th 6th century BC *uvamokozis* <𐌖𐌅𐌀𐌌𐌏𐌊𐌏𐌆𐌉𐌔> should be interpreted as /φ/ because digamma, contrarily to <Y> is not used

[128] Matasović (2009), *s.v.* **sowno-*.
[129] de Bernardo Stempel (1999), p. 255, fn. 136.
[130] Matasović (2009), *s.v.* **dawnā*.
[131] McCone (1996), p. 45.
[132] Maddieson (1984), p. 37.

for /w/ or /u/ (unlike Etruscan), but would have the same value as Latin and Faliscan /f/. Moreover, in the other Celtic languages, **upo-* became **wo-* (OIr. *fo-*, OW. and Br. *guo-*), were **u-* was reinterpreted as a semi-vowel, not as a vowel producing a glide ***uwo-*. [133] For Isaac though, since this very old inscription cannot be compared with any inscription of the same period, no conclusion can be drawn on the graphic conventions of this time. Moreover, the fact that the Latin wrote /f/ with a digamma <Ϝ> (and even <ϜΗ>, *i.e.* <*FH*>, in the earliest texts) does not imply that the Lepontic should have done the same. If **upo-* became monosyllabic in Insular Celtic, it does not mean that it could not be disyllabic in Lepontic (**upo-* > PC. **uφo* > **u.o* > IC. **wo* but Lep. **uwo*). Finally, it is not likely that /φ/ was written with <Ϝ> (<F>) in the 6th century but rather with <ΗϜ> (<HF>), <ϜΗ> (<FH>) or <Θ>. Isaac contests also the fact that <Υ> and <Ϝ> would have two clearly distinguished use, basing this objection on the Etruscan written forms (gen. sg. <ΤΙΥϹ> *tius* and <ΤΙϜϹ> *tivs* 'month'). He concludes then that this word must be interpreted as [uwamogostis] /u.amogostis/ or /wamogostis/ (where <ΥϜ> would be a digraph for /w/ like in Etruscan).

Following Isaac, we will consider here that **p* left indeed not trace in the Celtic languages. However, contrarily to him, the intermediary stage **φ* will not be retained since the only change in which **φ* was at stake is **ptr-* > **pətər-* > **φətər-* > MW. *atar* 'bird', which has been presented as doubtful (see 2.8.). This stage is also retained by Schrijver for the cluster **sp-* in **(t)sperH-et-s* > **sφerets* > OIr. *seir* 'heel', du. *di pherid*, W. *ffer* 'ankle'[134] (Lat. *spernere* 'push away, despise', Skt. *sphuráti* 'kicks away')[135] where McCone simply posits the retention of **p* after **s*, interpreted as an allophone of **b* (parallel to Germanic **p-* > *f-* but **sp-* > *sp-*), which eventually developped into **sw-* in Irish and **f-* in British.[136] Whatever the exact development is, and even if **φ* is undoubtedly a necessary stage to explain the loss of **p*, in our chronology, it remains accessory.

*2.11.2. Chronology of *p > ø*

This loss is absolutely crucial in the establishment of a relative chronology of Celtic. Indeed, its consonantic value helps in determinating the development of non-syllabic resonants, its loss produces new diphtongs and long vowels, and reveals the chronology of the developments of its surviving reflexes. Among those dramatic changes, we can cite its relation with the creation of the long vowel **ē,* bound to evolve into **ī.* For Thurneysen, indeed, we can derive OIr. *ír* 'granted' from **īre* < **ēre* < **e.ere* < **pepe/orh₃-e* 'bestowed, gave', which would mean that first **p* is lost, then **ē* becomes **ī*. For Schumacher,[137] the loss of **p* is after **ē* > **ī* because of:

- **tepents* > *te.ents* > *tēnts* > OIr. *té* (instead of **tīnts* > OIr. ***tí*)
- **tepes-mo-* > **tēmmo* > W. *twym*
- **nepotos* > **ne.otos* > Ogam *NIOTTA*, OIr. *niad*

[133] Eska (1998), Schumacher (2004). In: Isaac (2007), pp. 11-12.
[134] Schrijver (1995), p. 348.
[135] Lubotsky (2006), p. 1007.
[136] McCone (1996), p. 44-45.
[137] Schumacher (2004), pp. 509-510.

For Isaac, it is possible to replace the full grade of the suffix **-ent-* by a zero-grade on the basis of **h₁d-nt* > OIr. *dét*, MW. *dant* 'tooth', **kh₂r-nt-* > MW. *carant* 'kin', 'companions', which would produce **tep-nt-* > **tepant-* (with the normal vocalisation of **n̥* > **an*) > **te.ant* > OIr. *té*. In that case, the vocalisation of **N̥* must be put before **p* > *Ø* and before **pN* > **u̯N*.

For W. *twym*, it could be derived from **tep-s-mo-* > **teχsmo-* > **teχmo-* > **tēmo-*, like in **tep-s-m-ieh₂* > **teχsmyā* > **teχmiyā* > OIr. *timme* (instead of ***tepesmieh₂* > *tēmmyā* > OIr. ***tímme*). Here it means that **p* > *Ø* is after **T[labial/velar]t/s* > **χt/s*.[138]

Concerning **nepotos*, we would have a very early raising **-e.o-* > **-i.o-*, which is not supported by any other word in Old Irish. The only example we have come from the creation of hiatus after the loss of intervocalic **s*, but not **p*. Moreover, we would have to suppose that Celtic preserved the alternation between strong stem **nepōts* > **ne.ūts* > **ne.ūss* > *ne.īh* > W. *nei* 'nephew', and weak stem **nepŏtos* > **ne.otos* > **ni.oθah* > Ogam *NIOTTA*, both form having, in a second time, undergone a distinct paradigmatic levelling in Welsh and Old Irish, which would mean that Celtic was the only Indo-European branch which preserved (at least for a certain time) both stems, contrarily to Latin (**nepōt-* > nom. sg. *nepōs,* acc. sg. *nepōtem*), Sanskrit (**nepōt-* > nom. sg. *nápāt,* acc. sg. *nápātam*), Lithuanian (**nepōt-* > *nepuotis*). Isaac prefers to consider that Celtic continued **nepōt-*, like the other Indo-European branches. The specific developments of long **ō* in Proto-Celtic is resolved by a second levelling *nom. sg. *neūts* >> gen. sg. **neūtos* (instead of **neātos*):[139]

nepōts* > **neūts* (o /_(C)# > **u*) > W. *nei*

nepōtos* > **neātos* (ō* > *ā*) >> **neūtos* (levelling) > **ni.uθah* > **ni.oθah* > *NIOTTA*

Matasović briefly notices that the loss of **p* must have happened after **ē* > *ī* (*contra* Thurneysen and Isaac) because of **h₁epi-ro-m* > **eu̯ro-* > **ēro-* > OIr. *íar* 'after' (and not **ēro-* > **īro-* > ***ír*).[140] However he also says that **ē* > *ī* must predate **eu̯* > **ē* because of **(H)reu̯d-* > PCelt. **rēd-o-* 'ride' > Olr. *réidid* (and not **rīd-o-* > ***rídid*),[141] so in any case it is impossible that **eu̯ro-* > **ēro-* becomes **īro-*. The diphthongization of PC. **ē* (from PIE. **-eu̯-*) to OIr. *-ía-* is perfectly regular (**weu̯dos* > **wēdos* > OIr. *fíad* 'in the presence of', to compare with Gr. *εἶδος*, Skt. *védaḥ*) and alternates in oldest texts with *-é-*, as in *réidid*.[142] The case of **h₁epirom* only proves the following chronology:

*1. *p* > *Ø*

*2. *eu̯* > *ē* > *OIr. -é-* > *-ía-*

We will consider then that the correct chronology of the changes mentioned above is:

1. **pL* > *bL*, **pn* > *bn*, **T[labial/velar]* > **χ / _t,s*, **pe(R)kʷ* > **kʷe(R)kʷ*
2. **p* > *Ø*

- **h₁epirom* > **eu̯rom* > **ērom*, OIr. *íar* shows that **p* > *Ø* predates **eu̯* > **ē*.[143]

[138] Isaac (2007), p. 15.
[139] *ibid.*, pp. 16-20.
[140] Matasović (2009), p. 8.
[141] *ibid.*, p. 9.
[142] Pedersen (1909), pp. 58-59. Thurneysen (1946), p. 36.
[143] In terms of combinatorics, the development of **h₁epirom (*1. > 3.) is unnecessary to establish a totally ordered set since we already have 1. > 2. and 2. > 3., then by transitivity 1. > 2. > 3..

- **peperh₃e* > **ēre* > OIr. *ír* shows that **p* > *Ø* predates **ē* > **ī.*
  3. **ē* > **ī*
- **(H)reḭd-* > PCelt. **rēd-o-* 'ride' > Olr. *réidid* shows that **ē* > **ī* predates **eḭ* > **ē.*
  4. **eḭ* > **ē*

3. Fricative **s*

*3.1. *-sl/n/m- > *-ll- / *-nn- / *-mm-*

This rule only applies in internal position; in anlaut, OIr. maintained the cluster: OIr. *slán* 'safe, healthy' < **slāno-* < **slH-no-* (Lat. *sōlor* 'comfort, relief'), OIr. *smech* 'chin' < **smeḱru-* (Hit. *zamankur*, Skt. *śmáśru-*), OIr. *snaïd* 'swim' < **sneh₂-* (Skt. *snā́ti*).

McCone provides the following examples:[144]

- Gaul. *ιμμι* 'I am' < **h₁es-mi*
- Celtib. *iomui* 'to whom' < **yos-mōi*
- W. *twym*, Br. *tomm* 'warm' < **tepes-mo-*
- **os-no* > MW. MBr. *onnen*, Gaul. *onno*, OIr. *uinn-ius* 'ash tree'
- **asn* > OIr. *ann*: **prh₂/₃-sn-* > OIr. MW. MBr. *rann*

Even though this kind of assimilation of trivial (Gr. *εἰμι,* Lat. *cōmis* < **cosmis*, *aēnus* <**aesnos*[145]), McCone prefers to consider it as Proto-Celtic for reasons of economy.

The same assimilation can be seen for **sl* > **ll* in **kos-lo* > OIr. OW. *coll* 'hazel(s)'.

In regard to its chronology, all that can be said is that it is probably a Proto-Celtic development but could also be language-specific. McCone argues that **-asn-* yields OIr. *-ann-* (**rasnā* > *rann*) and that **-andn-* became **ænn* > *-enn-* (**g^{h}n-n-d-* > **gandn-* > **gænn-* > OIr. *ro:geinn*), with a raising and fronting also visible in **enT/s* > **ɪnT/s*, which as a consequence would show that the assimilation **-sR-* > *-RR-* happened after the raising and fronting of the vowels before nasal + obstruant + nasal and the later assimilation of this cluster.[146]

1. Fronting and raising
2. Various assimilations: **-sR-* > **-RR-*, **-nT/sn* > **-nn-*

One should notice that those assimilations are actually of little importance in Celtic and their influence on other changes is rather small. Isaac and Matasović, by the way, do not integrate those changes in their chronologies.

*3.2. The clusters *#sr- and *-sr-*

Schrijver proposed that the internal cluster **-sr-* became **-ðr-*, like in the feminine number 'three' and 'four'**tesres* > **teðres* > OIr. *téoir* and **k^{w}etesres* > **k^{w}eteðres* > OIr. *cethéoir* (Skt. *tisráḥ*, *cátasraḥ)*, on the basis of the Gaulish reflex *tidres*,[147] which is a contested attestation.[148] The initial cluster **sr-* would have become **θr*: **sruto-* > **θruto-* > OIr. *sruth*

[144] McCone (1996), pp. 45-46.
[145] Meiser (1998), p. 118.
[146] McCone (1996), p. 46.
[147] Schrijver (1995), p. 448, (2016), p. 494.
[148] Delamarre (2003), *s.v. tri-, treis, tidres*, 'trois'

‘stream, flow’, W. *ffrwd*. Both changes would be Italo-Celtic (**srīgos* > **θrīgos* > Lat. *frīgus* ‘cold).[149]

The internal cluster **-ðr-* would have had exactly the same development as **-exr-* and **-eɣr-* becoming OIr. *-eoir, -euir.*[150] However, McCone remarks that such a change is only true if **r* is palatal, otherwise, those clusters only develop into OIr. *-ér-*:

- palatal *-r-*: **uegrī* > **ueɣŕĭ* > OIr. gen. *féuir* ‘grass’
- non-palatal *-r-*: **ueg-ro-s* > **ueɣrah* > OIr. nom. *fér* ‘grass’

The reconstruction can therefore only be:

- **teysōr-* > *tēsūr-es* > OIr. *téoir*
  **tēsūr-es* > PBrit. **tēhireh* > **teīr* (shortening in hiatus) > W. Br. *teir*
- **k^{w}etesōr* > **k^{w}etēsūr-es* (coll/nom. pl) > OIr. *cethéoir*
  **k^{w}etēsūr-es* > PBrit. **petēhīreh* > **pedeīr* (shortening in hiatus) > W. *pedeir*, Br. *peder*

The change **eu* > **ei* in British would be attested in **nepōs* > *neūs* > *neīh* > W. *nei* ‘cousin’. Schrijver points however that **tēsūr* and **k^{w}etēsūr* should have yielded W. ***twyr, **pedoer* Br. ***touer, **pedoar* or ***pedor* because **ehī* would have become **ę̄* and then a diphthong, like in **suesūr* > **hu̯ehīr* > **hu̯ɛīr* > **hu̯ēr* > **hu̯oer* > MW. *chwaer*, MBr. *hoer*, OCo. *huir*.[151] Such a complicated development is, for McCone, hardly compelling and he proposes a rule that he recognizes himself as *ad hoc*: **ei / hu̯_r* > *oi*, hence **hu̯oir* > W. *chwaer*, and the preservation of the diphtong **ei* in the other environments (W. *nei, teir, pedeir*).[152] Finally, it seems that indeed the Old Irish reflexes *fér, féuir* prevent us from reconstructing PC.**tesres, *k^{w}etesres* (*contra* Schrijver), and that whether McCone’s reconstruction is true or not, the possibility that **sr* became **rr* is heuristicly useless since, apart from the consistency with the other assimilations of the type **sR* > **RR*, there is no compelling reason, based on the Celtic material, to reconstruct such a change. The main issue is actually to know if this unique inscription *tidres*, found in La Graufesenque, and identified by Thurneysen[153] as the feminine form of “three” is correct.

Concerning the initial cluster **sr-* which would have become **θr* during the Italo-Celtic period, one could also suppose more economically a late merger with PIE. **spr-* > **sφr* > **sr*, as it can be seen in the following examples:

- **sprh$_2$-u-* > **sφrau-* > **srau-* > MBr. *frao* ‘crow’. See Lat. *parra* ‘a kind of bird’, OE. *spearwa* ‘sparrow’.[154]
- **sprHǵtó-* > **sprăgtó-* > **sφrăgto-* > **srăgto* > W. *ffraeth* ‘fluent, eloquent’, MBr. *fraez*. See Gr. *σφαγαρέομαι* (crackle, hiss) and 1.7. and 1.9. for **CRHC*, and Dybo’s law.[155]
- **spreu-* > **sφreu-* > **sreu-* > W. *ffrwst* ‘rush, hast’. See Go. *sprautō* ‘quick’[156]

[149] Schrijver (2016), p. 494.
[150] Schrijver (1995), pp. 451-442.
[151] *ibid.*, pp. 388-389.
[152] McCone (1996), pp. 47-48.
[153] Thurneysen (1925), p. 380-381.
[154] Matasović (2009), *s.v. *sfrawo-*.
[155] *ibid., s.v. *sfraxto-*.
[156] *ibid., s.v. *sfrusso-*.

Those examples could simply show that **sr-* became **fr-* in British after the loss of **p*, then it could not be Italo-Celtic. In that case, we would also have to assume a different treatment of the cluster **sp-* in **spV-* where **φ* was retained longer (**sφ* > W. *ff*, OIr. *s- / ph-*, see 2.11.) and **spr-* where **φ* regularly disappeared.

The following chronology concerning **sr-* > *PBrit. *fr-* is integrated in the final chronology since it is a British development.

1. **CRHC* > **CRāC*, Dybo's law **V̄CV́* > **V̆CV*
2. **p* > *Ø*
3. **sr-* > *PBrit. *fr-*

4. Resonants

4.1. **CLT* > **CLiT*

This change is quite agreed upon, albeit quite unique, compared with the other Indo-European reflexes of vocalic liquids. We can cite:

- **plth₂no-* > **litano* > *Gaul. litano-* 'broad', OIr. *lethan*, MW. *llydan*, OBr. *litan*.
- **ḱrd-yo* > *OIr. cride* 'heart'

For both forms, we can find a zero-grade in other languages, respectively Gr. *πλάτανος*, and Gr. *καρδία*, Lat. *cor*.

It must have happened before **T[labial/velar]t/s* > **χt/s* since it only applies before a stop, and not a fricative like **χ*. An example can be found in **prptu-* > **priptu-* > **riχtu-* > OIr. *richt* 'form' (otherwise **farχtu-* > OIr. ***archt* ?, see also 2.8.).[157] It also predates **T[dental]T[dental]* > **ss* for exactly the same reason: **krd-tu-* > **krid-tu-* > **krissu-* > OIr. *cris* 'belt', MW. *crys* 'shirt', MBr. *cres* (Rus. *čéres* 'belt'). Finally, all the vocalic liquids (and nasals) that did not precede a stop evolved into **aL*, which then must be put after (**krso-* > **karro-* > OIr. *carr* 'wagon').

1. **CLT* > **CLiT*
2. **R̥* > **aR*, **T[labial/velar]t/s* > **χt/s*, **T[dental]T[dental]* > **ss*

4.2. **R̥* > **aR*

The vocalic resonants evolved regularly into **aR*:

- **mr-uo-* > **maruo-* > OIr. *marb* 'dead', MW. *marw*, MBr. *marf, maru* (Skt. *mṛ́tá-*, Lat. *mortuus*), where the suffix **-wo-* would be analogical with **gʷiHwos*.[158]
- **krso-* > **karso-* > OIr. *carr* 'wagon'

This change predates **CHV* > **CV*, because of PIE. **ḱlH̥eto-* > **kalHeto-* > **kaleto-* > OIr. *calad*, MW, MBr. *caled* 'hard' (not ***kleto-*), **snHi* > **sani* > OIr. *sain* 'particular', OW. OBr. *han* 'different'.[159]

Concerning the nasals, Old Irish presents a reflex *-aN-*, *-eN-*, and **-iN-*: **ǵnh₁-ie/o-* > OIr. *-gainethar* 'is born', **n-uid-s* > OIr. *ainb* 'ignorant', but **bnd-no-* > OIr. *benn* vs. MW, Br. *bann*., **h₁n-dom* > OIr. *ind-* 'in'. For Schmidt and De Bernardo Stempel, it is explained by

[157] *ibid.*, p. 7-8.
[158] *ibid., s.v. *marwo-*.
[159] *ibid.*, p. 8.

an early split of Proto-Goedelic from the rest of Proto-Celtic, however for McCone, OIr. *-e-* and *-i-* must be interpreted as a later raising specific to Old Irish, according to the following environments:

- PC. **an/m+m, w, y,* (*r, l* ?), V > OIr. *an/m*
- PC. **an/m + b, d, s* > OIr. *an/m, en/m, in/m*
- Elswhere PC. **an/m* > OIr. *en/m*

He also notices that such fluctuations between *-a-* and *-e-* are also found in Gaulish and British: Gaul. *Brigant- vs. Brigind-oni,* Gaul. *Iouinc-*, OC. *iouenc vs.* MW. *ieuanc,* MBr. *youanc*.[160]

Zair tried to isolate the sequence **HRHC,* however, here the laryngeal can also be simply considered as a consonant, this sequence simply falling in the type **R̥C*.

- **HnH-mn- > *anman-* > OIr. *ainm* ‘name’, OW. *anu*, MBr. *hanu*, Gaul. *anuana*. The types of the laryngeals are a controversial issue, but in the Celtic case, since there can be no colouring effect in such a position, the type is irrelevant. McCone clearly sees no influence of the laryngeals and reconstructs the intermediary stage **n̥m-*.

For McCone, it must also have happened before the Proto-Gaelic development **Vns* > **V̄s*, as the development of acc. sg. **reǵ-ns* proves it: **reǵ-ns > reg-ans > rīg-ās* > OIr. *ríga*. Otherwise, we would expect **rīgns > *rīgs*, which would probably undergo the rule **T[labial/velar]t/s > *χt/s* (OIr. ***richs* ?).[161]

It must also precede **p > Ø,* like in OIr. *té,* where Isaac supposes a zero-grade of the participial suffix **-nt-*: **tep-nt- > *tepant- > *teant-* > OIr. *té*.[162] From this same word, we can also say that it preceded **pn > *u̯n* (otherwise **tepnt- > *teu̯n- > *tou̯n- > OIr. **túa*).

1. **CLT > *CLiT*
2. **R̥C > aRC*
3. **pn > u̯n, *CHV > *C*
4. PGa. **Vns > *V̄s*

*4.3. *mu̯ > *u̯*

This change is proved by PIE. **kom-uer- > *kom-uar- > *kou̯ar-* > OIr. *coir,* MW. *kyweir* ‘right’ and **kom-ueh₁r-ro- > *kou̯īro-* > MW. *kywir*, Gaul. *Co-uirus*. Bernardo de Stempel rejected this rule by refering to OIr. cubus ‘conscience’, from **kom-uid-*,[163] an objection that McCone dismissed by interpreting it as a calque of Lat. *con-scientia*: PGa. **koṽ-u̯issuh* > OIr. *cubus*.[164]

This change cannot be related to any other one, however, Schrijver describes this change as Italo-Celtic, as the following development seems to prove it: **kom-u̯ir-io/ā* >

[160] McCone (1996), p. 50.
[161] *ibid.*, p. 50.
[162] Isaac (2007), p. 15.
[163] De Bernardo Stempel (1990), pp. 31-2, 35.
[164] McCone (1996), pp. 48-49.

kou̯irjo/ā > Volscan *couehriu*, Lat. *cūria*.[165] One can notice however that the number of examples is quite scanty.

*1. *mu̯* > *u̯*
2. specifically Celtic changes

*4.4. *u̯n > *bn*

McCone cites *au̯n-er* > *abn-er* > OIr. *amnair* 'maternal uncle',[166] from PIE. *h_2euh_2-n-er* where the suffix *-*er* is analogical with *$ph_2tēr$, *$meh_2tēr$, etc,[167] and *ou̯-no-s* > *obnos* > Gaul. *-obnus*, OIr. *omun*, MW. *ofuyn*, MBr. *oun*, from PIE. *$pou̯$-no-* (Lat. *pavor*). According to him, those words should also be related to OIr. *úath* < *ou̯-tu-* < *$pou̯$-tu-*.[168] However, Matasović describes this Proto-Celtic root as obscure and mentions several explanations, in particular a correspondence with Croat. *jéza* 'fear', Lith. *éngti* 'to strangle', from PIE. *h_1eg^w-*. The labial stop *-b-* would therefore, at least in this case, come from the regular change *g^w > *b*.[169]

If the development *u̯n > *bn* is true, it must have happened before *pn > *u̯n*,[170] otherwise we would expect **supnos* > **su̯nos* > **subnos* > *OIr. **somun* instead of *súan*.

1. *u̯n > *bn*
2. *pn > *u̯n*

*4.5. *i̯e > *i, *ei̯e > *ē > *ī*

For the rule *i̯e > *i* we can find:

- *gab-i̯e > *gabi* > Gaul. *gabi*, OIr. *gaib* 'take!'[171], presented by McCone as *i*-presents, also interpreted as such by Kortlandt. [172]

Isaac adduces two other examples:[173]

- *(s)nig^{w}ieti > *nigieti > *nigiti* > OIr. *nigid* 'washes'
- *g^{wh}ed^{h}ieti > *g^{w}editi* > OIr. *guidid* 'prays'.

He posits this rule after the loss of laryngeal after a vowel and before a consonant (*VHC > *V̄C*) because of W. *cno-(af)* 'bite, gnaw' < **knāiti* < **knāi̯eti* < **knah$_2$i̯eti*, where the Welsh vocalism requires a long **ā*. If the order was reversed, the development would have been **knah$_2$iti* > **knăiti* > ***knait*.[174] It would be possible, however, to derive this long **ā* from the regular development of *CRHC > *CRāC*: **knh$_2$-i̯e-ti* > **knāi̯eti* > **knāiti*. Except from considering it as a Celtic change, it seems that nothing more can be said about its chronology; Isaac manages to put it in the 19th position of his chronology (out of 24), but it is

[165] Schrijver (2016), p. 494.
[166] McCone (1996), p. 49.
[167] Matasović (2009), *s.v. *awon-tīr*.
[168] McCone (1992), p. 103-106.
[169] Matasović (2009), *s.v. *obnu-*.
[170] McCone (1996), p. 49.
[171] *ibid*.
[172] Kortlandt (2007), p. 137.
[173] Isaac (2007), p. 68.
[174] *ibid.* pp. 69-70.

merely a *terminus ante quem*.[175] Furthermore, if Isaac's hypothesis about the simplification of **ǵʰdies* 'at the day' > **ǵʰdʰes* is to be admitted, it must have occurred before **ie* > **i*. This change will not be considered in our final chronology since it cannot be situated.

For **e̯ie* > **ī*:

- **sonh-eie-ti* > Celtib. *uer-zoniti*.[176]

The change **eie* > **ī* would have had an intermediary stage **ē,* which means that we must posit it before **ē* > **ī*. The word **gab-ie-* is also related by McCone to Celtib. *kabizeti* < **gabiyeti* where **iy* would have become **z*,[177] however in this explanation, he does not seem to take into account the rule **ie* > **i*, which would probably generate ***kabiziti* or ***kabīti*. At least we can say that this verbal suffix and its various evolutions in Celtic would deserve a further analysis.

1. **eie* > **ē*
2. **ē* > *ī*

5. Vowels

*5.1. *eRă > ăRă*

This rule was first presented by Joseph in 1982 and is based on the following development:[178]

- **dmh₂-to-* >> **demh₂-to-* > **demato-* > **damato-* > OC. *dauat* 'sheep', MW. *dafad,* MoBr. *dañvad*, to be compared with Gr. *ἀ-δάματος* 'untamed'. In Greek, we find a zero-grade, but for Celtic, Joseph explains the e-grade by an 'Indo-European vrddhi', that is to say the introduction of a full-grade to an adjective which was substantivized. As Schrijver notices, it is possible however to reconstruct a zero-grade (Gr. *ἀ-δμήτος*), and a normal development of a vocalic nasal:[179] **dmh₂eto-* > *damh₂eto* > **damato-* (**R̥C* > *aRC* before **CHV* > *CV*, see 1.2.).
- **(h₁)el-r-sko-* > **elarsko-* > **alarsko-* > MW. *alarch* 'swan', MoBr. *alarc'h*, to be compared with Lat. *olor* 'swan'. In Old Irish we find *elu*, possibly from **elon-*, which would explain why Joseph's rule did not apply.[180]
- **h₁elHn-* > **elan-* > **alan-* > MW. pl. *alanet* 'doe, hind', to be compared with Gr. *ἐλλός*, Lith. *álnė*, OCS. *lani*, Arm. *eln*.[181] In Middle Irish we find *elit*, and in Gaulish *Elantia*, which comes from a different formation **h₁el-n-t-iH* > **elantī,* without the application of Joseph's rule. Such a development would mean that Joseph's rule happened before the vocalisation of interconsonatic nasals **R̥C* > *aRC*, otherwise we would have **elantī* > **alantī*.[182]

[175] Isaac (2007), p. 70.
[176] Eska (1989), pp. 116-117.
[177] McCone (2001), p. 486.
[178] Joseph (1982), pp. 35-42.
[179] Schrijver (1995), pp. 77-78.
[180] Matasović (2009), *s.v. *elV-*.
[181] Schrijver (1995), p. 78-79.
[182] Matasović (2009), p. 8.

- **telH-mō(n)* > **telamon* > **talamon* > OIr. *talam* ‘earth), to be compared with Gr. *τελαμών* ‘strap of a shield’. Those meanings would be derived from the verb ‘to support’. A zero-grade **tlH-mōn* > **talHmōn* could however also be reconstructed (Gr. *τλήμων* ‘patient’). Hamp proposed **tlH-e-mon*[183] but Schrijver clearly showed that the suffix was always **-mōn*, without **-e-* (Gr. *ἄκ-μων* ‘anvil’, *Skt. dhar-mán* ‘carrier’).[184]
- **terh₁tro-* 'auger' > **teratro-* > **taratro-* > OIr. *tarathar* ‘auger’, W *taradr*, MBr. *tarazr*, MC. *tardar*, Gal.Lat. *taratrum* (> Fr. *tarière*, Sp. *taladro*), to be compared with *Gr. τέρετρον*, Lat. *terebra* ‘auger’. In this case, a zero-grade, albeit proposed by Hamp (**trh₁-etrom* > **taretrom*),[185] is problematic in regard to the British development (**e* > *a* ?) and the pre-suffixal **-e-* which is attested nowhere.[186]
- **uelH-trom* > **uelatrom* > **ualatrom* > MW. *gwaladyr* ‘lord, leader’, OBr. *-gualatr*, where the root is to be compared with Lat. *ualēre*, OIr. *flaith*, Toch. B *walo*. Again, a pre-suffix **-e-* (**ulh₂-etrom* > **ualatrom*) is morphologically unlikely, as well as a zero-grade (**ulH-tro* > **ualatro-*).

Other instances were presented by Joseph but because of their lower reliability, they will not be mentioned here (see Schrijver (1995) pp. 73-94 for a full evaluation of this rule).

Some counterexamples are found in Old Irish, which Joseph explained by a limitation of his rule, **eRaCV* > **araCV*, discarding then such reflexes like OIr. aor. *do˙cer* ‘fell’ < **kerat* < **ḱerH-t*. For Schrijver, such a limitation has no phonetic ground, and it would be also possible that **kerat* was replaced by **keret*, by analogy with **berat* >> **beret*, giving OIr. *˙ber* instead of *˙beir* (with a palatal *-r-*).[187] As McCone notices, three assumptions are to be made, *˙ber* is not an orthographical variant of *˙beir*, *-r-* was depalatalized in *˙ber,* and *˙cer* is analogical of *˙ber*, which, according to him, is much less economical than Joseph’s explanation. He finally proposes quite an easy solution, but which requires to introduce another phoneme /æ/: in Proto-Celtic, **eRa* became **æRæ*, which, after the period of apocope in Primitive Irish, turned into **aRa* and **eR*. However, such a development would probably entail more variability between *-e-* and *-a-* in Celtic reflexes.

1. **CHC* > **CăC*
2. **eRa* > **aRa*
3. **R̥* > **aR*

5.2. **ē* > **ī*

Here is a typical Celtic change which does not create much debate. Long *ī* is maintained in Old Irish, except before a nasal and a voiceless stop where it became *e* (see 5.4.).

- **h₃rēǵs* > **rīgs* > OIr. *rí* ‘king’, OW. *ri*, Gaul. *Rigo-*, *-rix*, Celtib. *-reikis* /rīxs/. See Skt. *rāj-*, Lat. *rēx*.[188] The Celtiberian pronunciation is deduced by McCone by means of

[183] Hamp (1983), p. 91.
[184] Schrijver (1995), p. 84.
[185] Hamp, *ibid.*
[186] Schrijver (1995), p. 87.
[187] *ibid.*, pp. 88-89.
[188] McCone (1996), p. 59. Matasović (2009), *s.v. *rīg-*.

relative chronology: if this language had undergone **ō(C)# > *ū(C)#* (see 5.3.), then it must have known the very early change **ē > *ī*.[189]

- **seh₁-lo-m > *sēlom > *sīlom* > OIr. *síl* 'seed'. See Lat. *sēmen* (see 1.3.1.1).[190]

This change is also visible in all the kinship terms ending with the suffix **-tēr*. The vocalism is unchanged between Proto-Celtic and Old Irish, but long vowels were shortened in unstressed syllable in Primitive Irish, as the loanword *cugann* 'kitchen', from Lat. *coquīna*, shows it:[191] OIr. *athir* 'father' < **ph₂tēr, máthir* 'mother' < **meh₂tēr*, *bráthir* 'brother' < **bʰreh₂tēr*. See Gr. *πάτηρ, μήτηρ, φράτηρ*. This proves that when **ē* became **ī*, the laryngeal had had its colouring and lengthening effect and had clearly disappear, since PIE. **eh₁* and PIE. **ē* have the same reflex. For Isaac, however, this loss must follow **ē > *ī*.[192]

The development **h₂weh₁nto > wēnto > wīnto > winto* shows that **ē > *ī* must have happened before the Osthoff-type shortening **V̄RC > *VRC*.[193]

The development **(H)reid-* > PCelt. **rēd-o-* > Olr. *réidid* 'rides' proves that it pedates **eį > *ē*,[194] otherwise we would have **rīdo-* > OIr. ***rídid*.

1. **eh₁ > *eH*
2. **VH > *V̄* (total loss of the laryngeal)
3. **ē > *ī*
4. **eį > *ē, *V̄RC > *VRC*

5.3. **ō(C)# > *ū(C)#*

In Proto-Indo-European, this long vowel **ō* is only found in suffixes, case, and tense endings. It can come from:

- nominative singular of amphikinetic roots (see 'nephew' in 2.11.2), among which we find the agent suffix *-tōr,* which was lost in Celtic.
- first person singular active present *-ō*, probably from **-oH*: OIr. *-marbu* 'I kill'.
- ablative singular of thematic nouns **-ōd*[195]
- dative singular of thematic nouns **-ōi < *-ohei < *-o-ei*
- nominative plural of thematic nouns **-ōs < *-o-es*

It must be noted that the thematic genitive plural is sometimes reconstructed as **-ōm*, which leads McCone to suppose a shortening of **ō* before a nasal.[196] For Beekes, however, the Old Irish evidence simply points to PIE. *-om*, instead of **-ōm*,[197] but then it does not explain why we have Celtib. *-um* instead of ***-om*. McCone explains this Celtiberian vocalism by

[189] *ibid.*, p. 16.
[190] Matasović (2009), *s.v. *sīlo-*.
[191] McCone (1996), p. 110.
[192] Isaac (2007), p. 70.
[193] Matasović (2009), p. 8.
[194] *ibid.*, p. 9.
[195] Beekes (2011), p. 213. Also for the following case ending reconstructions.
[196] McCone (1996), p. 61.
[197] Beekes (2011), p. 213.

supposing that this language tried to maintain the opposition between PC. acc. pl. *-*om* and gen. pl. *-*om* by a vocalic raising in the latter *-*ŏm* > Celtib. -*um*.[198]

The traditional interpretation is that -*ō#* developed into -*ū#* before the general change -*ō-* > -*ā-*. Indeed, if the contrary had to be supposed, we would find -*ā-* everywhere (**kwōn* > OIr. ***cá*, instead of *cú* 'dog').[199] However, the chronology of this change has been debated by Villar and De Bernardo Stempel on the basis of Celtiberian evidence. Villar showed that this development is much more recent than we expected, since several Celtiberian coin legends present an *ō*-vocalisme in the nom. pl. -*oś*, gen. pl. -*om*, dat. sg. -*oi*, in -*ō-* (gen. pl *belikiom, kontebakom* < PIE. -*ōm*, nom. pl. *teitiakoś, lutiakoś* < PIE. -*ōs*)[200]. On the other hand, inscriptions from Botoritta only show a *u*-vocalism, which is explained by a higher tendency to archaism in the numismatic use.[201] It also appears that nominative singular *n*-stems always present an *u*-vocalism (*abulu, letontu* < PIE. -*ōn*) whereas we find an *o*-vocalism in the genitive singular (*śekilako, laśtiko* < PIE. abl. sg. -*ōd*). This leads Villar to establish the following chronology:[202]

*1. *ōn# > ū#, *ōd > ō*, and **ō > *ā* in the first syllable, before the written documentation.

*2. *ōi#, ōm#, ōs# > *ūi#, ūm#, ūs#* during the period of written documentation.

One of the problems is to specify how **ō* becomes **ā only* in the first syllable. Villar's assumption is based on Celtib. *śua* 'so' derived from **swō,* he omits however that it could also be reconstructed as **swād.*[203] He also proposes that the *n*-stem gen. sg. *letontunoś* < -*ōnos* proves that **ō* becomes **ā* only in initial syllable, whereas an analogy with the nominative *-*ōn# > *-ūn* is quite plausible, compared with the lautgesetzlich outcome (*letontu*, ***letontānoś*). Then, it is not necessary anymore to create such a distinction. Moreover, **ō > *ā* also appears in OIr. gen. pl. *(in)na*^{N}, in auslaut. On this specific development, McCone refuses the development **sindōm > sindām > OIr. inna*^{N} and prefers to see a spread of the feminine form **sindās, sindāsom.*[204]

De Bernardo Stempel tried to subsume this chronology in the common Celtic one by proposing the following rules:

- **ō > ā* in internal position
- **ō(V)# > u(V)#*
- **ōC# > ō(C)# > u(C)#*

However, we prefer here to follow the more economical explanation of McCone by positing **ōC# > ō(C)# > u(C)#* before **-ō- > -ā-*.

*1. *ōC# > ō(C)# > u(C)#*

[198] McCone (1996), pp. 57, 61.
[199] Matasović (2009), p. 8.
[200] Villar (1990), p. 200.
[201] *ibid.*, p. 201.
[202] *ibid.*, pp. 204-205
[203] De Bernardo Stempel (1993), pp. 40-41.
[204] McCone (1996), p. 60.

*2. *ō > *ā*

*5.4. *V̄RC > *VRC*

This change can easily be compared with Osthoff's law which describe, in Greek, the shortening of a long vowel before a resonant and a consonant: **ǵneh₃-nt-es > *gnōntes > γνόντες*.

In regard to relative chronology, it is important to relate this change to other developements of long vowels. McCone proposed that **ē > *ī* took place before the shortening: **h₂ueh₁nto- > *uēnto- > *uīnto- > *uinto-* > MW. *gwynt* (m.) 'wind', MBr. (m.) *guent*, **u̯īnta > *u̯intā* > OIr. *fet* (f.) 'whistling sound', to be compared with Lat. *uentus* 'wind', Skt. *vā́ta-*, Lith. *vė́tra* 'storm' (with an acute proving the presence of a laryngeal). The problem is that British reflexes do not account for the vocalism of this word because **ĕ* and **ĭ* merged before a nasal and a stop (PC. **sentu-* > MW. *hynt*, MBr. *hent*), but in Old Irish, both vowels remained distinct, according to Schrijver,[205] which explains why he rather reconstructs **uēntos > *uĕntos*, only for British.[206] The correspondence with OIr. *fet* (feminine) is presented by McCone with the reconstruction **widā*, where **ā* can explain the lowering of **i* to *e*. Schrijver also proposed to relate OIr. *sell* 'iris of the eye, eye, glance' with MW. *syllu* 'gaze at', Br. *sellout* 'watch', reconstructing the form **sillo- < *stīrlo < *h₂stēr-lo-* where the word for 'star' (Lat. *stēlla*, Gr. *ἀστήρ*) would have been taken metaphorically to describe the iris, which would match quite well with PC. *sāwol-* 'sun' and its semantic treatment in Old Irish *súil* 'eye'. If such a link is to be made, W. *-y-* would indeed be the regular reflex of short **ĭ*.[207]

This Osthoff-like development would also have taken place after **ō > *ā*, as exemplified by **kōrd- > *kārd- > *kard-* > OIr. fo:*caird* 'threw, put' where the long **ō* would come from the Celtic perfect sg. **Ce-CoT-*, pl. **CōT-*.[208]

1. **ē > *ī, *ō > *ā*
2. **V̄RC > *VRC*

*5.5. *ō > *ā*

As was shown in 1.3.1.3 and 1.3.2., the regular reflex of PC. **ō < *oH, *eh₃* is **ā*. The PIE long vowel **ō* is only found in final syllable, therefore there is no reflex of this sound since they all became **u* in that position (see 5.3.). Kortlandt reconstructs the 1st. sg. ending **-ōro* in the present intransitive middle and explains the development OIr. *-moiniur < *maniōro* by an analogy with the active **-ō* > OIr. *-u*.[209] For a deeper analysis, refer to the already mentioned words in the previous sections.

- **moHro-* > *māro-* > OIr. *már* 'great'

[205] Schrijver (1995), pp. 29-30.
[206] *ibid.*, p. 158.
[207] *ibid.*, pp. 421-422.
[208] McCone (1986), p. 237.
[209] Kortlandt (1981), p. 46, fn. 13.

- **deh₃-* > **dānu-* > OIr. *dán* ‘gift’.
- **HoHmó-* > **ōmó-* > *ŏmó-* > OIr. *om.*
- **kōrd-* > **kārd-* > **kard-* > OIr. fo:*caird* ‘threw, put’: before **V̄RC* > **VRC* (see 5.4.)

1. **eh₃* > *ō, *oH* > *ō,*
2. *Dybo’s law*
3. **ō* > *ā*
4. **V̄RC* > **VRC*

*5.6. *eį > *ē*

This monophthongisation takes place when **i* is vocalic, whereas consonantal **į* in the sequence **eįe* gives **ī* (see 4.5.). That law can be seen in:

- **(H)reid-* > **rēd-o-* > OIr. *réidid* ‘he rides’, Gal.Lat. *rēda* ‘chariot’, *uerēdus* ‘post horse’.[210] See OE. *rīdan* ‘to ride’,[211] Lith. *riedė́ti* ‘roll’
- **deiuo-* > Gaul. *Deuo-* ‘god’,[212] Celtib. *teiuo-*, OIr. *día* (*é* regularly develops into a diphthong *ía*). See Skt. *devas*, Lat. *diuus*.[213]

Concerning the pronunciation of {ei}, McCone notices that there is a fluctuation between {e} and {ei}, for example in *areikoratikos* and *arekoratika*,[214] moreover, the Iberian alphabet, which the Celtiberian adopted, came from the Phocaean Greeks who colonised Iberia in the beginning of the 6th century, and who spoke an East Ionic dialect where the diphthong /ei/ had already monophthongised (*ἐκοσι* for Attic *εἴκοσι*, an inscription found in Ampurias, a port in the north of actual Catalonia). The Iberian/Celtiberian spelling {ei} would reflect the archaic Ionic written form {ει} which stood for the pronunciation /ē/ in all those languages.[215] The same phonetic realization could then be assigned to the dative singular ending in *LUGEI* ‘to Lug’ (Latin alphabet) and *GENTE, STENIONTE*.[216]

For Lepontic, McCone mentions the dative singular *PIUONEI* which leads to think that **ei* > *ē* was a very late change, maybe not shared by all branches.

*5.7. *eu̯ > *ou̯*

The vowel **e* becomes **o* before vocalic **u̯*:

- **teuteh₂* > **teutā* > **toutā* > OIr. *túath* ‘people’, MW, MBr. *tut*, Co. *tus*, Gaul. *Touto* (name), Celtib. *Toutinikum* (name). See Go. *þiuda*, Lith. *tautà*.[217]
- **keud*^{h}- > MW. *cudd*, MBr. *cuz* ‘hide’. See Gr. *κεύθω*.[218]

[210] Matasović (2009), *s.v. *rēdo-, *rēd-o-, *ufo-rēdo-*.
[211] Kroonen (2010), *s.v. *rīdan*.
[212] McCone (1996), p. 63.
[213] Matasović (2009), *s.v. *dēwo-*.
[214] Villar (1995), p. 127.
[215] McCone (1996), pp. 15-16.
[216] Villar (1995), p. 91.
[217] Matasović (2009), *s.v. *towtā*.
[218] *ibid., s.v. *kowdo-*.

- **neu-io-* > **nouio-* > OIr. *núae*, MW. *newydd*, Br. *nevez*, MC. *noweth*, Gaul. *Nouio-*.[219] The development of Welsh and Breton *e* seems to be later.
- **h₁eu-n-* > **eun-* > **oun-* > OIr. *úam* 'cave, den'. See Gr. *εὔνις* 'deprived', Arm. *unayn*.[220] PC. **e* from PIE. **h₁e* acts exactly like PIE. **e*.

McCone mentions various written forms for the Gaulish term: *τοουτιος, -τοουτα*, TOUTAS (in Lugano alphabet), *touti-* (in Latin alphabet) which all point to a diphthong /ou/ or /oū/. The form *Teutates* remains surprising; for Matasović it can be the spelling of a diphthong that did not exist in Latin ({EU} > Lat. /eu/, but Gaul. /ou/);[221] Delamarre mentions the forms *teuta* and *touta* as traces of the ongoing change **eu̯* > *ou̯*. The same variation appears in Gaul. *Leucus, Loucis* 'bright, shining' (Gr. *λευκός*), and in the Pannonian toponym *Neuio-dunon*. In Late Gaulish, *ou* was monophthongised and raised: *Tota, Tuta*.[222] The same monophthongisation took place in Insular Celtic since Old Irish *úa* reflects **ō*. Given that this development seems to be taking place in various locations during the beginning of the historical period, it is safer to assume that this change, albeit shared, does not reflect necessarily a common change in the unified language of a specific community but rather a long-term change that was bound to take place, although the languages and their speakers had already split geographically.

*5.8. *uu̯ > *ou̯*

- **supno-* > **suu̯no* > **sou̯no-* > **sōno-* > OIr. *súan*, MW, MBr. OC. *hun* (see 2.10.). **ō* > OIr. *úa*, PBrit. *ū* > MW. Br. *u*.[223]

MW. *creu* 'blood' is related to OIr. gen. sg. *crú* and Lat. *crūdus*, Gr. *κρέας*, Skt. *kravíḥ*, from **kruh₂-ós*. A Proto-Celtic form like **krū-* (OIr. *crú*) would develop into MW. *cri* (**kū* > MW. *ci* 'dog'),[224] so here we must reconstruct an ablauting form, PGa. **krū-* for Irish nominative, PBrit. **krou-* for Welsh, and Old Irish genitive.[225]

For the word 'two', Cowgill reconstructed PCl. **du̯o-* > PBrit. *dou̯o-* > OW. *dou*, MC. *dow*, OBr. *dou*. and OIr. *dóu*.[226]

No example was found in Celtiberian an Gaulish for this probably very late development.

*1. *pn* > **u̯n*
*2. *uu̯* > **ou̯*

[219] *ibid., s.v. *nowyo-*.
[220] *ibid., s.v. *owmā*.
[221] *ibid., s.v. *towtā*.
[222] Delamarre (2003), *s.v. teuta, touta*; *leucos*; *nouiios*.
[223] Schrijver (1995), p. 192.
[224] Matasović (2009), *s.v. *krū-*.
[225] Schrijver (1995), p. 330.
[226] Cowgill (1985), p. 20-25.

II. A relative chronology

The following relative chronology tries to embrace all the possibilities that have not be limited by any argument. For that reason, it is impossible to establish one clear and well-ordered chronology but rather some broad indications. Twenty-nine rules are ordered but the following rules have been excluded either because it was impossible to relate them to other changes or since they are considered as doubtful:

- **CRHC > *CRăC*
- **-sl/m/n- > *-ll-/-mm-/-nn-*
- **-i̯e- > *-i-*
- **eu̯ > *ou̯, *uu̯ > *ou̯:* those rules are probably recent and could be put in the last stage, or after, since the written material attests that they are in progress in Continental Celtic.

The laws in boldface define the relative sub-periods. For example, we know that **CLT > *CLiT* is one of the earliest changes of Proto-Celtic because it is before **R̥ > *aR*, which is before **pn > *u̯n*, which is before **p > Ø*, which is before **ē > *ī,* which is before **ei̯ > *ē*, however the change **pL > *bL* could be before or after **CLT > *CLiT*, before or after **R̥ > *aR*, before or after **pn > *u̯n*, what is sure though is that it must be before **p > Ø*. As a consequence, the *terminus ante quem* (*a.q.*) of **pL > *bL* is situated among the very early Proto-Celtic changes (**CLT > *CLiT* and **eRa > *aRa*), and its *terminus post quem* (*p.q.*) is strictly situated before **p > Ø*.

The sub-period 3.6b. gathers all the changes that must take place after the changes of the sub-period 3.6. For example **g^w > b* (before **D^h > D*) could happen in 3.5. (before or after **ē > *ī*) and 3.6. (before or after **ei̯ > *ē*), so **D^h > *D* could take place in 3.6. and after 3.6.

1. Late Indo-European changes:
   - *1.1.* **Ḱ > *K*
     **TK > *KT*
     **$T^{[dental]}T^{[dental]}$ > *t^st*
     **HV > *V*
     **VH > *V̄(H)*
     **#HC > #C*

2. Italo-Celtic changes
   - 2.1. ****CRHC > *CRāC***: before Dybo's law, **CHC > *CaC*
   - *a.q.* **CHC > *CC:* before **$T^{[labial/velar]}t/s$ > *$\chi t/s$*
   - *a.q.* **pe(R)k^w > *k^we(R)k^w*: before **p > Ø*, **$T^{[labial/velar]}t/s$ > *$\chi t/s$*
   - *a.q.* **HRC > *aRC*: before **CLT > *CLiT*
   - *a.q.* **RDC > *RaDC*: before **CLT > *CLiT*, **R̥ > *aR*
   - *a.q.* **mu̯ > *u̯*

   - 2.2. **Dybo's law**: before **ē > ī*, **ō > *ā*

CHC > *CaC: before **pL > *bL*, **eRa > *aRa*, **pn > *u̯n*

p.q. **CHC > *CC:* before **T[labial/velar]t/s > *χt/s*

p.q. **pe(R)k^w > *k^we(R)k^w*: before **p > Ø*, **T[labial/velar]t/s > *χt/s*

p.q. **HRC > *aRC*: before **CLT > *CLiT*

p.q. **RDC > *RaDC*: before **CLT > *CLiT*, **R̥ > *aR*

p.q. **mu̯ > *u̯*

3. The Proto-Celtic stage

3.1. ***CLT > CLiT***: before **R̥ > *aR*, **T[labial/velar]t/s > *χt/s*

eRa > *aRa: before **R̥ > *aR*

a.q. **pL > *bL*: before **p > Ø*

a.q. **g^w > *b:* before **D^h > *D*

a.q. **u̯n > *bn:* before **pn > u̯n*

a.q. **ō(C)# > *ū(C)#*: before **ō > *ā*

a.q. **eie > *ī:* before **ē > *ī*

3.2. ***R̥ > *aR***: before **CHV > *CV*, **pn > *un*

**pL > *bL*: before **p > Ø*

**g^w > *b:* before **D^h > *D*

a.q. **D^h > *D*

p.q. **u̯n > *bn:* before **pn > *u̯n*

**ō(C)# > *ū(C)#*: before **ō > *ā*

a.q. **ō > *ā*: before **V̄RC > *V̆RC*

a.q. **T[labial/velar]t/s > *χt/s*: before **p > Ø*

**eie > *ī:* before **ē > ī*

3.3. ***pn > *un***: before **p > Ø*

a.q. **CHV > *CV*

**g^w > *b:* before **D^h > *D*

**D^h > *D*

**ō(C)# > *ū(C)#*: before **ō > *ā*

**ō > *ā*: before **V̄RC > *V̆RC*

**T[labial/velar]t/s > *χt/s*: before **p > Ø*

p.q. **pL > *bL*: before **p > Ø*

**eie > *ī:* before **ē > *ī*

a.q. **V̄RC > *V̆RC*

3.4. ***p > Ø***: before **ē > *ī, *ei̯ > *ē*

**CHV > *CV*

**g^w > *b:* before **D^h > *D*

**D^h > *D*

p.q. **eie > *ī:* before **ē > *ī*

**ō(C)# > *ū(C)#*: before **ō > *ā*

**ō > *ā*: before **V̄RC > *V̆RC*

*$\bar{V}RC$ > *$\check{V}RC$

3.5. ***$\bar{e}$ > *$\bar{\imath}$***: before *$\bar{V}RC$ > *$\check{V}RC$, *$e\underset{\circ}{\imath}$ > *$\bar{e}$
*CHV > *CV
*g^w > *b: before *D^h > *D
*D^h > *D
p.q. *$\bar{o}(C)\#$ > *$\bar{u}(C)\#$: before *$\bar{o}$ > *$\bar{a}$
*$\bar{o}$ > *$\bar{a}$: before *$\bar{V}RC$ > *$\check{V}RC$
*$\bar{V}RC$ > *$\check{V}RC$

3.6. ***$e\underset{\circ}{\imath}$ > *$\bar{e}$***
p.q. *CHV > *CV
p.q. *g^w > *b: before *D^h > *D
*D^h > *D
p.q. *$\bar{o}$ > *$\bar{a}$: before *$\bar{V}RC$ > *$\check{V}RC$
*$\bar{V}RC$ > *$\check{V}RC$

3.6. bis
p.q. *D^h > *D
p.q. *$\bar{V}RC$ > *$\check{V}RC$

A mathematical approach of the notion of relative chronology[227]

The chronology given above might not be entirely satisfying since a lot of orders can be established. This last section is quite accessory considering the chronology of Celtic changes, but it can help to understand what kind of work it is to create what should be seen in a more general mathematical framework. Indeed, all the changes can be considered as the elements of a set. To present only one relative chronology (an ordered set), it would be needed to have a linearly (or totally) ordered set. However, as it will be demonstrated, relative chronology of phonetic changes can only produce a partially ordered set, since it is impossible to relate successively each change.

1. Let us suppose a set of n elements. Without any relation between those elements, it is possible to find $n!$combinations:
$n! = 1 \times 2 \times 3 \times \ldots \times n$

   For example, with four elements ($n = 4$), we can find 24 combinations: $n! = 1 \times 2 \times 3 \times 4 = 24$

   → We have four unrelated phonetic changes. In that case, all the changes can be in any position, 24 chronologies could be produced, which is not what we want. In

[227] Here, I would like to thank Quentin Gazda and Clément Guérin, PhD students in mathematics from the ENS de Lyon for having helped me to reconsiderate this thesis in a mathematical perspective, and Rémy Grünblatt, Doctor in computer sciences and member of the computer sciences association *Association pour la Libre Informatique à l'ENS de Lyon*, who introduced me the software that could order my data.

our case, 31 elements make $8{,}22.10^{33}$ combinations. At that stage, no relative chronology can be established.

2. If we want to order those elements, we need to posit binary relations. For *n* elements, there should be *n - 1* immediate relations (*r* the number of immediate relations in a linearly ordered set).

   If $n = 4$
   and if $r = n - 1$
   then $r = 4 - 1 = 3$
   There should be 3 immediate relations.

   $$if\ a > b, b > c, c > d, then\ a > b > c > d$$

   Here there are three relations and one possible combination. This is called a linearly ordered set. In our case, there would be at least 30 immediate relations to establish one chronology.

3. For *n* elements, there can be, at most, *S* conditions:

   $$S = \sum_{i=1}^{n-1} i$$

   For a linearly ordered set of 4 elements (*n=4)*, there are, at most, 6 possible relations: $S = \sum_{i=1}^{4-1} i = 1 + 2 + 3 = \mathbf{6}$

   $$If\ a > b, a > c, a > d, b > c, b > d, c > d\ then\ a > b > c > d$$

In our case, 465 relations can be (very) theoretically found, in which case only one chronology would be presented.

4. Let us suppose now not a linearly ordered set but a partially ordered set, that is to say a set where at least one relation is missing. For example, in the set *E* with elements *a*, *b*, *c*, *d*, if we have five relations, a situation where just one, but essential, because it is immediate, is missing:
   $a > b, a > c, a > d, b > d, c > d.$
   Then we can say:
   If $\boldsymbol{a} > b, c > d$
   Then $a > \boldsymbol{b} > c > d$
   $a > \boldsymbol{c} > b > d$

   We cannot relate *b* with *c* and *c* with *b*. Therefore, one necessary relation is missing, namely $b > c$ *or* $c > b$. Then to have a totally ordered set, we need to know the relation between *b* and *c*.

   The fact that we have 3 relations, which is the number of relations we need to establish a totally ordered set, does not mean that we can have a totally ordered set, since some of those relations are useless, and some other are necessary.

5. The interesting point is that no matter how many relations we find between non-immediate events, there will always be more than one combination, or to put it another way, only a strict list of immediate events can produce one series. Once considered this fact, it appears clearly that it is impossible to relate successively all the linguistic changes and that we can only find several chronologies.

In spite of the number of relations that was found in this paper, once put in a lineary extension run on Python that can print all the possible combinations (such a work would be indeed

unfeasible for a human), their number is still tremendously huge. It seems to be quite an interesting lesson about what is often presented as a very clear and neat succession of events, whereas the truth is that thousands of different combinations, despise all the work that was done by the linguist, are still conceivable.

Conclusion

The chronology of Celtic sound changes is particular because of the periodicity that we can establish, if one acknowledges the relevance of an Italo-Celtic stage. Secondly, most of the relations are based on the unique (at least in the Indo-European area) gap of the voiceless bilabial stop **p*.

Some uncertainties remain regarding to the development of **ō* in final and internal position, where the Celtiberian material brings still some debate. The interpretation of IE stops can be hardly helped by Celtic developments since no rule seems to oppose series II and series III, whatever their exact phonetic realization may have been.

The relative chronology that is given here is still quite unclear since a lot of combinations can be conceived. It must be noticed that it is not very different from the one given by Matasović and Isaac but I hope that it shows more obviously and honestly how unsure the order is, and what precaution should still be taken.

Bibliography

ALBB: Le Roux, P. (1927) *Atlas Linguistique de Basse-Bretagne*. Paris: Librairie E. Droz.

BEEKES, R. S. P. (2011) *Comparative Indo-European Linguistics: An Introduction*. Revised and corrected by Michiel de Vaan. Amsterdam/Philadelphia: John Benjamins Publishing Company.

DE BERNARDO STEMPEL, P. (1987) *Die Vertretung der indo-germanischen liquiden und nasalen Sonanten im Keltischen*. Innsbruck: Innsbrucker Beiträge zur Sprachwissenschaft.
— (1990) "Einige Beobachtungen zu indogermanischem /w/ im Keltischen", in: Ann T. E. Matonis, Daniel Frederick Melia, *Celtic language, Celtic culture. Festschrift for Eric P. Hamp*, Van Nuys: Ford & Bailie.
— (1993) 'Probleme der relativen Chronologie: nochmals zu idg. **ō* im Keltischen', *Deutschsprachige Keltologen*, pp. 37-56.
— (1999) *Nominale Wortbildung des älteren Irischen, Stammbildung und Derivation*. Tübingen: Niemeyer.

COWGILL, W. (1970) 'Italic and Celtic superlatives and the dialects of Indo-European', G. Cardona (ed.) *Indo-European and Indo-Europeans*. Philadelphia: University of Pennsylvania Press, 113–153.
— (1980) 'The etymology of Irish *guidid* and the outcome of **g^{w}h* in Celtic', in: Mayrhofer, M. (ed) *Lautgeschichte und Etymologie*. Wiesbaden.
— (1985), 'PIE **duu̯o* '2' in Germanic and Celtic, and the nom.-acc. dual of non-neuter *o*-stems', *Münchener Studien zur Sprachwissenschaft*, 46, pp. 13-28.

DELAMARRE, X. (2003) *Dictionnaire de la langue gauloise : une approche du vieux-celtique continental*. Paris: Errances.

DESHAYES, A. (2003) *Dictionnaire étymologique du breton*. Douarnenez: Le Chasse-Marée.

DUNKEL, G. (1980) 'Ennian *atque atque; prope*', *Glotta* 58, pp. 97-103.

DYBO, V. (1961) 'Sokraščenie dolgot v kel'to-italijskix jazykax i ego značenie dlja balto-slavjanskoj i indoevropejskoj akcentologii', *Voprosy slavjanskogo jazykoznanija* 5, pp. 9-34.

ESKA, J. F. (1989) *Towards an interpretation of the Hispano-Celtic inscription of Botorrita.* Innsbruck: Innsbrucker Beiträge zur Sprachwissenschaft.
— (1998) 'PIE **p* ≻ Ø in Proto-Celtic.' *Münchener Studien zur Sprachwissenschaft*, 58, pp. 63-80.

HAMP, E. (1983) 'Varia XII OIr. *talam, tarathar*', *Etudes celtiques*, 20/1, p. 91.

Hoenigswald, H. M. (1973) 'Indo-European **p* in Celtic and the claim for a relative chronology', *The Journal of Indo-European Studies*, pp. 324-329.

ISAAC, G. R. (2007) *Studies in Celtic Sound Changes and Their Chronology*. Innsbruck: Innsbrucker Beiträge zur Sprachwissenschaft.

JACKSON, K. (1953) *Language and History in Early Britain*. Edinburgh: The University Press.

JOSEPH, L. (1982) ‘The treatment of *CR̥H- and the Origin of CaRa- in Celtic’, *Ériu,* 33, pp. 31-57.

KORTLANDT, F. (1981) ‘More evidence for Italo-Celtic’, *Ériu,* 32, I-22. In: Kortlandt, F. (2007) *Italo-Celtic origins and prehistoric development of the Irish language,* Amsterdam/New York: Rodopi, pp. 25-50.
— (2006) ‘More on the Celtic verb’. In: Kortlandt, F. (2007) *Italo-Celtic origins and prehistoric development of the Irish language*. Amsterdam: Rodopi, pp. 133-147.

KROONEN, G. (2010) *Etymological Dictionary of Proto-Germanic*. Leiden/Boston: Brill.

LOTH, J. (1884) *Vocabulaire vieux-breton*. Paris: F. Vieweg.

LUBOTSKY, A. (2006) ‘Indo-European “heel”’, in: R. Bombi et *alii* (eds), *Studi Linguistici in onore di Roberto Gusmani*, Alessandria: Edizioni dell’Orso, pp. 1005-1010.

MADDIESON, I. (1984) *Patterns of Sound*. Cambridge: Cambridge University Press.

MATASOVIĆ, R. (2009) *Etymological Dictionary of Proto-Celtic*. Leiden/Boston: Brill.
— (2012), ‘Dybo’s law in Proto-celtic’, *Zeitschrift für celtische Philologie*, 59, pp. 129-141.

MCCONE, K. R. (1986) ‘From Indo-European to Old Irish: conservation and innovation in the verbal system’, in: Ellis Evans, D., Griffith, J. G., Jope, E. M. (eds) *Proceedings of the Seventh International congress of Celtic studies, held at Oxford, from 10th to 15th July*, Oxford.
— (1992) ‘OIr. *aun* ‘river’ and *amnair* ‘maternal uncle”’, *Münchener Studien zur Sprachwissenschaft*, 53, pp. 99-100.
— (1996) *Towards a Relative Chronology of Ancient and Medieval Celtic Sound Changes,* Maynooth Studies in Celtic Linguistics 1, Maynooth: Department of Old Irish, St. Patrick’s College.
— (2001) ‘Celtibérico, Celta continental y Celta común’. In: Villar, F. and Fernández Álvarez, M. P. (eds) *Religión, lengua y cultura prerromanas de Hispania*. Salamanca: Ediciones Universidad de Salamanca. pp. 483-494.

MEISER, G. (1998), *Historische Laut- und Formenlehre der lateinischen Sprache,* Darmstadt: Wissenschaftliche Buchgesellschaft.

PRÓSPER PÉREZ, B. M. (2013) ‘Sifting the evidence: new interpretations on Celtic and non-Celtic personal names of Western Hispania in the light of phonetics, composition and suffixation’, García Alonso, Juan Luis (ed.), *Continental Celtic word formation: the onomastic data*, Aquilafuente 197, Salamanca: Ediciones Universidad de Salamanca, pp. 181–200.

PEDERSEN, H. (1909-1913) *Vergleichende Grammatik der keltischen Sprachen I, II*, Göttingen: Vandehoeck und Ruprecht.

SCHINDLER, J. (1977), ‘A thorny problem’, *Die Sprache,* 23, pp. 25-35.

SCHRIJVER, P. (1991) *The Reflexes of the Proto-Indo-European Laryngeals in Latin.* Amsterdam: Rodopi.
— (1993) ‘Varia IV. Olr. *deec, deac’*, *Eriu* 44/1993: pp. 181-184.

— (1995) *Studies in British Celtic Historical Phonology*, Leiden Studies in Indo-European 5. Amsterdam: Rodopi.
— (2016) 'Sound change, the Italo-Celtic linguistic unity, and the Italian homeland of Celtic', *Celtic From the West* 3*: Atlantic Europe in the Metal Ages — Questions of Shared Language*. J.T. Koch; B.W. Cunliffe (eds.), Oxford: Oxbow, 492-503.

SCHUMACHER, S., SCHULZE-THULIN, B., AAN DE WIEL, C. (2004) *Die keltischen Primärverben. Ein vergleichendes, etymologisches und morphologisches Lexicon*. Innsbrucker Beiträge zur Sprachwissenschaft 110, Innsbruck: Institut für Sprachen und Literaturen der Universität Innsbruck

SIHLER, A. (1995) *New comparative grammar of Latin and Greek.* New York - Oxford: Oxford University Press.

SILVESTRI, D. (1970) 'Lat. *cunctus,* itt. *pankuš*', *Eurasiatica* 6, pp. 3-16;

STEINBAUER, D. (1989) *Untersuchungen zu den bei Plautus belegten Verben der lateinischen ersten Konjugation. Unter besonderer Berucksichtigung der Denominative.* Dissertation Regensburg. Altendorf b. Bamberg: Druckerei Grabner.

THURNEYSEN, R. (1925) 'Gallisches'. *Zeitschrift für celtische Philologie,* 16, pp. 285-304.
— (1946) *A Grammar of Old Irish*, transl. from the German by D. A. Binchy and Osborn Bergin, Dublin: The Dublin Institute for Advanced Studies.

DE VAAN, M. (2008) *Etymological Dictionary of Latin and the other Italic languages*, Leiden/Boston: Brill.

VENDRYES, J. (1908) *Grammaire du vieil-irlandais (phonétique morphologie syntaxe).* Paris: E. Guilmoto.

VILLAR, F. (1990): 'Tratamiento de *-ō* en sílaba final, algunes posibles formas de imperativo en celtibérico', *Veleia*, 6, 1989, pp. 199-205.
— (1995) *Estudios de celtibérico y de toponomía prerromanas*. Salamanca: Ediciones Universidad de Salamanca.

WATKINS, C. (1966) 'Italo-Celtic Revisited', *Ancient Indo-European Dialects, Proceedings of the Conference on Indo-European Linguistics*, Berkeley/Los Angeles: University of California Press, pp. 29-50.

ZAIR, N. (2012) *The Reflexes of the Proto-Indo-European Laryngeals in Celtic.* Leiden/Boston: Brill.

ZINK, G. (1986) *Phonétique historique du français*. Paris: Presses Universitaires de France.